Determinants of consumer attitudes and purchase intentions with regard to genetically modified foods – Results of a cross-national survey

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PREFACE

This working paper presents the results of a cross-national survey that was carried out as a task of the project Consumer Attitudes and Decision-Making with Regard to Genetically Engineered Food Products, funded by the European Commission through contract no FAIR-PL96-1667.

Co-ordinator of the project was Professor Klaus G. Grunert, The MAPP Centre. Participating organisations were the Technical Research Centre of Finland; Universität Potsdam, Germany; ISIDA, Italy; Institute of Food Research, the UK; Oy Panimolaboratorio-Bryggelaboratoriet AB, Finland, and Chr. Hansen A/S, Denmark.

I would like to thank all members of the project group for helpful comments on the research which is reported in this paper, and particularly Joachim Scholderer, Universität Potsdam, Francesco Guadalupi and Daniela Mori, ISIDA, and Clive Downs and Lynn Frewer, The Institute of Food Research, for arranging the data collections in Germany, Italy and the United Kingdom.

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EXECUTIVE SUMMARY

1. Previous research has shown consumers to be highly sceptical towards genetic modification in food production. So far, however, little research has tried to explain how consumers form attitudes and make decisions with regard to genetically modified foods.

2. The paper presents the results of a survey which was carried out in Denmark, Germany, Italy and the United Kingdom to investigate the formation of consumer attitudes towards genetic modification in food production and of purchase decisions with regard to genetically modified yoghurt and beer. Altogether, 2031 consumers were interviewed in the four countries.

3. Results show that attitude formation and decision-making are more comparable among Danish, German and British consumers than with Italian consumers. Likewise, Italian consumers turned out to be significantly less negative towards genetic modification in foods than particularly Danish and German consumers. This points to a possible North-South division in consumer perceptions of genetic modification.

4. Across countries, attitudes towards genetic modification in food production were deeply embedded in more general attitudes held by the consumers, in particular attitude towards nature and attitude towards technology. These general attitudes were found to influence attitudes towards genetic modification through their impact on perceived risks and benefits of the technology. In Denmark, Germany and the United Kingdom, perceived risks of applying genetic modification in food production in themselves prevented the perception of benefits, while in Italy the impacts of perceived risks and benefits on attitudes were identified as entirely additive.

5. Purchase decisions with regard to the two product examples were almost exclusively determined by attitudes towards purchasing the products, which were, in turn, significantly influenced by overall attitudes towards genetic modification in food production through their effects on beliefs that consumer hold about the quality and trustworthiness of the products.

6. The results clearly verify that consumer acceptance of genetically modified foods is low at present. The strong links of attitudes towards genetic modification in food production to higher-order attitudes and knowledge domains suggest that attitudes towards genetically modified foods are quite strong, despite their lack of basis in actual product experience. Likewise, the strong relation of product-specific attitudes to overall attitudes towards genetic modification in food production suggests that at present consumers tend to reject the technology overall rather than to consider products on a case-by-case basis. This situation may, however, be changed by a possible increased availability of genetically modified food products on the consumer market.

INTRODUCTION

At the end of 1996 an Århus harbour quay was turned into a seething whirlpool for several weeks when consumers demonstrated against the discharge of genetically modified soy beans. Highly spectacular pictures of demonstrators having chained themselves to the quay soon reached the national media and contributed to the intensification of the public debate on the use of genetic modification in food production. Similar situations occurred in several other European countries that received genetically modified soy beans at about the same time. Since then, numerous opinion polls, with the Eurobarometer survey as the most comprehensive example (European Commission, 1997), have shown that not only highly involved consumers such as the demonstrators on the Århus quay oppose genetic modification in food production but that consumers in general are highly sceptical of genetically modified food products.

Despite the high public awareness and the vested interests of many parties in this new production technology, few research projects have yet tried to explain how consumers form attitudes towards the use of genetic modification in food production and, equally important, how these attitudes can be expected to influence subsequent purchase behaviour with regard to genetically modified foods[1]. This paper reports the results of an empirical study that was conducted to investigate these issues.

THEORETICAL APPROACH AND RESEARCH OBJECTIVES

In cognitive psychology, attitudes are recognized as one of the major factors that guide human behaviours. Acknowledging that not all behaviours are under complete volitional control, the concept of behavioural intentions has been introduced as an intermediate which moderates the impact of attitudes on behaviours. A behavioural intention reflects a person's decision to perform the behaviour, and the idea behind introducing the concept is that a decision to engage in a certain behaviour will be realized only to the extent that the person is in full control of performing the behaviour (Fishbein & Ajzen, 1975).

Applying genetic modification in food production is a relatively new phenomenon and consumers have not yet had much opportunity to actually purchase genetically modified foods, simply because few products are yet marketed and labelled as such. In general, consumers therefore only have very limited, if any, direct product experience. This makes it reasonable to expect consumers' attitudes towards purchasing specific genetically modified foods to be influenced by their overall attitudes towards the use of genetic modification in food production.

