Communicating about the risks and benefits of genetically modified foods: effects of different information strategies

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COMMUNICATING ABOUT THE RISKS AND BENEFITS OF GENETICALLY MODIFIED FOODS: EFFECTS OF DIFFERENT INFORMATION STRATEGIES

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Preface

This report presents the results of the information strategies task in the project *Consumer Attitudes and Decision-making with Regard to Genetically Engineered Food Products* (CADE-GENTECH), funded by the European Commission through contract number FAIR-PL96-1667. The project was co-ordinated by Professor Klaus G. Grunert, The MAPP Centre at The Aarhus School of Business, Denmark. The participating organisations included the Technical Research Centre of Finland; Oy Panimolaboratorio-Bryggerilaboratorium, Finland; Chr. Hansen A/S, Denmark; University of Potsdam, Germany; ISIDA, Italy; and the Institute of Food Research, United Kingdom.

Executive summary

The research reported here aimed to investigate the effects of different types of information about genetically modified foods on both consumer attitudes towards genetic modification and their tendency to choose genetically modified products (compared to more traditionally manufactured alternatives).

The impact of information strategy (balanced, or product specific), attributed information source (The “European Association of Consumers”, the “European Association of Industry” or the “European Commission”) and type of product (yoghurt or beer) were systematically examined in the four European countries involved in the research. The effects of a classical advertising approach were also examined in Denmark and Germany.

The results indicated that

- Providing information does not increase acceptance of genetically modified foods. The reverse was found to be true.

- In all countries, consumers tended to select non-genetically modified products. Cross-national differences related to type of product were not very pronounced.

- Those respondents who had positive prior attitudes towards genetically modified foods were more likely to select genetically modified foods. These attitudes were not influenced by information provision.

- The form of information strategy about genetically modified foods was not important. However, the provision of information (in itself) was more likely to activate existing attitudes already held by respondents than change these attitudes.

- Labelling of genetically modified products alone was unlikely to result in attitude activation.

- These results are likely to be applicable only in cultures in which attitudes towards genetically modified foods are already well established. Information may have a different impact in countries in which the public have not been exposed to information about genetically modified foods.

- Information source characteristics do influence consumer choices regarding genetically modified foods. In particular, consumers are more likely to choose genetically modified products if the source providing information about them is perceived to be honest, and the information is product specific, or if the source is perceived to be dishonest, and the information is balanced and general in content.

- Industry was perceived to be more dishonest providers of information about genetically modified foods in Denmark, Italy and the United Kingdom, but not in Germany, where industry was as trusted as the other sources.

- Increased transparency might improve public trust in industry. However, the public are more likely to believe the European Commission or consumer organisations when communicating about genetic modification.

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Introduction

Foods produced with the help of gene technology are increasingly coming "on stream", and are being made available for purchase and consumption by the European consumer. Developments in food processing, food ingredients, functional foods and whole products mean that there are potential advantages for both producers and consumers. Some consumers and non-governmental organisations have argued, however, that the technology is too risky to develop further. It is essential to remember that issues associated with consumer preference and choice will be important determinants of how the public respond to these technological innovations in food production (Deliza, Rosenthal, Hedderley, MacFie & Frewer, in press). Experts in biotechnology have bemoaned public rejection of genetically modified foods as reflecting "ignorance" and "irrationality". These people have argued that the public should be "educated" to accept genetically modified foods.

It is not desirable or democratic to try to persuade consumers to accept genetically modified foods, as the debate about risk and ethics implies more than a marketing issue is at stake in the minds of the public. Rather, in the context of democratising science strategy, many would argue that increased public involvement in the debate about genetic modification and regulatory practice entails more effective information provision to enable individual citizens to enter the debate (Rowe & Frewer, 2000). However, providing information will enable consumers to make up their own minds about consuming genetically modified foods or not. It is also important to consider the effects of social context of information on consumer choice. Trust in science, regulatory systems and information providers may be as important as information provision in terms of influencing public responses to information about genetically modified foods (Frewer, 1998).

The aim of the research presented here was to determine whether different types of information strategy resulted in greater acceptance of specific genetically modified foods, and whether there was cross-cultural variation in the extent to which information provision was an influential determinant of consumer choice decisions regarding genetically modified products. In particular, the influence of information source on consumer reactions to genetically modified foods was systematically assessed in Denmark, Germany, Italy and the United Kingdom. Other attitudes known to be influential determinants of whether or not consumers select genetically modified foods were also assessed, both with respect to product choice, and as mediating factors between information provision and product selection. Perceived control was not found to be important in terms of attitudes in a previous task in the project (the survey), and so was not considered further in the current research.

The research forms one of the tasks in the EU funded project *Consumer Attitudes and Decision Making with Regard to Genetically Engineered Food Products* and has been directly informed by the other tasks in the project.

Consumer perceptions of genetically modified foods and the need to develop effective communication strategies

Research which has been directed towards understanding public perceptions associated with potential food hazards has largely, but not exclusively, focused on issues associated with risk and benefit. How the public defines risk and benefit, and how the experts define the same issues, may be very different. Non-experts should not be viewed as irrational. Rather public opinion should inform the debate about the strategic development of genetic modification. Research has demonstrated that risk perception is "socially constructed" – that is, the way that people represent risks psychologically is a more important determinant of the way in which people react to risks when compared to probabilistic risk assessments.

Risk perception research has demonstrated that risks which are perceived as involuntary and unnatural are viewed as more threatening than those over which people perceive they have a choice, even if the probability of occurrence of such a risk is very low (Slovic, 1993). In the case of genetically modified foods, consumer perceptions of choice are likely to be particularly relevant to acceptance or rejection of particular products. If people think that they have no choice about consuming genetically modified products, they are likely to be very negative towards them. In psychological terms, the threat value of genetically modified products is compounded by perceptions that genetic modification is unnatural, and the associated risks are poorly understood, (by science and the consumer).

Developing an effective risk-benefit communication strategy may improve people's understanding of genetic modification, so that they can make informed choices about whether to consume genetically modified foods or not. Whilst such an approach assumes an effective product labelling strategy, other influences may also determine whether or not genetically modified products are acceptable to the consumer. These may include, for example, perceived characteristics associated with the information source to which the information is attributed, the content of the information itself, the prior attitudes about genetic modification by consumers receiving the information, and product characteristics associated with particular applications.

Potential influences on consumer responses to information about genetic modification of food

Information source characteristics

Trust in information source is likely to be a particularly important determinant of public responses to that information. The importance of source characteristics has long been recognised in social psychological models of communication and attitude change (McGuire, 1985). Two major dimensions have emerged as being important in determining trust – that of "competence", the expertise held by the communicator and the extent to which they are able to pass on information about a particular subject area, and "honesty", the extent to which a communicator will be truthful in communication of information.

Expertise without honesty is unlikely to result in long-term changes in attitude. Moreover, trust appears to be linked to perceptions of accuracy, knowledge and concern with public welfare. Distrust is associated with perceptions of deliberate distortion of information, being biased, and having been proven wrong in the past. Sources which are perceived to be over-accountable, or protecting a vested interest, are not trusted to the same extent as sources which are not associated with these attributes. However, perceptions that a source is not accountable at all may also lead to distrust (Frewer, Howard, Hedderley & Shepherd, 1996). In the United Kingdom, government and industry sources are distrusted, NGOs, and environmental pressure groups, and the quality media highly trusted (Frewer et al., 1996; Miles & Frewer, in preparation). There is some evidence that differences in trust exist between different European countries, with the Scandinavian public being more likely to trust government than people from the United Kingdom and Southern Europe (Eurobarometer, 1998; Sjoeberg, in press).

Consideration of the extent to which a source is trusted or distrusted is very important if people's attitudes are not yet crystallised, as this information may influence the direction of attitude change (Frewer, Howard & Shepherd, 1998). Use has been made of one theory of persuasive communication called the "Elaboration Likelihood Model" or ELM (Petty & Cacioppo, 1984). The basic premise of the model is that there are two routes to persuasion, the "central" route and the "peripheral" route. Use of the central route results in in-depth processing of the information, whereas the peripheral route utilises external cues which are associated with the information to permit the person receiving the information to make simple inferences about the merits of its content without recourse to complex or elaborative processing.

The model assumes that people tend to engage in effortful processing activity only when they think it necessary, an effect prone to both individual and situational differences. Persuasiveness has been found to increase elaborative processing, and thus the likelihood that people will use the central route in processing the information. A similar effect is observed if the personal relevance of information is increased, or if trust in the information source providing the information is very high. Central processing is less likely to occur if the information is low in persuasive content and personal relevance, and attributed to a distrusted source.

An example of the utility of the ELM in understanding the importance of trust in risk communication is provided by an example involving genetic modification (Frewer, Howard, Hedderley & Shepherd, 1999). Other manipulations were embedded in the experimental design. These included perceived risk relevance, (either high – respondents were told that they were able to buy genetically modified food in shops at the time of the experiment, which was not the case at the time of data collection, or low – respondents were told that genetically modified foods would not be available to consumers for many years). The persuasive strength of the information supplied to people taking part in the experiment was also manipulated to be either high or low (where highly persuasive information promoted the benefits of genetic modification).

Thus the experimental work was conducted in two stages, the first being the pre-selection of messages of high and low persuasive strength about acceptance of genetic modification in food and agriculture. The second stage comprised of the systematic examination of the effects of perceived risk relevance, persuasive strength, and source credibility on elaborative processing and attitudes towards genetic modification. In the first stage, thirty "messages" about the use of genetic modification in food production were selected from a variety of information pamphlets and textbooks, which were then rated by 26 members of the public for their persuasive strength.

The ten most persuasive, and ten least persuasive statements were then used as “information” about genetic modification in the second part of the study, in which 166 respondents participated. Respondents received information which was attributed to either a consumer organisation (highly trusted in the UK) or to the government (highly distrusted in the UK). The third factor was that of risk relevance. All respondents then rated the information for their perceptions of source characteristics and informational qualities. Post-information provision assessments were also taken of their attitudes to genetic modification used in food production. They were also required to complete a thought listing procedure which is thought to be indicative of elaborative processing – the more a respondent writes about a topic after receiving information, the more likely they are to have processed the information in an elaborative way (Brock, 1967).

Under the low risk relevance condition, the information was more trusted if it was both high in persuasive strength and attributed to the government. For respondents in the high-risk relevance condition, highly persuasive information from a consumer organisation, or information from government which was low in persuasive strength was more trusted. Differences in attitudes towards technologies between conditions tended to be associated with the most controversial examples of genetic modification involving human DNA or animals. In these examples, distrusted source attributions resulted in more negativity towards genetic modification.

Contrary to predictions, low perceived personal relevance was more likely to lead to elaborative processing than high relevance – perhaps reflecting the perceived “power” that people believe that they have to influence the strategic development of genetic modification. People felt that they were able to express negative views about genetic modification if they were still able to influence outcomes. People perceived a “knowledge bias” if the information originated from the trusted source (that is, the source was not able to convey accurate information because it did not possess appropriate expertise) or “reporting bias” on the part of the government when persuasive information was being used (that is, the source was believed to be distorting information to promote a particular vested interest). It is extremely important to consider trust in information source when developing effective communication about genetically modified foods.

Potential impact of specific applications of genetic modification on attitudes

There is substantial evidence that people have very different attitudes and concerns about different applications of genetic modification, within the agro-food sector as well as relative to other sectors, such as pharmaceutical development. In general, genetic modification of micro-organisms has been viewed as more benign and less risky than applications involving plants or animals (Frewer et al., 1998; Hamstra, 1998). One might expect information source characteristics to exert greater influence on consumer reactions to genetic modification in cases where attitudes are more extreme at the outset – that is, perceptions of potential vested interest are more likely in cases where people have more concern about a particular application.

It is certainly possible that information about biotechnology in general may have a very different effect than information about specific products, although at present it is not known how such an effect might operate on consumer acceptance, or interact with source. Furthermore, information about specific products might be simple reiteration of details about processing and tangible benefits, or "classical" advertising – a hard sell approach to the sale of a particular product (Scholderer & Balderjahn, 1999; Scholderer, Balderjahn & Will, 1998). Whilst it is arguably unethical for regulatory bodies to use such an approach to "selling" potentially hazardous processes whilst they are simultaneously responsible for protecting the public against the risks, the approach still merits investigation within the context of industrial information sources.

Finally, it has been found that what many experts regard as the benefits of genetic modification are simultaneously perceived by consumers as risks – it is important to provide information about the opinions of both those opposed to genetic modification as well as it proponents if the consumer is not to perceive the information to be biased or promoting a particular view (Scholderer, Balderjahn, Bredahl & Grunert, in press).

Prior attitudes and information about genetic modification

Trust in information source is unlikely to be very influential for potential hazards where people already hold very extreme attitudes about a particular hazard. Under these circumstances, people are more likely to assess the information with which they are presented, to see if it aligns with the view that they already hold – if it does not, they change their opinion about the information source rather than change their attitudes. Empirical research has confirmed this effect for people who have very negative attitudes towards applying genetic modification in food production. If these people are provided with information which is neutral to positive about the use of genetic modification, they do not change their attitudes about the technology. Rather they tend to distrust the source more than they did before they received the information. It is likely that this distrust might spread such that all information disseminated by the source about other hazards is subsequently distrusted (Frewer et al., 1996). For this reason, consumers who already have very positive or very negative attitudes towards genetic modification were excluded from the current study, as these extreme attitudes are unlikely to change following information provision, nor be amenable to indirect influence attributable to source effects.

A further point might be made regarding the potential impact of prior attitudes on reactions to information. Fazio (1986, 1989, 1990; Fazio, Chen, McDoal & Sherman, 1983) has proposed a causal relationship to describe the relation between attitudes towards targets and behaviours. Fazio describes the approach as a "spontaneous" or automatic processing model. The model proposes that an attitude towards a target is accessed from memory by the presentation of cues related to the object focused by the attitude. This activation process is automatic. The model proposes that, if a favourable attitude is activated, positive qualities are ascribed to the attitude object, whereas, if an unfavourable attitude is activated, negative qualities are ascribed to the attitude object. Fazio has proposed that automatically activated attitudes toward a target involve a consciously controlled, active search for the most strategically appropriate behaviour. Providing information about a genetically modified food might activate previously held attitudes about genetic modification, resulting in greater or lesser acceptance of genetically modified foods independent of the information content or, indeed, external factors such as source attribution.

Understanding the consumer at the European level

As food markets become increasingly globalized, it is important to understand cross-cultural and demographic differences in consumer attitudes. If products are acceptable to consumers in one country, but not another, the development of international trade and regulatory practices are likely to be impeded. Within Europe, the market introduction of genetically modified foods is regulated at the European level (European Parliament, 1997) although there are marked differences in attitudes between different European states. A great number of opinion surveys have been conducted in Europe and elsewhere which have attempted to pinpoint likely consumer responses to genetically modified products (Zechendorf, 1994). One of the most extensive, at least in terms of the number of people surveyed, is the Eurobarometer survey, last conducted in 1996 (European Commission, 1998).

The Eurobarometer has indicated that (with the exception of Finland) consumers are more concerned about the risks of genetic modification of food in northern European countries compared to Southern Europe. This may be because consumers in Northern Europe are “risk averse” – that is, they base decisions about food consumption on avoiding risks. Consumers in Southern Europe may be more concerned about potentially negative impact on food quality – that is, perceptions of benefit are more likely to influence food choice decisions in southern European countries. However, care must be taken in determining which question will provide information about consumer acceptance of novel products. Ethical concerns about genetically modified foods appear to be important in both Italy and the United Kingdom, and it is essential that assessment of consumer attitudes extends beyond the debate about risk (Saba, Moles & Frewer, 1998).

Cross-cultural differences have also been found to be associated with people’s attitudes to very specific applications of genetic modification. In the current project, attitudes to genetically modified yoghurt and beer (which are among the least controversial applications of genetic modifications of food) were examined (Bredahl, 1999). At the time of data collection (1997) consistently low preferences for the genetically modified product alternatives were found in all the countries surveyed – Denmark, Germany, Italy and the United Kingdom. Traditional product alternatives were preferred. In all four countries, genetic modification was seen as unnatural, unfamiliar and unethical. Respondents were as concerned about the genetic modification as a process as much as products, which linked to higher order concerns such as responsibility for nature and for the welfare of other people.

However, attitudes which have not yet crystallised or formed are dynamic, and likely to change as new information about a technology is placed into the public domain. Once attitudes have become very well established, they are unlikely to change further as new information becomes available. During the last year, the level of media reporting about genetic modification in the United Kingdom has been very high. Certainly if British citizens had not been aware of the debate about risk and benefit before this increased level of reporting, recent "saturation" levels of media coverage were certainly enough to ensure that most members of the public would now be aware of genetically modified foods. Consumer negativity in the United Kingdom is greater than in 1996, at the time of the last Eurobarometer survey, partly because more members of the public are now aware of the debate, and partly because of saturation levels of media coverage that have appeared in the United Kingdom press and news broadcasts (Miles & Frewer, in preparation). Interpretation of the results of the current research must take account of recent changes in public opinion, particularly in the United Kingdom. A factor of particular relevance unique to the British situation reflects recent moves by industry to withdraw genetically modified ingredients from processed products – whilst this response to consumer demand has probably increased consumer trust in food manufacturers, it has also provided the signal that the use of genetically modified ingredients might compromise consumer safety.

METHODS

Participants and procedure

Altogether, N=1655 respondents from Denmark, Germany, Italy, and the United Kingdom participated in the experiments. All respondents were recruited in major shopping malls during shopping hours. Passing shoppers were addressed at random. Upon agreement to participate, respondents were screened according to the criteria in Annex 6. Respondents were quota sampled (on the basis of age, gender and socio-economic class) and excluded from the study if they did not meet the inclusion criteria. Demographic details of respondents are provided in Table 1. Respondents were then assigned to one of two product choice conditions – either genetically modified yoghurt or beer. They received different kinds of information according to the condition to which they were assigned. This was either:

- product specific information, which described in detail either the genetically modified yoghurt or beer (Annex 1), or

- balanced (general) information about genetically modified foods (Annex 2), or

- an advertisement promoting the benefits of genetic modification, appealing to consumer innovativeness (Annex 3), or

- an advertisement promoting the benefits of genetic modification, appealing to consumers' social values (Annex 4).

If participants were assigned to the control condition, they were not provided with information about genetic modification at all (further details about the scientific basis of the information strategies are given in Scholderer & Balderjahn, 1999). Respondents assigned to the product-specific and balanced information conditions received information attributed to either an industrial source (the European Association of Industry), a regulatory/governmental

Table 1. Demographic characteristics of respondent sample

Country	*N*	Per cent female, male	Mean age (SD)
Denmark	452	45.8 female, 54.2 male	33.03 years (14.49)
Germany	500	39.6 female, 60.4 male	32.65 years (15.86)
Italy	350	53.9 female, 46.1 male	34.14 years (11.56)
United Kingdom	353	41.6 female, 58.4 male	28.96 years (09.40)
Total	1655	44.7 female, 55.3 male	32.27 years (13.53)

source (the European Commission) or a non-governmental organisation source (the European Association of Consumers). All respondents were issued with a disclaimer at the end of the experiment indicating that the information was, in fact, not issued by these organisations and that the European Association of Industry and the European Association of Consumers did not exist – the attribution was an experimental manipulation designed to test the effects of source on consumer reactions to information.

Respondents were then asked to rank their preferences for the different kinds of yoghurts or beer samples provided, from 1 (most liked) to 4 (least liked). The yoghurt products varied with respect to fat content, production method, presence of additives, and texture: (a) fat-free yoghurt produced with genetically modified starter cultures, characterised by 'a nice taste and smooth texture', (b) traditional full-fat whole-milk yoghurt without additives, characterised by 'a nice taste and smooth texture', (c) traditional low-fat skim-milk yoghurt without additives, characterised by 'a nice taste and thin texture', (d) fat-free yoghurt containing stabilisers and antioxidants, characterised by 'a nice taste and smooth texture' (see Annex 5).

The beer products varied with respect to production method, energy consumption/environmental soundness, quality of raw materials, and price: (a) beer produced by means of genetically modified yeast, ensuring reductions in time and energy expenditure during the production process, and thus more environmentally sound, sold at a low price, (b) beer produced in a traditional way from high quality raw materials, sold at a medium price, (c) beer produced in a traditional way from standard quality raw materials, sold at a low price, (d) beer produced by means of modern process technology (but not genetic modification), ensuring lower time and energy expenditure during the production process, and thus more environmentally sound, sold at a high price (see Annex 5).

Thus, the consumer benefits of applying genetic modification in the yoghurt example were absence of fat and a smooth texture without the use of artificial additives, whereas in the beer case the consumer benefits of applying genetic modification were environmentally sound production and a lower price. Naturalistic yoghurt products were created from new yoghurt cups, which were filled with a substance resembling yoghurt in weight and filling, and provided with labels containing the relevant product information. Naturalistic beer products were created from existing bottled beers that had their original labels removed before being equipped with the new labels containing the product information developed for this study. In this way, identical products were obtained for all beer and yoghurt alternatives, except for the label information. To make the product examples still more realistic, it was decided to supply the beer products with brand names ("Brewmaster's Korbacher" for the genetically modified beer; "Brewmaster's Muehlberger" for the traditional, medium price beer; "Brewmaster's Alfeleder" for the traditional, low price beer; and "Brewmaster's Steinfurter" for the beer produced by unspecified modern process technology). The yoghurts were assigned a joint brand name ("Dairy fresh"). All products were used for visual presentation only.

After ranking these products according to their personal preferences, all respondents completed items relating to their general attitudes towards genetic modification, food neophobia, and perceptions of informational qualities. General attitudes towards genetic modification of food and a person's tendency to avoid new or unfamiliar foods, or food neophobia (Pliner & Hobden, 1992), have been shown to be good predictors of acceptance of genetic modification of food products in previous research (Bredahl, in press a, b). Finally, attitudes to the information and attributed source were also assessed using items validated in the United Kingdom (Frewer et al., 1996; Annex 7).

Experimental design

The experimental design is summarised in Table 2. The design incorporated four between-subjects factors: (a) country, (b) product category, (c) information strategy, and (d) attributed information source, resulting in a 4 (Denmark, Germany, Italy, United Kingdom) x 2 (beer, yoghurt) x 2 (balanced information, product information, advertisement appealing to consumer innovativeness, advertisement appealing to social values, control) x 3 (industry association, consumer organisation, European Commission) design.

However, the design was incomplete with respect to two factor relations. First, a variation of information sources was not possible with the control group – no information, no source – and not reasonable with the advertising approaches: only the industrial suppliers of a given product would use product advertising as a communication strategy. Thus, the information strategy x information source relation is not complete. Second, recent media attention focusing on genetic modification in the United Kingdom has been extremely negative. It was decided that, as public attitudes were likely to become more negative, and, as a result, critical of institutions directly promoting genetic modification, the testing of the advertising approaches in the United Kingdom might result in unintended public negativity towards the research institute conducting the research. Similarly, data resulting from advertising approaches were not collected from Italian consumers. The advertising approaches were therefore only applied in Denmark and Germany, resulting in an incomplete country x information strategy relation.

Table 2. Experimental design

Product	Information strategy	Attributed information source	Country DK	D	I	UK
Beer	Balanced information	European Association of Industry	x	x	x	x
		European Association of Consumers	x	x	x	x
		European Commission	x	x	x	x
	Product-specific information	European Association of Industry	x	x	x	x
		European Association of Consumers	x	x	x	x
		European Commission	x	x	x	x
	Advert appealing to consumer innovativeness	n.a.	x	x		
	Advert appealing to social values	n.a.	x	x		
	Control (no information)	n.a.	x	x	x	x
Yoghurt	Balanced information	European Association of Industry	x	x	x	x
		European Association of Consumers	x	x	x	x
		European Commission	x	x	x	x
	Product-specific information	European Association of Industry	x	x	x	x
		European Association of Consumers	x	x	x	x
		European Commission	x	x	x	x
	Advert appealing to consumer innovativeness	n.a.	x	x		
	Advert appealing to social values	n.a.	x	x		
	Control (no information)	n.a.	x	x	x	x

Data analysis and results

Attitude change

Analysis of variance (ANOVA) was used to test for differences in post-experimental attitudes. Since the design was fractional, we used sequential ("Type I") partitioning of the total sums of squares. Prior attitudes and food neophobia were entered first. To gain maximum statistical power, both attitude variables were not dichotomised but included as single degree of freedom predictors. Step by step, the experimental factors were added, followed by the two-way interactions between experimental factors, the two-way interaction between covariates and experimental factors, the three-way interactions between experimental factors, and finally, the four-way interaction between the experimental factors. Covariate-by-covariate interactions were not included.

A split-plot partition was introduced to account for the incomplete crossing of country and information strategy. Denmark and Germany (where all information strategies had been tested) formed the first level of the between-plots factor. Italy and the United Kingdom (where the advertising strategies had not been tested) formed the second level of the between-plots factor. Information strategy was estimated as a separate simple effect within each plot. Only after this, the sums of squares accounted for within each plot were pooled to test for the total effect of information strategy (hence the six degrees of freedom for the total effect). The same procedure was chosen for all higher-order interactions involving information strategy. The incomplete crossing of information strategy and information source was accounted for by a similar split-plot partition. Thus, the ANOVA results in Table 3 cover all experimental conditions. Altogether, the model could account for 56 per cent of the variance in perceived benefit and for 53 per cent of the variance in perceived risk.

Cross-national differences and product category effects

The four national sub-samples showed considerable variation on the prior attitude dimensions. Global prior attitudes were somewhat skewed to the negative in Denmark, but did not differ across the other countries. People expressed least food neophobia in the United Kingdom and highest levels of food neophobia in Italy. The two post-experimental attitude measures, on the other hand – perceived risk and perceived benefit – followed a coherent pattern. German consumers were most positive about genetically modified food products, Danish consumers were most negative, and Italian and British consumers were in between (Figure 1).

The two product categories used in the experiments showed an unconditional difference only with respect to perceived benefit. On average, consumers in the beer group perceived gene technology to be slightly more beneficial (M = 3.708, SD = 1.482) than did consumers in the yoghurt group (M = 3.517, SD = 1.458).