As indicated, the sparse occurrence of foods which are marketed as genetically modified implies that the use of genetic modification in food production represents a new attitude object to consumers. It has been proposed that attitudes towards emergent attitude objects are in general weak and therefore also poor predictors of behaviour, because they are only based on indirect experience with the attitude object (Fazio & Zanna, 1978; 1981). However, the case of genetic

1 The term 'genetically modified foods' is used in this paper as a general designation of foods that have been produced with genetic modification, regardless of whether the products contain genetically modified material, and regardless of whether the characteristics of the products deviate from those of conventionally produced foods.

modification has been shown to be one of great social and individual involvement, especially because the technology offers barrier-crossing possibilities for developing products which may significantly transform our future life. Attitudes that are powered by such high involvement are generally found to be quite deeply embedded in higher-order life values (Ostrom & Brock, 1968; Thomsen, Borgida & Lavine, 1995). Values can be characterized as enduring beliefs about desirable goals that serve as guiding principles in people's lives (Rokeach, 1973; Schwartz, 1992). Strong links with values therefore suggest that attitudes towards the use of genetic modification in food production are, in fact, quite strong and generally express more fundamental beliefs. Previous research has provided support for this by showing that attitudes towards genetic modification in food production are directly linked to a number of more general attitude domains such as attitude towards nature and attitude towards technology (Frewer, Hedderley, Howard & Shepherd, 1997; Sparks, Shepherd & Frewer, 1994). These attitudes are generally of a more abstract nature, which makes it likely that they may work as intermediaries between values and attitudes towards genetic modification in food production.

The above considerations can be summarized into a hierarchy in which values are antecedents of more general attitudes which frame attitudes towards genetic modification in food production. These attitudes then feed into the formation of attitudes towards purchasing specific products manufactured by means of genetic modification, and, together with other factors, these product-specific attitudes eventually determine purchase intentions and behaviour. The hierarchy is similar to value-attitude-behaviour hierarchies identified in other research (eg Homer & Kahle, 1988; Thøgersen & Grunert-Beckmann, 1997) and can be listed as follows:

$$V \Rightarrow GA \Rightarrow A \Rightarrow AB \Rightarrow BI \Rightarrow B$$

These relationships form an important theoretical basis for the research presented.

Specifically, the objective of the research was to investigate the formation of consumer attitudes towards the use of genetic modification in food production and the formation of purchase decisions with regard to genetically modified foods by empirically estimating the attitude and purchase intention models developed by Bredahl, Grunert and Frewer (1998).

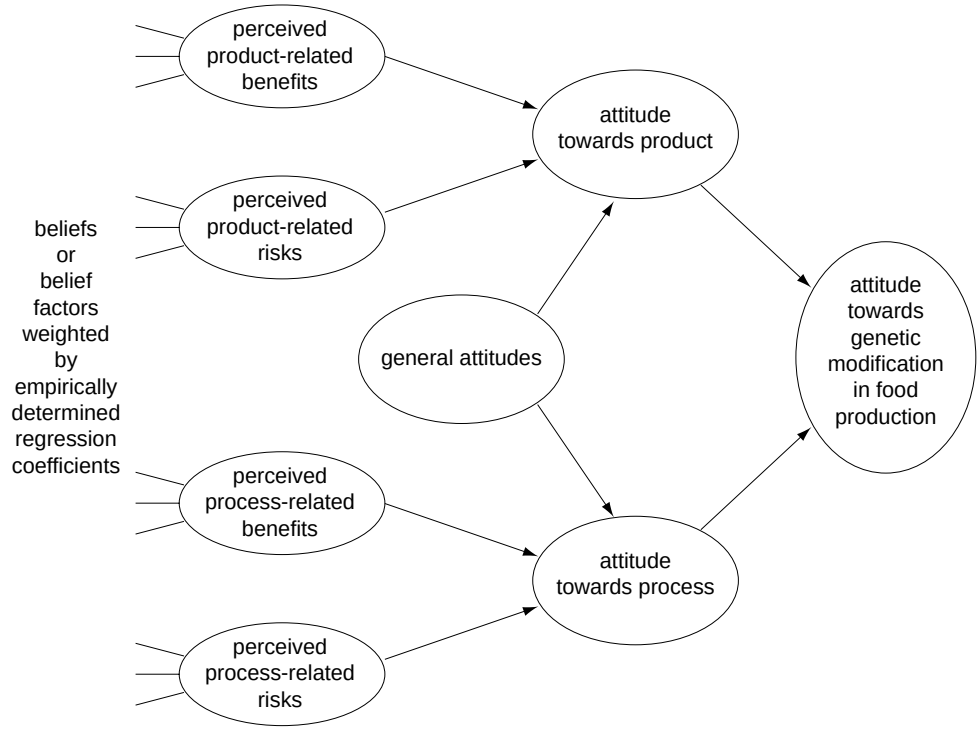
Both models adopt a belief-based approach and build on Fishbein's multiattribute attitude model (Fishbein, 1963) and the extension of this framework into The Theory of Planned Behavior (Ajzen, 1985; Ajzen & Fishbein, 1980). In his model Fishbein suggests that a person's attitude towards an object is determined by the sum of beliefs that the person has about the consequences or attributes of the object weighed by how they are evaluated, commonly referred to as outcome beliefs and outcome evaluations. In the Theory of Planned Behavior this principle is used to explain behavioural intentions as a combination of attitudes towards the behaviour, perceived social pressure, called subjective norm, and perceived behavioural control over performing the behaviour. Following Fishbein's model, the three subconstructs are seen as determined by outcome beliefs weighed by outcome evaluations, normative beliefs weighed by motivation to comply with the opinions of the normative referents, and control beliefs weighed by their powers, respectively.