Figure 1. Mean pre-experimental (global prior attitude and food neophobia) and post-experimental (perceived risk and perceived benefit) attitudes as a function of country

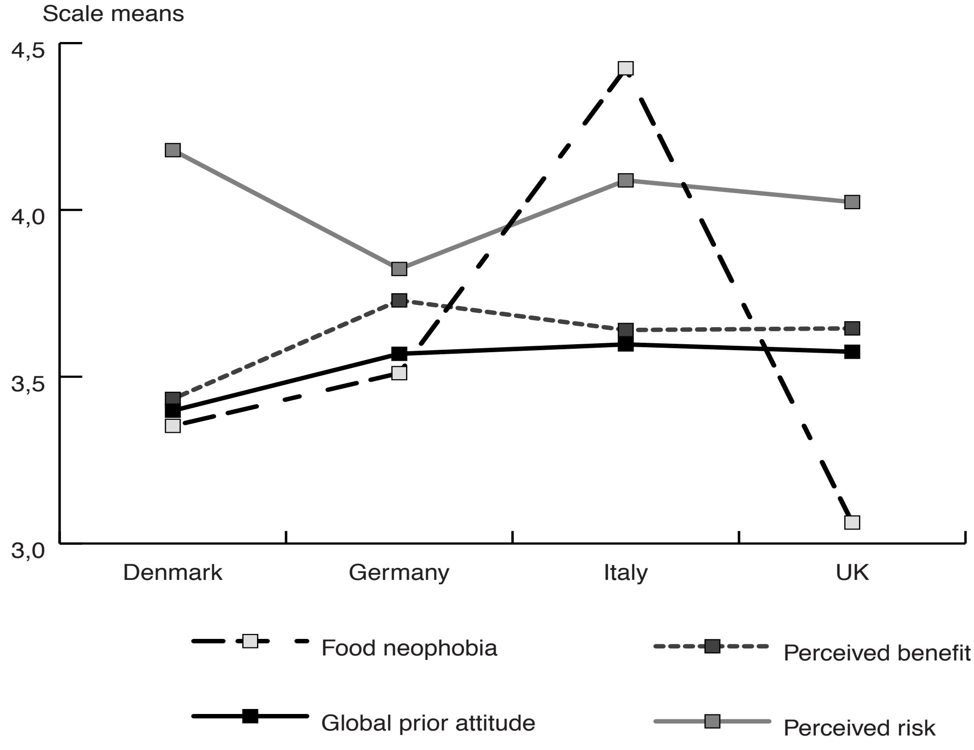


Table 3. ANOVA results for post-experimental attitudes

Effect	Perceived benefit			Perceived risk		
	F	*df*	*p*	*F*	*df*	*p*
Main effects of covariates						
Prior attitude towards gene technology	1697.42	1	.000	883.12	1	.000
Food neophobia	28.66	1	.000	58.70	1	.000
Main effects of experimental factors						
Country	4.01	3	.007	6.63	3	.000
Product category	5.46	1	.020	.03	1	.870
Information strategy	.38	6	.893	.27	6	.952
Information source	2.20	2	.111	.55	2	.578
Two-way interactions between experimental factors						
Country x Product	1.60	3	.188	.16	3	.925
Country x Strategy	1.25	6	.278	1.21	6	.300
Country x Source	.51	6	.802	1.41	6	.207
Product x Strategy	1.52	6	.166	1.12	6	.349
Product x Source	.91	2	.402	.26	2	.769
Strategy x Source	.33	2	.721	.59	2	.555
Two-way interactions between covariates and experimental factors						
Prior attitude x Country	.53	3	.664	8.62	3	.000
Prior attitude x Product	.16	1	.690	.32	1	.572
Prior attitude x Strategy	1.39	6	.216	1.56	6	.156
Prior attitude x Source	.47	2	.625	2.58	2	.076
Food neophobia x Country	1.10	3	.350	1.96	3	.118
Food neophobia x Product	.02	1	.888	.46	1	.497
Food neophobia x Strategy	1.16	6	.327	1.95	6	.069
Food neophobia x Source	.86	2	.423	3.04	2	.048
Three-way interactions between experimental factors						
Country x Product x Strategy	2.20	6	.041	.98	6	.437
Country x Product x Source	.61	6	.726	.21	6	.973
Country x Strategy x Source	1.20	6	.301	.85	6	.535
Product x Strategy x Source	.83	2	.437	.67	2	.514
Three-way interactions between covariates and experimental factors						
Prior attitude x Country x Product	1.20	3	.308	.29	3	.832
Prior attitude x Country x Strategy	1.23	6	.287	.64	6	.701
Prior attitude x Country x Source	1.62	6	.137	.71	6	.639
Prior attitude x Product x Strategy	.75	6	.609	1.92	6	.075
Prior attitude x Product x Source	1.68	2	.186	.49	2	.614
Prior attitude x Strategy x Source	1.05	2	.350	.12	2	.885
Food neophobia x Country x Product	.33	3	.801	.34	3	.797
Food neophobia x Country x Strategy	.16	6	.987	.80	6	.566
Food neophobia x Country x Source	.45	6	.845	1.45	6	.191
Food neophobia x Product x Strategy	1.80	6	.095	.94	6	.465
Food neophobia x Product x Source	1.84	2	.159	1.69	2	.185
Food neophobia x Strategy x Source	.80	2	.447	.09	2	.917
Four-way interaction between experimental factors						
Country x Product x Strategy x Source	1.89	6	.080	.54	6	.779
Error		1496			1496	

Dependent variables: Perceived benefit, Perceived risk

However, unconditional differences between countries and product categories should be interpreted with caution (if at all). First and foremost, the present study is an experimental one. In such a context, variables like country and product category refer to different populations rather than experimental conditions. Their main effects are not of substantial interest. They only become relevant once their interaction with experimental factors is considered. In experimental designs, these interactions test if an experimental effect can be generalised over different populations and situations. The second reason for cautious interpretation of cross-national differences and product category effects is due to measurement problems. In most cases, it is not entirely clear if observed differences in attitude scores are due to true differences in the underlying dimensions or just a product of country-specific response biases. Separating true differences from response bias requires sophisticated statistical modelling techniques – the section on source credibility and trust (see below) may serve as an example here.

Prior attitude effects

In a similar fashion, prior attitudes should be seen as a baseline against which the experimental design is tested – substantial interest is directed more at the interactions between prior attitudes and experimental factors than at their unconditional main effects. Nonetheless, prior attitudes made the highest single contribution to the fit of the models. The main effects of global attitude towards genetic modification, as well as of food neophobia were highly significant. Together, both prior attitude dimensions accounted for 51 per cent of the variance in perceived benefit and 36 per cent of the variance in perceived risk. Comparing these figures to the total validity of the model, we see that prior attitudes determine 51 out of 56 per cent total variance explained in perceived benefit, whereas they only determine 36 out of 53 per cent total variance explained in perceived risk. This suggests that the variations in the design exerted much more influence on perceived risk than on perceived benefit. However, the ANOVA yielded a strong moderator effect of country, indicating cross-national differences in the correlations between prior global attitude and post-experimental perceived risk. Italian respondents showed the highest absolute pre-post correlation ($r = -.705$), followed by Danish ($r = -.653$), German ($r = -.499$), and British respondents ($r = -.396$).

Information strategy effects

At a first glance, post-experimental attitudes did not differ under the various information conditions to which the participants had been exposed. The main effect of information strategy was insignificant, indicating that no attitude change had occurred. Two explanations are most likely in such situations: (a) true absence of attitude change, where one would predict the same pre-post correlations in all groups, or (b) unsystematic attitude change, where one would predict low pre-post correlations in the experimental groups and high pre-post correlations in the control group.

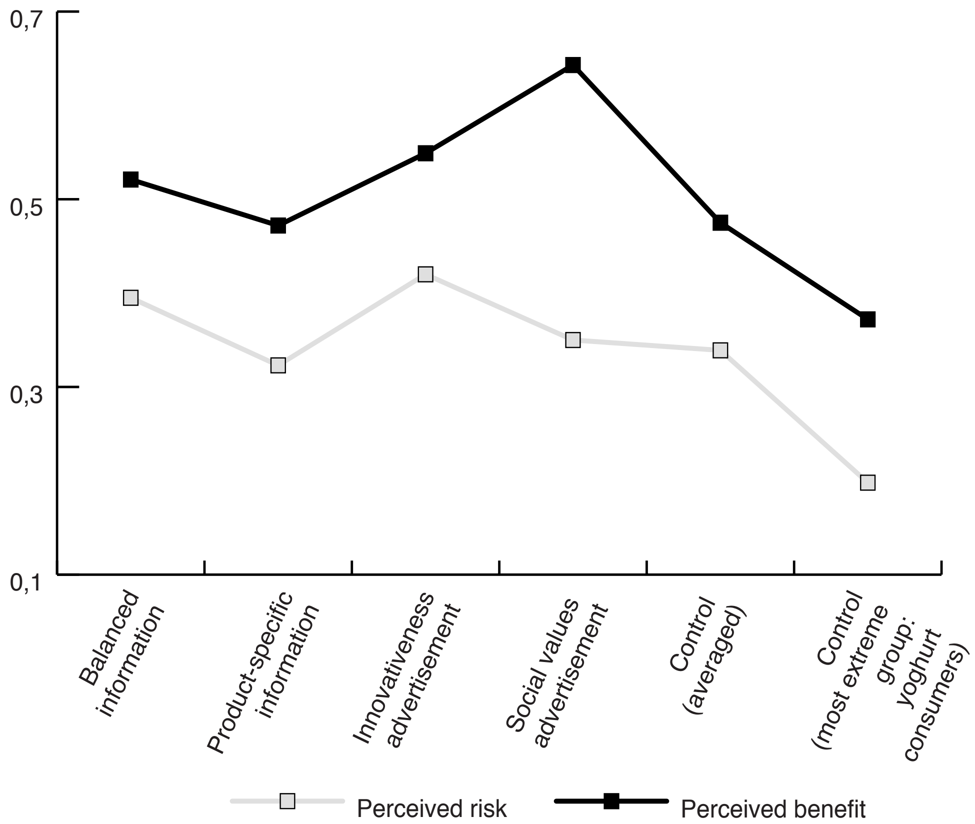
Yet a closer look at the interactions revealed some very interesting results. The interaction effect of food neophobia and information strategy on perceived risk was nearly significant. Moderated by product category, the same pattern occurred again with two three-way interactions: the interaction effect of prior global attitude, product and strategy on perceived risk was nearly significant, and likewise, the interaction effect of food neophobia, product and strategy on perceived benefit was nearly significant. Since the general pattern seemed to be the same for both prior attitude dimensions, we combined them into a linear regression model and predicted posterior attitudes within each strategy group. Figure 2 shows the squared multiple correlations resulting from these models.

Astonishingly, this is quite the reverse effect of the above standard explanation in terms of unsystematic attitude change.

Information source effects

Attributing the information materials to different sources did not result in a significant main effect either. However, the ANOVA again yielded a nearly significant interaction with prior global attitude on perceived risk and a significant interaction with food neophobia on perceived risk. For a closer examination of the interaction structure, we computed linear regressions predicting perceived risk by prior global attitude and food neophobia within each information source group. The squared multiple correlations indicate that the overall pre-post consistency did not differ much between the information sources (R^2 = .341 for the industry association; R^2 = .380 for the consumer association, and R^2 = .378 for the European Commission). Instead, the relative distribution of weights between prior global attitude and food neophobia changed. Prior global attitude and food neophobia differed least in their

Figure 2. Total pre-post attitude consistency as a function of information strategy: squared multiple correlations from a linear regression of post-experimental attitudes (perceived risk, perceived benefit) on prior attitudes (global attitude, food neophobia)



standardised weights when the information was attributed to the industry association (β = -.437 for prior global attitude; β = .299 for food neophobia). Food neophobia had less influence than prior global attitude when the information was attributed to the consumer association (β = -.553 for prior global attitude; β = .145 for food neophobia), and no substantial influence when the information was attributed to the European Commission (β = -.570 for prior global attitude; β = .069 for food neophobia).

Product choice

Logistic regression was used to predict actual product choice. The probability of the genetically modified product being the most preferred product was regressed on a linear predictor including the same set of independent variables as the ANOVA design above. Again, the prior attitude dimensions were not dichotomised but included as continuous variables. To separate main effects from interactions involving continuous variables, a blockwise estimation procedure was chosen. The initial model included only a constant. The independent variables were then entered in seven blocks: (1) main effects of covariates, (2) main effects of experimental factors, (3) two-way interactions between experimental factors, (4) two-way interactions between covariates and experimental factors, (5) three-way interactions between experimental factors, (6) three-way interactions between covariates and experimental factors, and (7) the four-way interaction between the experimental factors. Covariate-by-covariate interactions were not included. The results are presented in Table 4. Aggregated over all sub-samples, the probability of consumers choosing the genetically modified product was .147. Compared to the initial model including only a constant (-2 log likelihood = 1353.621), the final model showed a significantly better overall fit (-2 log likelihood = 1037.537; $\Delta\chi^2$ = 316.084, Δdf = 135, p < .0001).

Cross-national differences and product category effects

As can be seen from Table 4, the logistic regression analysis yielded a highly significant main effect of country, indicating different base rates of consumers who preferred the genetically modified product (either beer or yoghurt) to three competing products that were conventionally produced. In Denmark, the probability of consumers choosing the genetically modified product was p = .120. In Germany, the probability was p = .104, in Italy p = .206, and in the United Kingdom p = .187. The base rate did not differ unconditionally between the two product categories used in the experiments. However, a significant interaction between country and product category indicated that the relative base rates for beer versus yoghurt differed between countries but averaged out in total. In Denmark, base rates hardly differed between beer (p = .128) and yoghurt (p = .111). In the other countries, consumers tended to prefer the genetically modified beer in a more pronounced way than the yoghurt. In Germany, consumers found the genetically modified beer (p = .128) more attractive than the yoghurt (p = .080). In Italy, the relative probabilities were, for beer, p = .160 and for yoghurt, p = .148. In the United Kingdom, consumers also showed more taste for the genetically modified beer (p = .229) than for the yoghurt (p = .148).

Table 4. Logistic regression results for product choice. Dependent variable: probability that genetically modified product is preferred to three competing products that were conventionally produced

Effect	Wald statistic	*df*	*p*
Block 1. Main effects of covariates			
Prior attitude towards gene technology	78.111	1	.000
Food neophobia	2.63	1	.105
Blcok 2. Main effects of experimental factors			
Country	22.154	3	.000
Product category	.24	1	.619
Information strategy	10.289	4	.036
Information source	2.013	2	.366
Block 3. Two-way interactions between experimental factors			
Country x Product	9.898	3	.020
Country x Strategy	4.969	8	.761
Country x Source	8.409	6	.210
Product x Strategy	3.469	4	.483
Product x Source	2.192	2	.334
Strategy x Source	7.412	2	.025
Block 4. Two-way interactions between covariates and experimental factors			
Prior attitude x Country	27.707	3	.000
Prior attitude x Product	1.687	1	.194
Prior attitude x Strategy	2.594	4	.628
Prior attitude x Source	2.608	2	.271
Food neophobia x Country	7.224	3	.065
Food neophobia x Product	.461	1	.497
Food neophobia x Strategy	4.196	4	.380
Food neophobia x Source	.807	2	.668
Block 5. Three-way interactions between experimental factors			
Country x Product x Strategy	10.676	8	.221
Country x Product x Source	1.525	6	.958
Country x Strategy x Source	2.103	6	.910
Product x Strategy x Source	1.565	2	.457
Block 6. Three-way interactions between covariates and experimental factors			
Prior attitude x Country x Product	2.875	3	.411
Prior attitude x Country x Strategy	12.402	8	.134
Prior attitude x Country x Source	6.253	6	.395
Prior attitude x Product x Strategy	2.104	4	.717
Prior attitude x Product x Source	4.795	2	.091
Prior attitude x Strategy x Source	4.869	2	.088
Food neophobia x Country x Product	6.258	3	.100
Food neophobia x Country x Strategy	6.639	8	.576
Food neophobia x Country x Source	17.215	6	.009
Food neophobia x Product x Strategy	5.715	4	.222
Food neophobia x Product x Source	7.691	2	.021
Food neophobia x Strategy x Source	1.547	2	.462
Block 7. Four-way interaction between experimental factors			
Country x Product x Strategy x Source	3.167	6	.788
Constant	5.524	1	.019

Prior attitude effects

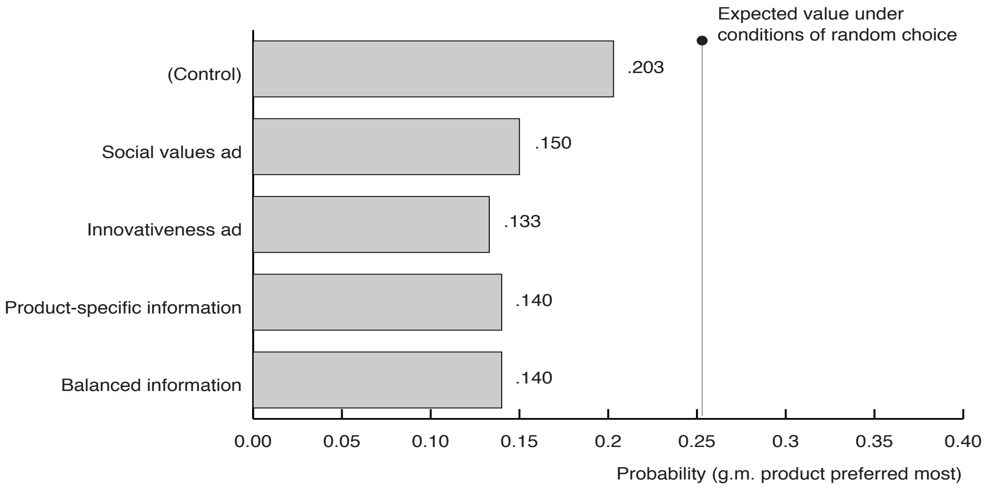
Global prior attitude had a highly significant main effect on choice probability. The more positive respondents' attitude towards gene technology, the higher the probability that they preferred the genetically modified product to all competing products (B = .490, $S.E.$ = .055, exp(B) = 1.632). However, the main effect was of prior attitude was qualified by a significant interaction with country. In Germany (B = .948, exp(B) = 2.582) and Denmark (B = .738, exp(B) = 2.092), product choice was fairly consistent with global attitudes towards gene technology in food production. In the United Kingdom, global attitudes had less influence on product choice (B = .496, exp(B) = 1.643), and in Italy hardly any at all (B = .039, exp(B) = 1.040).

Information strategy effects

The analysis of attitude change (see above) has already raised suspicions as to what kind of evaluation processes are actually induced when supplying consumers with information materials about genetically modified foods. These suspicions were strongly corroborated by the choice data. The logistic regression analysis yielded a significant main effect of information strategy. The respective choice probabilities are presented in Figure 3.

The nature of the effect seems quite obvious now: any kind of information supplied in addition to the labelled product decreased the probability of consumers preferring the genetically modified product. To confirm the reliability of the effect, the logistic regression model was re-estimated with a Helmert contrast imposed on the information strategy factor. The first degree of freedom, testing the choice probability in the control group against the average choice probability in the information groups, was significant (B = .423, $S.E.$ = .220, exp(B) = 1.527, Wald statistic = 3.698, df = 1, p(one-tailed) < .05), confirming the hypothesis. Taken together with the results on attitude change (see above), the strikingly uniform effects of our information materials make a strong case for concluding that an attitude activation process (Fazio et al., 1982) has been primed here.

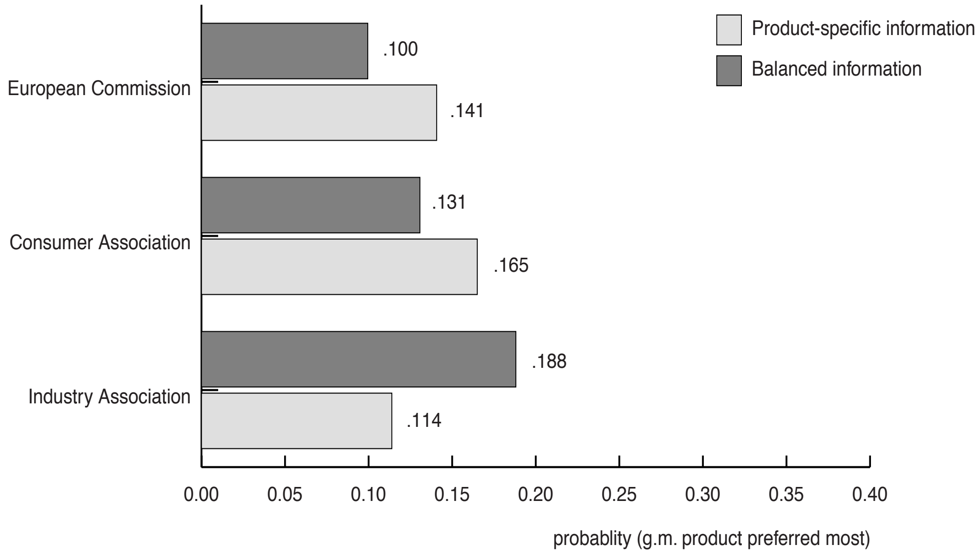
Figure 3. Probability that genetically modified product is preferred to three conventionally produced competing products as a function of information strategy



Source effects

The information source attributed to the different information materials did not have an unconditional effect but influenced product choice in interaction with other factors. First, a significant two-way interaction with information strategy was found. The interaction was semi-disordinal. When attributed to the consumer association or the European Commission, product-specific information resulted in higher choice probabilities than balanced information. When attributed to the industry association, however, the reverse effect was found. Here, balanced information resulted in higher choice probabilities than product-specific information (Figure 4).

Figure 4. Probability that genetically modified product is preferred to three conventionally produced competing products as a function of information strategy and information source



Moreover, the logistic regression analysis yielded a significant three-way interaction between food neophobia, country, and information source. Computing partial logistic regressions of choice probability on food neophobia within each country-by-source cell, the three-way interaction could be traced back to two significant simple effects: (a) in the Danish sub-sample, food neophobia had a highly negative impact on choice probability when the information was attributed to the European Commission (B = -1.361, exp(B) = .256), but none when information was attributed to the industry association or the consumer association; and (b) food neophobia had a positive influence on choice probabilities in the Italian sub-sample (B = .489, exp(B) = .1.631), but a negative influence in Denmark (B = -.324, exp(B) = .724), Germany (B = -.625, exp(B) = .535) and the United Kingdom (B = -.343, exp(B) = .710). However, reinspecting Figure 1 confirms that Italian respondents reported much higher unconditional food neophobia levels than respondents did from the other three countries, so that the significant interaction should rather be interpreted as an artefact resulting from a ceiling effect in the Italian sub-sample.

The three-way interaction between food neophobia, product category and information source was also significant. Computing partial logistic regressions of choice probability on food neophobia within each product-by-source cell, the three-way interaction could be traced back to a significant effect reversal between product categories when the information was attributed to the European Commission. In the beer group, food neophobia had a positive effect on choice probability (B = .463, exp(B) = 1.589), but in the yoghurt group a negative one (B = -.305, exp(B) = .737).

Source credibility and trust

In the present study, one third of the respondents received information that was attributed to a fictitious industry association, one third received information that was attributed to a fictitious consumer association, and one third received information that was attributed to the European Commission. The items were framed according to the attributed information source. Since the factors country and information source are completely crossed, we end up with a total of twelve different groups.

This type of design is a special case of the population x situation relations from generalizability theory (Cronbach, Gleser, Nanda & Rajaratnam, 1972), where the invariance of effects across different populations and situations is not a matter of assumptions, but of empirical investigation. However, the statistical rationale underlying generalizability theory is closely tied to the variance component model (Hartley & Rao, 1967). Since the present study also asks about population x situation effects on the factorial invariance of our measures, we have to use a different methodology here. The following sections will outline the statistical models employed, giving a short introduction to multi-sample structural equation models, and extending their applicability to sample configurations generated by group variables which form a factorial design.

Measurement model for source credibility

Factor analysis is a special case of the general structural equation model for means and covariances (Sörbom, 1974). It represents the observed responses to p items as a linear function of m latent factors, p intercept terms, and p random errors. In our case, the observed responses are the participants' responses to the 19 items of the "Trust in information about food-related risks" scale (Frewer et al., 1996; also see Annex 7). In multi-sample models (Jöreskog, 1971), parameters are allowed to differ across groups.

$$\mathbf{x}^g=\tau^g+\Lambda^g\xi^g+\delta^g, \tag{1}$$

where x^g is the p x 1 vector of observed variables in group g, τ^g is the px1 vector of intercept terms in group g, ξ^g is the mx1 vector of latent factors in group g, Λ^g is the pxm matrix of factor loadings in group g, and δ^g is the px1 vector of random errors in group g, assumed to be uncorrelated with the latent factors and to have zero expectation. Thus, the expected values of the observed variables are

$$\mu^g=\tau^g+\Lambda^g\kappa^g, \tag{2}$$

where μ^g is the px1 vector of observed means in group g and κ^g is the mx1 vector of latent factor means in group g. Finally, the covariance matrix of the observed variables is

$$\Sigma^g = \Lambda^g \Phi^g \Lambda^{g'} + \Theta^g \quad (3)$$

where Φ^g is the *m*x*m* covariance matrix of latent factors in group g and Θ^g is the *p*x*p* covariance matrix of random errors in group *g*. Obviously, groups may differ in aspects that go beyond simple item means. The basic question here is to decide whether the construct has the same structure across groups. In other words, do we actually measure the same phenomenon when we translate a questionnaire and collect responses from different populations? And even if this is the case, will our measures follow the same metric when collected from different populations?

Levels of factorial invariance

Meredith (1993; also see Little, 1997) notes that meaningful comparisons of observed item means across different populations require scalar invariance, that is, equality of factor loadings plus equality of item intercepts. Otherwise, there would be no way to decide whether differences in observed item means are caused by true differences in the underlying constructs or merely by group-specific response biases. Fortunately, advanced SEM methodology allows estimation of latent factor means. Steenkamp and Baumgartner (1998; also see Byrne, Shavelson & Muthén, 1989) show that comparisons of latent factor means across populations require only partial scalar invariance in order to be meaningful: in fact, it is already sufficient when two items per factor have invariant loadings and intercepts.

In the following section, we will test sequentially which degree of invariance we can assume for our measurement model. Steenkamp and Baumgartner (1998) propose a hierarchical model comparison procedure for such situations, distinguishing between configural invariance (same pattern of zero factor loadings across groups), metric invariance (equality of nonzero factor loadings), scalar invariance (equality of nonzero factor loadings plus equality of intercept terms), factor covariance invariance, factor variance invariance, and error variance invariance. Since scalar invariance will be a sufficient condition for our measurement model to hold, we will confine the analyses to the first three steps of the Steenkamp and Baumgartner procedure.

Constraint sets for main effects and interactions

Our design includes two group variables: country and information source. In terms of metric and (in a next step) scalar invariance, this implies two constraints for the cross-national comparison between Denmark (DK), Germany (D), Italy (I), and the United Kingdom (UK):

$$\Lambda^{DK} = \Lambda^{D} = \Lambda^{I} = \Lambda^{UK}, \quad (4)$$

$$\tau^{DK} = \tau^{D} = \tau^{I} = \tau^{UK}, \quad (5)$$

and two additional constraints for the comparison between information sources, including the fictitious industry association (IND), the likewise fictitious consumer association (CON), and the European Commission, which is a government source (GOV):

$$\Lambda^{IND} = \Lambda^{CON} = \Lambda^{GOV}, \quad (6)$$

$$\tau^{IND} = \tau^{CON} = \tau^{GOV}, \quad (7)$$

Finally, two additional constraints are needed for testing if the information source effects are the same for all countries or if there is a moderator effect:

$$\Lambda^{DK.IND} = \Lambda^{DK.CON} = \Lambda^{DK.GOV} = \Lambda^{D.IND} = \Lambda^{D.CON} = \Lambda^{D.GOV} =$$

$$\Lambda^{I.IND} = \Lambda^{I.CON} = \Lambda^{I.GOV} = \Lambda^{UK.IND} = \Lambda^{UK.CON} = \Lambda^{UK.GOV}, \quad (8)$$

$$\tau^{DK.IND} = \tau^{DK.CON} = \tau^{DK.GOV} = \tau^{D.IND} = \tau^{D.CON} = \tau^{D.GOV} =$$

$$\tau^{I.IND} = \tau^{I.CON} = \tau^{I.GOV} = \tau^{UK.IND} = \tau^{UK.CON} = \tau^{UK.GOV}, \quad (9)$$

The constraints on the Λ^g alone define a metrically invariant measurement model, while constraints on both Λ^g and τ^g define scalar invariance across groups g. Unfortunately, factorial designs of group variables have never been an issue in multi-group structural equation modelling. The following section will outline a procedure for partitioning the global goodness-of-fit χ^2 into country effects, information source effects, and country-by-information-source effects.