In empirical research using Fishbein's and Ajzen's models, global measures of the subconstructs are usually taken and their determinants are estimated by multiplying measures of belief strengths with measures of the belief weighing aspects (ie outcome evaluations, motivation to comply with referents and power of control beliefs). After this, the obtained belief composites are either added and correlated with or regressed on global measures of the corresponding subconstruct. This multiplication principle to estimate attitudes and other subconstructs in Fishbein and Ajzen's models has been heavily criticized by, among others, Schmidt (1973) and Evans (1991) who emphasized that correlation and regression analyses using multiplicative variables are inappropriate because the results will depend on the scales used to measure the components of each composite variable. Bredahl, Grunert and Frewer (1998) therefore omitted direct belief weighing measures in their proposed attitude and purchase intention models. Instead, they suggest deriving belief weighing measures empirically as standardized regression coefficients by regressing the measured beliefs on the corresponding global measures of the subconstructs.

In their models, Bredahl, Grunert and Frewer also take into account previous research on the determinants of consumer perceptions of modern food biotechnology. The proposed attitude and purchase intention models therefore deviate from Fishbein and Ajzen's models in a number of other ways as well.

Thus, the proposed attitude model predicts that a person's attitude towards the use of genetic modification in food production is determined both by the attitude that the person holds towards the process of applying genetic modification in food production and by the attitude that the person has towards the resulting products. Attitude towards process and product are in turn hypothesized to be determined by more general attitude domains, and by product and process-related beliefs about the risks and benefits of applying genetic modification in food production. In addition, it is hypothesized that the beliefs about risks and benefits will be related not only to the self, as in Fishbein's model, but also to other groups, such as the environment or one's family. Finally, it is hypothesized that these beliefs may precede attitudes either independently of each other or, depending on their correlations, through underlying belief factors. A graphic representation of the model can be seen in figure 1.

Figure 1. The attitude model

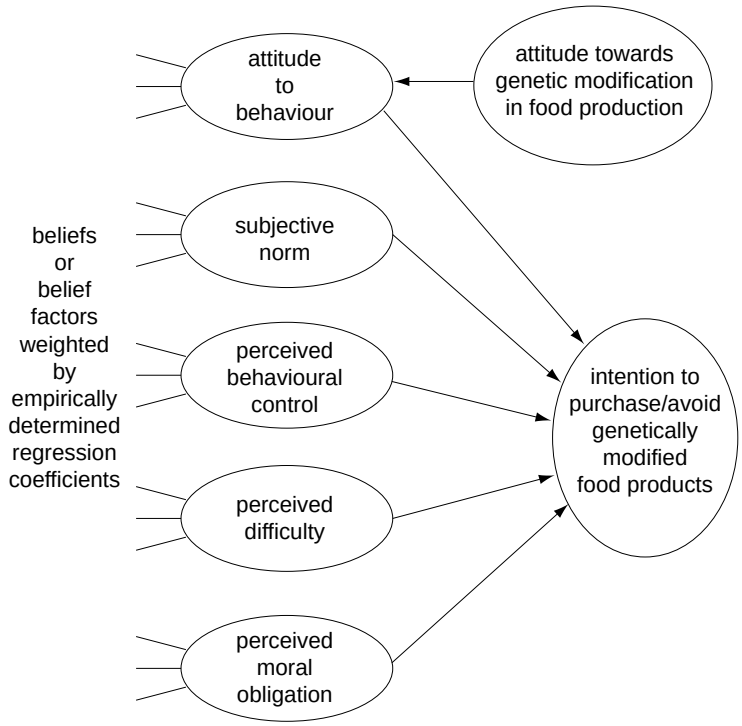


Source: Bredahl, Grunert & Frewer (1998)

The proposed purchase intention model suggests that a person's intention to purchase or avoid a genetically modified food product may be determined both by the attitude that the person has towards purchasing the product, by the subjective norm, by the perceived control over the decision to purchase the product, by the perceived difficulty of avoiding the product, and, finally, by the perceived moral obligation to avoid the product. In accordance with the structure of the Theory of Planned Behavior, each of these subconstructs are in turn hypothesized to be determined by beliefs held by the person. Also in this model, it is suggested that these beliefs may precede the global subconstructs either independently of each other or grouped in belief factors. An overview of the model is shown in figure 2.