Separation of effects

Imposing the above constraints on a multi-group SEM is quite similar to defining main effects and interactions in ANOVA. The constraints defined by Equations (4) and (5) test for the main effect of country, the constraints defined by Equations (6) and (7) test for the main effect of information source, and the constraints defined by Equations (8) and (9) test for the interaction between country and information source.

As in ANOVA, however, an interaction is only an interaction when the main effects are eliminated beforehand (see Rosnow and Rosenthal, 1995). Otherwise, the interaction would be confounded with the main effects. To disentangle them, an approach similar to the sequential ("Type I") partitioning of the total sums of squares in ANOVA may be constructed. Type I sums of squares involve the estimation of a hierarchical series of regression equations, at each step adding an additional effect into the model. The sums of squares for each effect are determined by subtracting the predicted sums of squares with the effect in the model from the predicted sums of squares for the preceding model not including the effect. Tests of significance for each effect are then performed on the increment in the predicted sums of squares accounted for by the effect (for a thorough discussion see Goodnight, 1980).

Due to its additivity, sequential partitioning of the χ^2 goodness-of-fit measure in SEM is nearly as straightforward as sequential partitioning of the total sums of squares in ANOVA (Lancaster, 1951). Four different models have to be estimated using conventional SEM software packages (such as AMOS, EQS, LISREL, or MPLUS). The resulting χ^2 values and the respective degrees of freedom have to be retained for subsequent model comparisons. In addition, one intermediate model has to be "analytically" evaluated. When all models converge, the resulting statistics will be sufficient for performing an ANOVA-like test of both main effects and their interaction. In detail, the following models have to be estimated:

Full invariance model. Λ^g (and for scalar invariance also τ^g) are assumed to be invariant across all cells. The model as such tests if full metric (scalar) invariance holds across all twelve country-by-source groups. Moreover, the full invariance model will serve as the baseline model in the model comparison sequence.

Main effect model COUNTRY. The nonzero elements of Λ^g (for scalar invariance also τ^g) are allowed to differ between countries. Within each country, however, Λ^g (for scalar invariance also τ^g) are assumed to be invariant with respect to the information sources. The main effect of the country factor is then evaluated by taking the difference of the χ^2 value from the COUNTRY model to the χ^2 value from the full invariance model. The resulting increment $\Delta\chi^2 = \chi^2_{\text{COUNTRY}} - \chi^2_{\text{FULL INVARIANCE}}$ is compared against a central χ^2 distribution with $\Delta df = df_{\text{COUNTRY}} - df_{\text{ FULL INVARIANCE}}$ degrees of freedom.

Main effect model SOURCE. The nonzero elements of Λ^g (for scalar invariance also τ^g) are allowed to differ between information sources. Within each information source group, Λ^g (for scalar invariance also τ^g) are assumed to be invariant across countries. The main effect of the information source factor is then evaluated by taking the difference of the χ^2 value from the SOURCE model to the χ^2 value from the full invariance model. The resulting increment $\Delta\chi^2 = \chi^2\text{SOURCE} - \chi^2_{\text{FULL INVARIANCE}}$ is compared against a central χ^2distribution with $\Delta df = df_{\text{SOURCE}} - df_{\text{FULL INVARIANCE}}$ degrees of freedom.

Combined main effects model COUNTRY + SOURCE. The two previous steps have evaluated the main effects separately. For separating and testing the interaction effect, however, we will also need the χ^2 value from a model that includes both main effects simultaneously. Fortunately, our design is balanced and orthogonal. Thus, both factors contribute independently to the combined χ^2 value, and we do not have to struggle with further correlations of parameter estimates. The combined increment with respect to the baseline model is then simply $\Delta\chi^2 = (\chi^2_{\text{COUNTRY}} - \chi^2_{\text{FULL INVARIANCE}}) + (\chi^2_{\text{SOURCE}} - \chi^2_{\text{FULL INVARIANCE}})$, which is compared against a central χ^2distribution with $\Delta df = (df\text{COUNTRY} - df_{\text{FULL INVARIANCE}}) + (df_{\text{SOURCE}} - df_{\text{FULL INVARIANCE}})$ degrees of freedom.

Confounded interaction model COUNTRY x SOURCE. The nonzero elements of Λ^g (for scalar invariance also τ^g) are allowed to differ between all groups. Yet in ANOVA terminology, the model estimated here would in fact be COUNTRY + SOURCE + COUNTRY x SOURCE. To test the interaction effect alone, we have to evaluate the incremental fit as compared to the combined main effects model COUNTRY + SOURCE. This is done by taking the difference of the χ^2 value from the confounded interaction model COUNTRY x SOURCE to the χ^2 value from the combined main effects model COUNTRY + SOURCE. The resulting increment $\Delta\chi^2 = \Delta\chi^2_{\text{COUNTRY X SOURCE}} - \chi^2_{\text{COUNTRY + SOURCE}}$ is then compared against a central χ^2 distribution with $\Delta df = df_{\text{COUNTRY X SOURCE}} - df_{\text{COUNTRY + SOURCE}}$ degrees of freedom.

However, it should be noted that this procedure – despite its intuitive appeal – still awaits more rigorous formal justification. This is fairly straightforward when interaction effects on mean vectors are concerned. Yet interaction effects on matrices of factor loadings are somewhat reluctant when it comes to identification of individual contributions. Work is still in progress.

Normality check

Maximum likelihood (ML) estimation of SEM parameters assumes multivariate normality. To check for violations of the assumption, skewness and kurtosis values were computed for the within-group item distributions. None of the 228 skewness values was above 1.00. The highest positive skewness was .97 for "proven wrong in the past" in the Danish subsample when the item was attributed to the consumer association. The highest negative skewness was -.84 for "favour" in the Italian subsample when the item was attributed to the European Commission. Only 9 out of 228 kurtosis values were above 1.00. Again, the highest positive value was 5.31 for "proven wrong in the past" in the Danish subsample when attributed to the consumer association. The highest negative kurtosis was -1.17 for "favour", again in the Italian subsample when attributed to the European Commission. On the whole, the data seem to depart only slightly from normality, so that ML estimation should be sufficiently robust.

Configural invariance

Before the actual magnitude of Λ^g or τ^g elements could be constrained across groups, configural invariance had to be established. In an initial step, the pattern of zero and non-zero factor loadings reported by Frewer et al. (1996) was assumed to hold for all groups. Unfortunately, neither ML nor generalised least squares estimation converged. Two explanations for this are most likely. First, Frewer et al. (1996) used principal components analysis (PCA) rather than factor analysis. Usually, both methods result in similar factor patterns. However, their differences become non-neglectable when the rather strict assumptions of the ML factor analysis model are violated in a way that is still consistent with the PCA model. Second, and more importantly, Frewer et al. (1996) used a sample that consisted only of British respondents, so that their design could indeed not account for cross-national differences.

Hence a new configurally invariant factor pattern had to be established. A series of within-group exploratory factor analyses was conducted. The results suggested that three factors were stable across groups. The within-group factor patterns were compared and synthesised into a simple structure model, including only one salient loading per item. The same pattern of salient and non-salient loadings was specified for all groups. ML estimation of the initial configural invariance model revealed a number of unacceptable item reliabilities. To improve this, all items with reliabilities below .10 in at least two of the twelve groups were removed from the model. The final configural invariance model included thirteen items and three factors:

ξ_1: *Honesty,* with salient factor loadings of the items "trustworthy", "accurate", and "factual";

ξ_2: *Deliberate manipulation*, with salient factor loadings of "withholding information", "distorted", "proven wrong in the past", and "self-protection"; and

ξ_3: *Responsible behaviou*r, with salient factor loadings of "knowledgeable", "responsible", "expert", "good track record", "public welfare", and "favour".

ML estimation of the final configural invariance model yielded a significant χ^2 value of 1450.301 with 744 degrees of freedom ($p < .001$). However, the global χ^2 goodness-of-fit test is notorious for its dependency on sample size. As noted by Bollen (1989), the χ^2/df ratio gives a more realistic evaluation of model fit and should lie below 2.5 for a model to be accepted. In our case, the χ^2/df ratio takes the value of 1.949, indicating an acceptable fit. Likewise, the RMSEA of .098 is acceptable, especially since we used Steiger's (1998) rather conservative multi-sample correction here. The single-sample RMSEA computed by most SEM software packages would have been .028, lying sufficiently below the conventional acceptance level of .05.

Metric invariance

Metric invariance across groups implies equality of factor loadings. In our case, metric invariance could exist on four levels: (1) not at all, implying an interaction between country and information source, (2a) across sources within each country, implying a main effect of country, (2b) across countries within each source, implying a main effect of source, and (3) across all groups, implying no effect. As outlined in the previous section, five models have to be estimated and compared to disentangle the respective effects. The results are shown in the upper part of Table 5.

The full metric invariance model yielded a rather satisfactory model fit (Model 3; $\chi^2 = 1633.678$, $df = 854$, $\chi^2/df = 1.913$, RMSEA = .096). Constraining the factor loadings to be invariant within countries (Model 2a) did not lead to a significant change in model fit, although the RMSEA slightly improved. Unfortunately, the constraints for Model 2b caused empirical under-identification problems, so that neither the country-independent main effect of information source nor the interaction effect could be separated by the model comparison procedure. However, the fit of the confounded interaction model (Model 1; $\chi^2 = 1450.300$, $df = 744$, $\chi^2/df = 1.949$, RMSEA = .096) hardly differed from the full metric invariance model, so that we will assume metric invariance to hold across all groups. The invariant part of the model is shown in Figure 5.

Figure 5: Metrically invariant measurement model for source credibility (loadings are unstandardised)

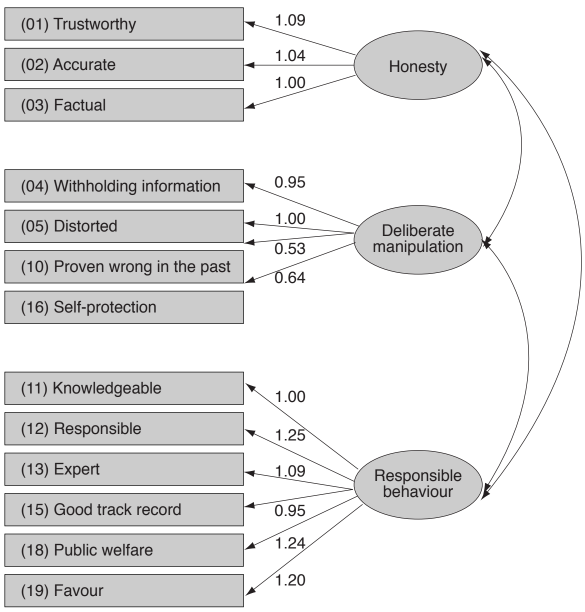


Table 5. Model comparisons

No.	Model	RMSEA	χ^2	*df*	Compared against	$\Delta\chi^2$	Δdf	*p*	Direction of Δ
Block I. Model comparisons with respect to metric invariance									
The following comparisons test whether allowing the nonzero elements of Λ^g to differ between groups *g* leads to significant changes in model fit (full configural invariance assumed).									
1	Confounded interaction model COUNTRYx SOURCE	.098	1450.30	744	2	n.a.	n.a.	n.a.	n.a.
2	Combined main effects model COUNTRY+SOURCE	No convergence reached			n.a.	n.a.	n.a.	n.a.	n.a.
2a	Main effect model COUNTRY	.094	1643.13	824	3	9.451	30	.999	n.s.
2b	Main effect model SOURCE	No convergence reached			n.a.	n.a.	n.a.	n.a.	n.a.
3	Full metric invariance model	.096	1633.68	854	n.a.	n.a.	n.a.	n.a.	n.a.
Block II. Model comparisons with respect to scalar invariance									
The following comparisons test whether allowing τ^g to differ between groups *g* leads to significant changes in model fit (full metric invariance assumed).*									
3	Confounded interaction model COUNTRY x SOURCE	.096	1633.68	854	4	3484.07	60	.000	+
4	Combined main effects model COUNTRY+SOURCE	.215	5117.75	914	5	2963.07	50	.000	–
4a	Main effect model COUNTRY	.178	3880.78	934	5	1726.11	30	.000	–
4b	Main effect model SOURCE	.162	3391.64	944	5	1236.96	20	.000	–
5	Full scalar invariance model	.112	2154.68	964	n.a.	n.a.	n.a.	n.a.	n.a.
Block III. Model comparisons with respect to partial scalar invariance									
The following comparisons test whether allowing a subset of two item intercepts out of τ^g to differ between groups *g* leads to significant changes in model fit (full metric invariance assumed).									
3	Confounded interaction model COUNTRYx SOURCE	.096	1633.68	854	6	327.78	24	.000	+
6	Combined main effects model COUNTRY+SOURCE	.112	1961.46	878	7	864.36	10	.000	+
6a	Main effect model COUNTRY	.115	2038.11	882	7	787.71	6	.000	+
6b	Main effect model SOURCE	.146	2749.17	884	7	76.65	4	.000	+
7	Partial scalar invariance model	.148	2825.82	888	n.a.	n.a.	n.a.	n.a.	n.a.

Scalar invariance

Assuming that full metric invariance holds across all groups, any subsequent model comparisons with respect to scalar invariance only involve the τ^g-part of the model. The results are shown in the medium part of Table 5. If we interpret the results in MANOVA terms, the pattern would point to a strong disordinal interaction. Although heavily constrained, the full scalar invariance model fitted the data surprisingly well (Model 5; $\chi^2 = 2154.680$, $df = 946$, $\chi^2/df = 2.235$, RMSEA = .112). However, the reason seems to be that the rather strong effects of country (Model 4a) and information source (Model 4b) cancelled each other out, resulting in an even stronger interaction effect (Model 3). Although the pattern is interesting in itself, it also disconfirms scalar invariance across countries or information sources.

As noted by Steenkamp and Baumgartner (1998), *partial* scalar invariance would actually be sufficient to conduct meaningful comparisons between latent factor means. For each factor, the intercepts of the respective marker item plus one additional item have to be invariant. Thus, we computed the between-groups variance for each item intercept estimated in the metric invariance model (see above). For each factor, the item with the lowest between-groups variance was selected and constrained to be scalar invariant across all groups (Model 7), within countries (Model 6a), and within information sources (Model 6b).

The results are shown in the lower part of Table 5. Compared to the "new" full scalar invariance model, both main effects yielded a significant improvement in model fit. For country, the χ^2 value decreased by $\Delta\chi^2 = 787.710$ ($\Delta df = 6$, $p < .001$). For source, the χ^2 value decreased by $\Delta\chi^2 = 76.650$ ($\Delta df = 4$, $p < .001$). However, the interaction was also significant ($\Delta\chi^2 = 327.780$, $\Delta df = 24$, $p < .001$). The relative fit measures were $\chi^2/df = 1.913$ (RMSEA = .096) for the interaction model, $\chi^2/df = 2.302$ (RMSEA = .115) for the COUNTRY model, $\chi^2/df = 3.117$ (RMSEA = .146) for the SOURCE model, and $\chi^2/df = 3.182$ (RMSEA = .148) for the invariance-across-all-groups model. Referring to Bollen's (1989) criteria, the country model yielded a still reasonable fit. Also considering the pragmatic advantages of a strong measurement model, we decided to accept partial scalar invariance within countries.

Effects of information sources on latent factor means

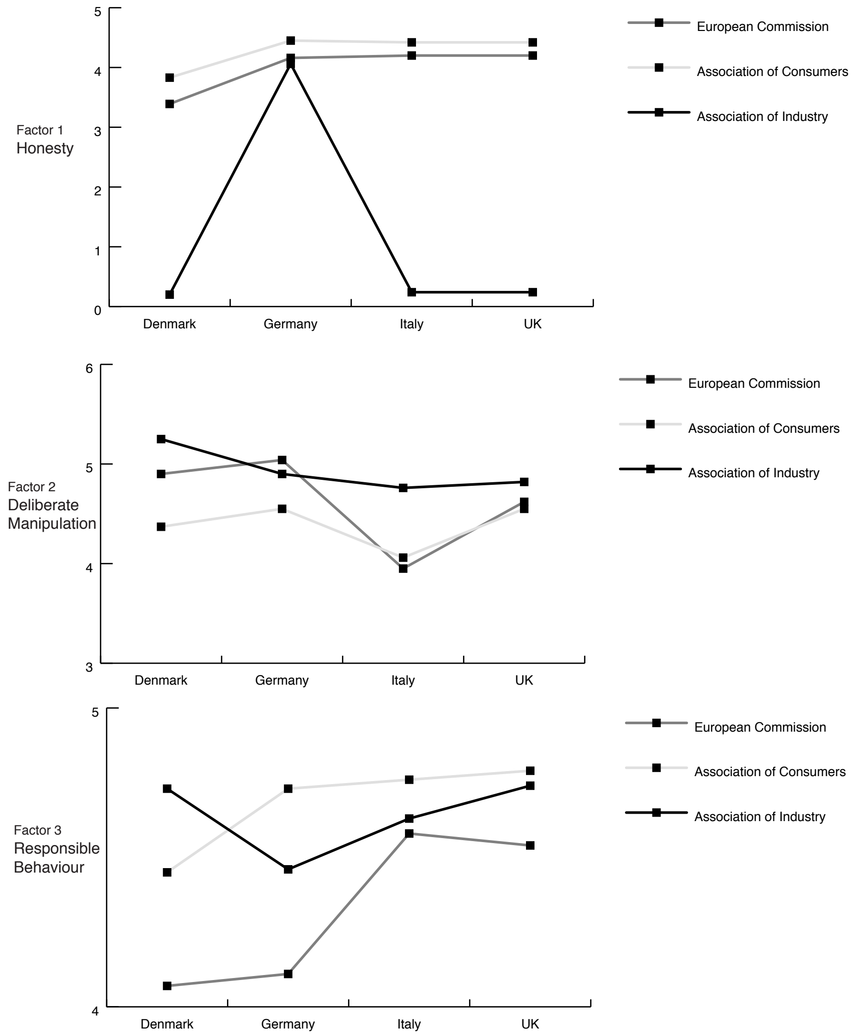
A full-profile MANOVA of observed item means would have required full scalar invariance. Full scalar invariance was disconfirmed, so we resorted to partial scalar invariance, and this could be confirmed to hold within each country. Partial scalar invariance invokes a common metric for the latent factor means κ^g (see Equation 3) associated with the three information sources, so that within-country comparisons of information sources become meaningful. The results are shown in Figure 6.

The strongest effects emerged with Factor 1 ("Honesty"). In Denmark, Italy and the United Kingdom, the industry association was perceived to be far less honest than the consumer association and the European Commission. A series of paired comparisons confirmed that these effects were highly significant (all *t*s > 15.380, all Bonferroni-adjusted *p*s < .001). No such difference emerged in Germany. In all four countries, the consumer association and the European Commission were judged equally honest.

Three significant effects emerged with Factor 2 ("Deliberate manipulation"). In Denmark, the industry association was perceived to be more prone to deliberate manipulation than the consumer association (t = 4.120, Bonferroni-adjusted p < .001). In Italy, the industry association was perceived to be more prone to manipulation than the consumer association (t = 2.765, Bonferroni-adjusted p < .05) and the European Commission (t = 2.906, Bonferroni-adjusted p < .05). All other effects in Denmark and Italy were insignificant. In Germany and the United Kingdom, no significant differences between industry association, consumer association, and European Commission were found at all.

Finally, two significant effects emerged with Factor 3 ("Responsible behaviour"). In Denmark, the industry association was perceived to show a more responsible behaviour than the European Commission (t = 4.151, Bonferroni-adjusted p < .001). In Germany, the consumer association was perceived to show a more responsible behaviour than the European Commission (t = 3.542, Bonferroni-adjusted p < .01). All other differences in Denmark in Germany were insignificant. No significant effects on this factor were found in Italy and the United Kingdom.

Figure 6. Latent means of credibility factors (1) honesty, (2) deliberate manipulation, and (3) responsible behaviour as a function of country and information source

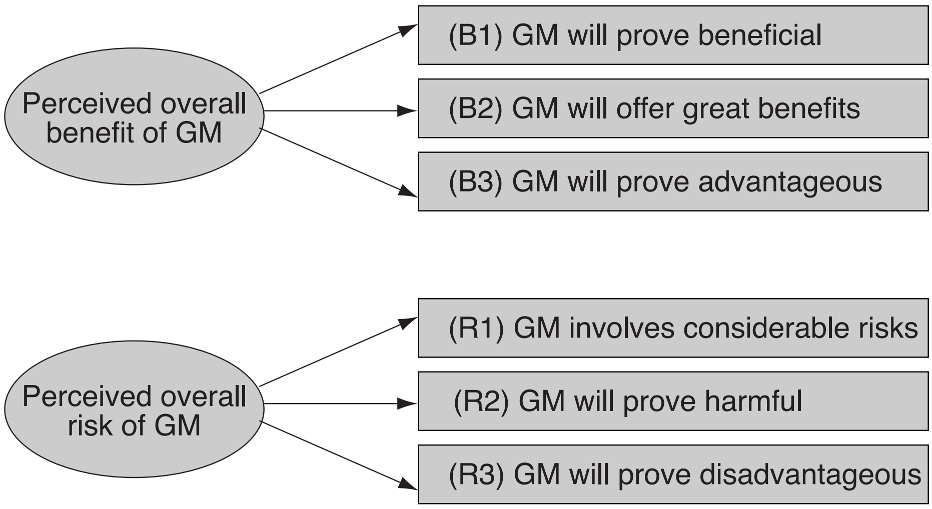


Measurement model for post experimental attitudes

Post-experimental attitudes had been measured on two scales: "Perceived overall benefit of applying gene technology to food production" (3 items) and "Perceived overall risk of applying gene technology to food production" (also 3 items). Both scales have already been validated in a large cross-cultural survey (Bredahl, in press). Nevertheless, we intended to replicate the findings and test whether the factorial structure of the attitudes remains invariant after an experimental information manipulation. A two-factor structure identical to the one in Bredahl (in press) was specified, assuming scalar invariance across all groups.

ML estimation of the model yielded a significant χ^2 value of 368.419 with 184 degrees of freedom. Applying the same mix of statistical and pragmatic considerations as before, the relative model fit measures appear still reasonable (χ^2/df = 2.002, RMSEA = .101). Thus, full scalar invariance was accepted. Model structure and invariant factor loadings are shown in Figure 7.

Figure 7. Measurement model for post-experimental attitudes (loadings are unstandardised)



Full structural equation model

Predicting latent factors for post-experimental attitudes by latent factors for source credibility means matching the two measurement models together. Equation (1) has already been used above to define the measurement model for source credibility. In the full structural equation model, this is the measurement model for the exogenous (independent) variables:

$$\mathbf{x}^g = \tau_x{}^g + \Lambda_x{}^g \, \xi \, g + \delta^g \, .$$

A structurally equivalent model can be defined for post-experimental attitudes, yielding the measurement model for the endogenous (dependent) variables:

$$\mathbf{y}^g = \tau_y{}^g + \Lambda_y{}^g \, \eta^g + \varepsilon^g, \tag{10}$$

where $\mathbf{y}^g$ is the qx1 vector of observed variables in group g, τ_y^g is the qx1 vector of intercept terms in group g, η^g is the nx1 vector of the latent endogenous factors in group g, Λ^g is the qxn matrix of factor loadings in group g, and ε^g is the qx1 vector of random errors in group g, assumed to be uncorrelated with the latent factors and to have zero expectation. Finally, the structural model defines the relationship between the endogenous variables η^g and the exogenous variables ξ^g in group g:

$$\eta^g = \alpha^g + B^g\, \eta^g + \Gamma^g\, \xi^g + \zeta^g, \tag{11}$$

where α^g is a vector of constant intercept terms, is an nxn matrix of coefficients of the relationships among the endogenous factors, Γ^g is an nxm matrix of coefficients of the regression on the exogenous factors, and ζ^g is an *nx1* vector of equation errors (random disturbances) in the structural relationship between η^g and ξ^g.

Structural effects of source credibility on post experimental attitudes

Since the final measurement model for source credibility was only invariant within each country, there were only two possible levels of invariance left for the structural model: (a) a model assuming a common but country-specific matrix of regression coefficients Γ for all three information sources, implying a main effect of country, or (b) a model assuming different matrices of regression coefficients for each source in each country, implying a country-by-source interaction.

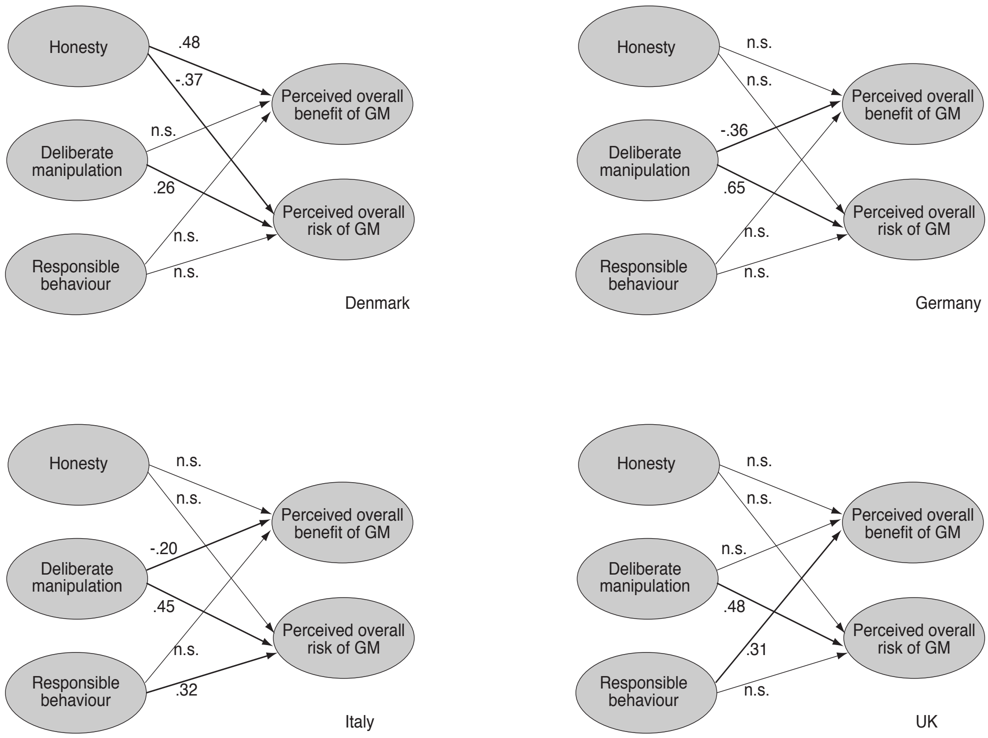
ML estimation of the COUNTRY model yielded a significant χ^2 value of 3975.686 with 2000 degrees of freedom. The χ^2/df ratio of 1.988 indicated an acceptable fit (RMSEA = .099). Relaxing the constraints and allowing different regression coefficients in each country x source group did not improve the fit of the model ($\chi^2 = 3993.685$, $df = 1952$, $\chi^2/df = 2.046$, RMSEA = .103; $\Delta\chi^2 = 17.999$, $\Delta df = 48$, $p > .999$). Thus, the COUNTRY model was accepted. The path diagrams are shown in Figure 8.

In Denmark, the perceived honesty of a source played a key role in consumers' judgements of the risks and benefits of gene technology: the more honest the source, the more beneficial and the less risky the technology. Perceptions of deliberate manipulation of the public, on the other hand, led to an increase in perceived risk. Consumers seem to draw inferences from such behaviour, regarding it as an instrumental act to hide existing but not widely known risks.

Perceptions of deliberate manipulation had an even stronger effect in Germany and Italy. Here, it was the dominating influence on perceived risk as well as on perceived benefit. In Italy, this was amplified by a quite disturbing phenomenon: the very same inferences seem to be drawn from responsible behaviour, relating it immediately to a hidden agenda. This fatalistic view of society and its agents is a cultural stereotype about Italy. Nevertheless, it seems to bear some true importance for the understanding of public responses to corporate communication.

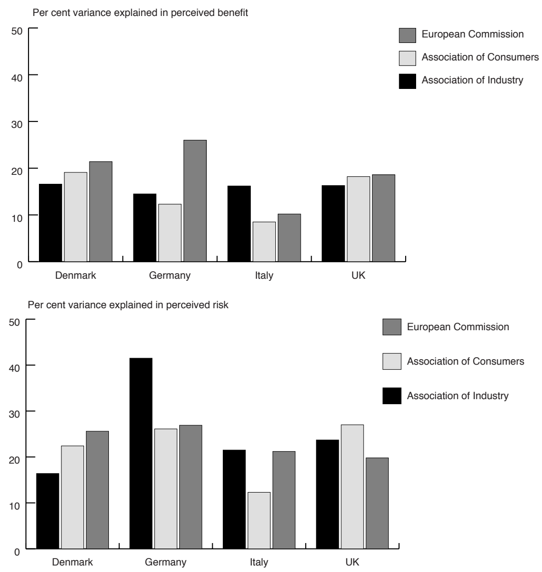
In the UK, perceptions of responsible behaviour had the expected effect, increasing the perceived benefit of gene technology. Perceptions of deliberate manipulation had the same effect as in Denmark, Germany and Italy. Again, consumers seem to infer a hidden risk that is to be kept from public awareness.

Figure 8. Country-specific structural models for the effects of source credibility on post-experimental attitudes (unstandardised coefficients; measurement models are omitted)



Overall, the effects of source credibility on post-experimental attitudes were strong. On average, source credibility could explain 19.0 per cent of the variance in perceived benefit in Denmark, 17.6 per cent in Germany, 11.6 per cent in Italy, and 17.7 per cent in the United Kingdom. Similarly, it could explain 21.5 per cent of the variance in perceived risk in Denmark, 31.5 per cent in Germany, 18.3 per cent in Italy, and 23.5 per cent in the United Kingdom. The distributions across countries and sources are shown in Figure 9.

Figure 9. Amounts of variance in post-experimental attitudes explained by source credibility



Discussion

The research developed here demonstrates that the relationship between information provision about genetically modified foods, and subsequent consumer behaviour is complex – simply bombarding consumers about genetically modified foods is unlikely to improve consumer acceptance of products. Other factors are likely to be influential in determining behaviours.

In all countries, consumers tended to select non-genetically modified products. Cross-national differences related to type of product were not very significant- there was a clear consumer preference for non-genetically modified products. Those respondents who had positive prior attitudes towards genetically modified foods were more likely to select genetically modified products, particularly in Denmark and Germany. These attitudes appeared relatively stable, and were not influenced by information provision.

One of the most important results indicates that the form of information strategy was less important than had been predicted. The provision of information (in itself) was more likely to activate existing attitudes already held by respondents than change these attitudes. This observation was consistent with the attitude accessibility model. The pattern of observed *higher* pre-post correlations in the experimental groups than in the control group is consistent with Fazio's attitude accessibility model (Fazio et al., 1982). As the model would have predicted, all information conditions – independent of their design and evaluative tendency – were more likely to activate existing attitudes towards gene technology than the no-additional-information condition in the control group. The activation of these attitudes did apparently not result in attitude change, but merely in attitude-consistent responses to the questionnaire. In the control group, on the other hand, participants only saw product examples with a "genetically modified" disclosure information on the labels. Judging from the low pre-post consistencies, the label information was less likely to activate pre-existing attitudes.

Also consistent with Fazio's attitude accessibility model (Fazio & Zanna, 1981) is the moderating effect of the actual product presented. The disclosure information on the yoghurt label claimed a direct-experience benefit (low fat content), thus increasing the likelihood that product-specific evaluations predominate. The disclosure information on the beer label claimed an indirect consumer benefit (environmentally sound production) that even required the activation of additional attitude dimensions in order to be evaluated, thus increasing the likelihood that evaluative processes are driven by global attitude dimensions rather than by product-specific judgements. It is likely that most consumers have been exposed to the debate about genetic modification to the extent that their attitudes are well established already. Labelling alone was unlikely to result in attitude activation.

It should be noted that the attitude activation model presupposes the existence of specific attitudes towards a particular action or object. The results described here are likely to be applicable only in cultures where attitudes towards genetically modified foods are already well established. Dual processing models such as the ELM would imply that, in situations where attitudes are not well formulated, and where personal salience of information about a particular topic is very low, then peripheral processing of that information is more likely to occur, and be influenced by contextual cues (such as perceived characteristics of the information source). If such peripheral processing occurs, attitude change is likely to be short-lived. In-depth processing of information is likely to occur only if the information is highly salient or relevant – and such in depth processing is less likely to depend on contextual cues associated with the information. Trust in information source would be less important under these circumstances – that is, under conditions where attitudes are uncrystallized but the issue is perceived to be highly salient.

The current research does not support the use of the ELM in the current European situation as the basis for formulating an information campaign about genetic modification. However, in other cultures (where public awareness about the issues associated with genetic modification are not so well formed) or in other areas of information dissemination (where a new or emerging technology may merit information dissemination with the public), it may be useful to adapt insights from dual processing theories such as the ELM in the development of information campaigns.

Trust does appear to influence the effect of information strategy. Preference for genetically modified products appears to increase if a source is perceived to be honest, and the information is product specific, or, if the source is perceived to be dishonest, if the information is balanced and general in content. This would align with the idea that information sources perceived to be promoting a vested interest are unlikely to be believed.

There are, as might be expected, strong cross-national differences between groups in terms of honesty, deliberate manipulation and source reliability. In particular, industry was perceived to be more dishonest providers of information about genetically modified foods compared to either the consumer association or the European Commission, at least in Denmark, Italy and the United Kingdom. This effect was not observed in Germany, where industry was as trusted as the other sources, and it is not immediately obvious why this is the case. One possible reason is that German industry sectors have always had greater and more visible concern with public safety through independent safety assessment procedures being instigated at its behest. This may have generalised to the agro-food sector to result in improved public perceptions of transparency and concern with public safety, although this must be investigated in future research. Of course, the possibility that the source is perceived to represent industry in general rather than the agro-food sector cannot be discounted.

The results do show that perceptions of trust, honesty and responsible behaviour associated with information sources are important determinants of increases or decreases in perceptions of risk or benefit associated with genetically modified foods, although there are variations in the extent of the effects attributable to cultural differences. Ideally, an information source should be perceived by the public to be high in honesty (our model would suggest through being accurate and factual, as well as trustworthy) and exhibit "responsible behaviour" (through the demonstration of honesty and expertise, and concern with public welfare, and maintaining a good track record in these areas). Behaviour which leads to public perceptions of "deliberate manipulation" (through public beliefs that information is being withheld, or distorted, that the source is acting to protect itself, and has been proven wrong in the past) should be avoided.

High levels of industrial investment in communication are unlikely to result in acceptance of novel genetically modified products. Communication might better be performed by organisations who have a more direct role in developing information about genetic modification for its own sake (that is, for the public good) rather than with the intention of having a direct impact on attitudes and consumer acceptance. If industry is to communicate at all, it is best to adopt a "balanced information approach" rather than a product specific focus for information dissemination. More trusted information sources are better placed to disseminate information about specific products, but may risk compromising their credibility.

From the perspective of developing particular products, manufacturers might utilise only a labelling strategy, allowing other organisations (for example, government and NGOs) to develop communication with consumers.

Further increases in consumer negativity towards genetically modified foods appear to have arisen because of the order of entry of products into the market place. The European public perceived that the first genetically modified foods available were of benefit to industry rather than the consumer. Novel foods with direct and tangible consumer benefits are more acceptable than those from which only industry will benefit or profit. This "order of entry" effect may well have amplified public perceptions of distrust in industry in the first place, as the public believed that they were being introduced with the aim of benefiting industry, not consumers. Perceptions of need and advantage (particularly associated with human health, environmental advantages, or animal welfare) will offset perceptions of risk, but only if the claims made about these benefits are realistic (Frewer et al., 1996, 1997).

Overall, it seems that providing information without due consideration of source and culture is unlikely to result in increased consumer acceptance of genetically modified products. Trust in the information source is more likely to influence perceptions of risk and benefit associated with genetically modified foods than the information strategy adopted. Finally, providing any information at all is more likely to prime attitudes already held than to crystallise or persuade the public of a particular view, especially in populations where there has been wide public debate about the risks and benefits of the new biosciences. However, providing information about genetically modified foods is important if the consumer is to make an informed choice about consuming them, and if the public debate about strategic development of the biosciences is to continue in an up-to-date, modern, and transparent way. Failure to provide information will decrease trust in regulators and the industry through heightened public perceptions of deliberate manipulation of information. Whilst it is arguable that some distrust in the providers of information is desirable because it promotes a healthy scepticism in safety issues and efforts to maintain consumer protection, it is better to maintain consumer confidence through transparency and consumer confidence in the food supply.

We would like to emphasise that the results do not imply that information about products should not be provided – rather that the goal of information provision should be to permit consumers to make informed choices about the consumption of genetically modified food products, rather than to improve consumer acceptance of genetically modified foods.

Further research

It is important to recognise that consumer attitudes are dynamic, and may possibly change when new information becomes available to consumers. In particular, a crisis or problem associated with genetic modification (either in the agro-food or pharmaceutical sector) is likely to stigmatise the entire technology. It may be useful to study effective communication in a crisis management situation as well as under the more normative situation addressed in the research reported here.

Another area worthy of future study is that of minority group influence (where "minority groups" are represented by consumer groups, environmental groups, and other NGOs). Regulators and scientists often express concern about the undue influence that minority groups (such as environmental or pressure groups) appear to have on public opinion about risks. Understanding the social psychology of minority influence, and the role that trust has in determining the extent of this influence, may help interpret the role of stakeholder groups, NGOs, and other pressure groups in the media debate about risk, as well as providing the opportunity to understand the potential impact of risk communication emanating from these groups on public opinion. Research has indicated that minority groups were able to influence majority decisions, and had the potential to act as agents of social change and innovation to a far greater extent than that effected by majority groups (Moscovici, 1976).

Consumer beliefs about the quality of food products are derived from quality cues, which may be broadly classified as either "intrinsic" or "extrinsic" (Steenkamp, 1989). These cues reflect salient consumer perceptions, attitudes and knowledge which are important in the psychology of food choice (Frewer, 1998). Intrinsic quality cues as relating to factors such as fat content and general appearance, whereas extrinsic quality cues may be associated factors external to the physical product such as brand, price and packaging. It would be useful to generate predictive models of likely consumer acceptance of genetically modified foods using the relative importance of these different cues as predictors of consumer acceptance.

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Annex 1. Product specific information

Information about *Brewmaster's Korbacher*

This beer is produced by means of genetic modification. Genetically modified yeast is used in order to brew beer in a more environmentally friendly way while still ensuring high quality beer.

Genetic modification of the yeast means that beer no longer needs to be stored for several weeks to maturate. This shortens the total production time to about one week. The shortened production process leads to a better use of natural resources; the need for production equipment is reduced, and much less energy is needed to produce the beer.

The gene that is used in the genetic modification is extracted from a food-derived micro-organism. The yeast is completely removed from the beer and all the foreign genetic material eventually left in the beer is destroyed by pasteurisation so that no genetic material is present in the end product.

The shorter beer production process increases the quality consistency of the beer, so that the quality of the beer is the same as in beer that is produced in traditional ways, only the beer quality remains more constant.

(Supplied by Oy Panomilaboratorio Bryggerilaboratoriet AB, Espoo, Finland)

Information about genetically modified low fat *Dairy Fresh* yoghurt

This yoghurt has been produced by means of genetic modification. Usually yoghurt is produced by fermenting milk with two Lactic Acid Bacteria, but in this case genes from a third bacteria have been inserted. Usually low-fat yoghurts are made with skim milk, which, however, makes the texture of the yoghurt rather thin and aqueous. If a more smooth texture is wanted, processing aids like antioxidants and stabilisers are then usually added to the product.

With this new yoghurt cultures low-fat skim milk can be fermented in a yoghurt without addition of any processing aids. The yoghurt can be produced in conventional yoghurt equipment without any need for additional processing.

(Supplied by Chr Hansen A/S, Hoersholm, Denmark)

Annex 2. Balanced/general information about genetically modified foods

What is genetic modification?

All living organisms (plants, animals and human beings) are made up of cells. The cells contain, among other things, hereditary characteristics (genes) that determine what each organism will look like, for example whether a child will get blue eyes or whether a plant will be able to resist a certain pesticide.

The hereditary characteristics of all living organisms are changed from one generation to another, either naturally or through traditional breeding techniques. By gene technology the hereditary characteristics are altered in a new way. Gene technology can be used to modify the hereditary characteristics of an organisms, to move hereditary characteristics from one organism to another, or take away a specific hereditary characteristic from an organism.

The supporters and opponents of genetic modification – and their interests

Those who favour genetic modification include:

- Farmers, who wish to maximise productivity / profitability through higher yields and a reduction in costs

- Companies that are developing new genetically modified seeds and companies that supply the pesticides to which genetically modified seed varieties are resistant (often members of the same group)

- Food manufacturers who look for additional benefits in the raw materials they buy (e.g. better taste, prolonged freshness, less damage to crops from pests, weather etc.)

- Research scientists who wish to improve our knowledge of biochemistry and who are interested in innovation that would help us produce more food.

Those who have declared themselves against genetic modification include:

- “Green” activists concerned that the world’s ecological balance may be damaged

- “Healthy food” activists concerned by the possible longer-term health implications

- Consumer groups opposed to the influence of large corporations

- Campaigning journalists whose views coincide with those of the above groups

There is also a third group, the “wait and see” neutral observers in government, science, industry and the media. This group recognises potential benefits in genetic modification in the longer term, but demands safeguards (through testing) and respect for consumer rights (product labelling to ensure that consumers have a possibility of choosing whether they want to buy genetically modified products).

Arguments for and against genetic modification

Product quality

Those who are for genetic modification argue that we have engaged in selective breeding of both animals and plants for centuries to improve their characteristics. In their view genetic modification simply lets us do this more quickly and better. The opponents, on the other hand, say that consumers have not asked for these "improvements". In fact, the opponents claim, consumers are more interested in a return to more naturally grown foods.

Safety and health

Some people say lets farmers and the food industry produce safer and healthier products that also resists damage from e.g. pests or bad weather better but are otherwise identical to traditional foods. Against this the question has been put: How do we know what the longer-term effects will be on future generations? According to these people animal testing is not enough, and there is a danger that we will discover the harmful effects too late.

Here, proponents argue that all development and use of genetically modified products is subject to official approval to ensure that they are safe and do not result in unwanted side-effects, either on the general environment or human health. But not all experts agree with this. They don't trust the authorities, whom they believe have shown themselves to be on the side of the big corporations in this as in many other areas.

Human achievement

Some also see genetic modification as an outstanding example of our ability and emphasize that we have been using our creativity and capacity for innovation for thousands of years to harness natural resources. This has resulted in the scientific advances on which our modern civilization is based. Against this has been put the view that we do not know enough to interfere with natures basic building blocks, and that we should not "play god".

Environment

Nor do proponents and opponents agree on the environmental impact of genetic modification. Opponents claim that genetic modification may have damaging effects on the environment, because it is not natural and may lead to, for instance, plant resistance when it is used in pesticides. Proponents, on the other hand, claim that genetic modification results in higher yields and less waste. This will improve our use of valuable natural resources and thus protect the environment. Many proponents also argue that genetic modification can in fact be used to reduce the use of pesticides and chemical fertilisers.

Some also favour genetic modification because they believe that it will reduce our dependence on scarce raw materials, and that it will help us provide enough food for the world's rapidly increasing population. Others oppose this solution to the food shortage problem by stating that if a raw material is scarce, we have always been able to find alternatives or new methods to increase production without interfering with basic natural principles.

The use of genetic modification in food production

Genetic modification of organisms, mostly plants and microbes, is now used to help make food products. Scientists transfer hereditary material, DNA, from one organism to anther in a way which does not happen in nature to give the genetically modified organism new features. Ingredients in food production are often derived from genetically modified organisms. The best known examples are plant breeding, where scientists have modified crop plants both to help farming and to improve the quality of the product. Genetic modification techniques can also be used in food processing. Food producers use such methods to test for harmful bacteria. Many also use a number of enzymes such as rennet to produce cheese and amylase to make starch syrup. These enzymes are frequently made using genetically modified microbes to obtain an even and high quality.

Man has used microbes for thousands of years in food production. We use, for instance, yeast in baking and in the production of wine and beer. Many dairy products are made using lactic acid bacteria, and the old way of preserving vegetables by fermentation, e.g. in sauerkraut, is a microbiological process. Scientists have also modified the microbes used to produce food. In these developments they remove or enhance certain features of the microbe, or they may even transfer genes from one food producing microbe to another. Their reason for this is again either to improve the process or the product.

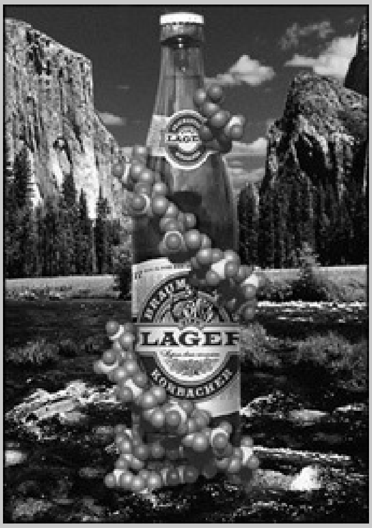
Scientists have modified both yeast and lactic acid bacteria, for instance to produce more vitamins, and to produce more, or less, of certain flavour compounds. We can control the way dough rises by genetic modification of the yeast. We can use modified microbes instead of additives and preservatives, also we can make low calorie products using modified microbes. Such microbes may help food production in other ways as well but only a few are on the market at present.

Clearly, we must avoid inventing new types of food which have health risks. We therefore have to do everything possible to ensure that these new products are safe.

Annex 3. Advertisements appealing to consumer innovativeness

Discussions won't save energy resources.

Biotechnology will.



Hence we have developed this beer. The new brewing technology requires 70% less energy.

Less energy. Less resource consumption. Lower environmental burden.

There is still so much to do. But we should begin somewhere.

Come with us.

Step into a new era.

Braumeister's Korbacher

Talk won't benefit the environment –

genetic modification will.

Therefore we have developed this beer. Because of genetic modification we have used 70% less energy to produce it.

Less energy. Less resource consumption. Lower environmental burden.

For the benefit of yourself and othes. And you even save money with it.

Of course, there is still much to do

But we should begin somewhere

Braumeister's Korbacher

Talk won't benefit the environment –

genetic modification will.

Therefore we have developed this beer. Because of genetic modification we have used 70% less energy to produce it.

Less energy. Less resource consumption. Lower environmental burden.

For the benefit of yourself and othes. And you even save money with it.

Of course, there is still much to do

But we should begin somewhere

Braumeister's Korbacher

Smooth without fat.

Creamy without additives.

Here is your chance, finally, of enjoying a lowfat yoghurt.

Full taste. Smooth texture. No fat. No additives.

A natural choice for your self and others.

Enjoyment and healthiness through genetic modification.

Dairy Fresh 0.05% – genetically modified

Annex 5. Choice sets

Beer products

1. *"Brewmaster's Korbacher"*. Beer produced by means of genetically modified yeast, which ensures that the production process becomes less time and energy consuming, and thus more environmentally friendly, sold at a low price.

2. *"Brewmaster's Steinfurter"*. Beer produced in a traditional way from high quality raw materials, sold at a medium price.

3. *"Brewmaster's Muehlberger"*. Beer produced in a traditional way from standard quality raw materials, sold at a low price.

4. *"Brewmaster's Alfelder"*. Beer produced by means of modern process technology (specified as not gene technology) which ensures that the production process becomes less time and energy consuming, and thus more environmentally friendly, sold at low price.

Yoghurt products

1. *"Dairy Fresh 0.05% fat, genetically modified"*. Fat-free yoghurt produced with genetically modified starter culture, characterised by a nice taste and smooth texture.

2. *"Dairy Fresh 0.05% fat"*. Fat-free yoghurt produced with stabilisers and antioxidants, characterised by a nice taste and smooth texture.

3. *"Dairy Fresh 0.1% fat"*. Traditional low-fat skim-milk yoghurt without additives, characterised by a nice taste and thin texture (owing to the low fat content).

4. *"Dairy Fresh 3% fat"*. Traditional full-fat whole-milk yoghurt without additives, characterised by a nice taste and smooth texture.

Annex 6. Respondent inclusion criteria

1. Must be the main or joint household shopper.

2. Must have purchased bottled lager or yoghurt for consumption in the home in the last 4 weeks.

3. Must consume bottled lager in the home at least once a week for the lager test.

4. Must consume yoghurt at least once a week for the yoghurt test (not necessarily in the home as yoghurts can be purchased for packed lunches etc).

5. Must have heard of genetic modification or equivalent (genetic engineering / biotechnology).

6. Do not have extreme attitudes about applying gene technology in food production (those responding "extremely bad" or extremely good" on a seven point scale were excluded from the study). Similar exclusion criteria applied to extreme scores on the items "applying gene technology to food production is extremely foolish" to "extremely wise" ; and "strength of feeling towards the application of gene technology in food production" from "strongly against" to "strongly in favour".

Annex 7. Design of questionnaire

Once it was ascertained that respondents met the entry criteria for either the yoghurt or the beer condition, they were assigned to one of the experimental groups as appropriate for the quota. They were then assessed on various attitudinal items according to the experimental condition to which they were assigned.

Stage 1. Prior attitudes towards genetic modification in food production

The attitudes that people had towards genetic modification in food production were assessed using the following items (people with extremely positive or negative attitudes were screened out at the stage of subject exclusion).

1. Applying gene technology in food production is: Extremely bad to extremely good, (7 point scale).

2. Applying gene technology in food production is: Extremely foolish to extremely wise, (7 point scale).

3. I am "strongly against applying gene technology in food production" to "extremely for applying gene technology in food production", (7 point scale).

Stage 2. Information intervention

Respondents got either the product specific information about either beer or yoghurt, the balanced information, or the classical advertising information (not United Kingdom), attributed to the sources described in Table 1. People in the control group got no information at this stage.

Stage 3. Product ranking

All respondents were then asked to rank either the four dummy beer products or the four dummy yoghurt products according to their preferences.

1. The product I like most is number…….

2. then number…….

3. then number…….

4. The product I like least is number…….

Stage 4. Attitudes to genetic modification of food

Attitudes to genetic modification of food were assessed using the following items. Respondents had to state the extent to which they agreed or disagreed with each of the following statements, using a seven point scale anchored at one pole by "strongly disagree" (1) and at the other by "strongly agree" (7).

1. Overall, applying gene technology to produce food products will prove beneficial to the environment, myself and other people that are important to me.

2. Overall, applying gene technology to produce food products involves considerable risk to the environment, myself and other people that are important to me.

3. Overall, applying gene technology to produce food products will offer great benefits to the environment, myself and other people that are important to me.

4. Overall, applying gene technology to produce food products will prove harmful to the environment, myself and other people that are important to me.

5. Overall, applying gene technology to produce food products will prove advantageous to the environment, myself and other people that are important to me.

6. Overall, applying gene technology to produce food products will prove disadvantageous to the environment, myself and other people that are important to me.

Stage 5. Food neophobia items

Respondents had to state the extent to which they agreed or disagreed with each of the following statements (taken from Pliner and Hobden, 1992), using a seven point scale anchored at one pole by “strongly disagree” (1) and at the other by “strongly agree” (7).

1. I am constantly sampling new and different foods.

2. I don’t trust new foods.

3. If I don’t know what is in a food, I won’t try it.

4. I am afraid to eat things I have never eaten before.

5. I will eat almost anything.

Stage 6. Qualities of the information: source credibility and trust

Perceptions of the qualities of the information were assessed using the following items. Respondents had to state the extent to which they agreed or disagreed with each of the following statements, using a seven point scale anchored at one pole by “strongly disagree” (1) and at the other by “strongly agree” (7). SOURCE was replaced by either “The European Commission”, the “European Association of Industry” or the “European association of Consumers” according to condition (this part of the questionnaire was omitted in the control conditions where no information was presented).

1. Information about food-related hazards from SOURCE is trustworthy.

2. Information about food-related hazards from SOURCE is accurate.

3. Information about food-related hazards from SOURCE is factual.

4. The SOURCE is likely to withhold information about food-related issues from the public.

5. Information about food-related hazards from SOURCE is distorted.

6. Information about food-related hazards from SOURCE is truthful.

7. Information about food-related hazards from SOURCE is biased.

8. The SOURCE has the freedom to provide information to the public about food-related hazards.

9. The SOURCE has a vested interest in promoting a particular view about food-related hazards.

10. Information about food-related hazards from the SOURCE has been proven wrong in the past.

11. The SOURCE is knowledgeable about food related hazards.

12. The SOURCE feels a responsibility to provide good food-related information to the public.

13. The SOURCE is expert in the area of food-related hazards.

14. The SOURCE provides sensationalized information about food-related hazards.

15. The SOURCE has a good track record of providing information about food-related hazards.

16. The SOURCE provides accurate information about food-related hazards only to protect themselves and their own interests.

17. The SOURCE is accountable to other (for example, regulatory bodies) if mistakes are made in the food-related information provided.

18. The SOURCE is concerned about public welfare.

19. I am personally in favour of using the SOURCE to obtain information about food-related hazards.