In this research, the models were employed to investigate the determinants of attitudes and purchase intentions of consumers in Denmark, Germany, Italy and the United Kingdom. The populations of these countries have previously been shown to differ in acceptance of food biotechnology and in food-related attitudes and behaviour (Askegaard & Madsen, 1995; Brunsø, Grunert & Bredahl, 1996; European Commission, 1997), but are at the same time part of the same Western culture and hence share some common characteristics and ways of thinking. The four countries were therefore regarded good candidates not only for validating the proposed models across different cultural environments but also for providing a comparable basis for detecting national differences in attitude formation and decision-making with regard to genetically modified foods.

Figure 2. The purchase intention model



Source: Bredahl, Grunert & Frewer (1998)

DESIGN OF THE STUDY AND DATA COLLECTION

The models were investigated by means of a survey methodology, and partly with genetically modified yoghurt and beer as examples.

Respondents

2031 consumers were interviewed with some 500 respondents in each country. The interviews were divided into two parts. First, respondents answered questions to estimate the attitude model. Half the respondents in each country then answered questions to estimate purchase intention models for genetically modified yoghurt, while the other half answered questions to estimate purchase intention models with regard to genetically modified beer.

Respondents were selected by stratified random sampling procedures. Only consumers who had heard about genetic modification were recruited, and minimum consumption frequencies were set to ensure that respondents were regular consumers of yoghurt and beer, respectively. Consumers who were interviewed about genetically modified yoghurt had to consume yoghurt at least twice a month, and, taking into account national differences in consumption levels, consumers to be interviewed about genetically modified beer had to drink beer at least once a week in Denmark and Germany, and at least twice a month in Italy and the United Kingdom. Major demographic characteristics of the samples are shown in table 1.

Table 1. Major sample characteristics

	Denmark		Germany		The UK		Italy	
	yoghurt (n=250)	beer (n=255)	yoghurt (n=258)	beer (n=258)	yoghurt (n=250)	beer (n=249)	yoghurt (n=256)	beer (n=255)
Gender, %								
– male	40	67	42	72	8	73	57	60
– female	60	33	58	28	92	27	42	40
Mean age, years (Standard deviation)	45.1 (15.6)	44.0 (17.4)	43.2 (17.2)	44.9 (15.4)	39.7 (13.5)	37.7 (12.1)	39.0 (11.9)	37.5 (11.1)

Products

The products were developed as examples of applications of genetic modification to produce foods with explicit consumer benefits, in the yoghurt case a health benefit and in the beer case an environmental benefit and a price benefit.

Prior to being interviewed about their purchase intentions, respondents were shown cards that displayed back and front labels with basic product information about the fictitious genetically modified yoghurt or beer product.

The yoghurt was presented as an example where genetically modified starter culture had been applied to produce a fatfree product with a creamy texture without the use of artificial additives. The beer was presented as a product where genetically modified yeast had been applied to produce a beer which was more environmentally friendly and also cheaper than traditional beers, due to lower energy consumption because the beer did not have to be stored for maturation. On the cards, only the yoghurt product was labelled 'genetically modified', which is in compliance with the latest EU regulations (brewing yeast would be filtered out of a product like the beer described here before marketing, and since the use of genetic modification in this way would not change the characteristics of the resulting product either, the beer example used would not have to be labelled, cf. Regulation 398R1139 and Directive 79/112/EEC). For both the yoghurt and the beer, the application of genetic modification was clearly stated on the displayed back labels of the products, however.

Elicitation of general attitudes, beliefs, outcome groups and normative referents

Substantial input for the questionnaire was obtained from a qualitative study conducted in the four countries using means-end chain theory and the laddering technique and the same product examples (Bredahl, 1999).

Drawing also on previous research on consumer perceptions of genetic modification in food products (reviewed in Bredahl, Grunert & Frewer, 1998), the fol-

lowing general attitude and knowledge domains were elicited as possible determinants of attitudes towards genetic modification in food production: attitude to nature (Frewer, Hedderley, Howard & Shepherd, 1997; Hamstra, 1995), attitude to technology (Borre, 1990; Hamstra, 1991; Sparks, Shepherd & Frewer, 1994), food neophobia, alienation from the market place (Frewer, Howard, Hedderley & Shepherd, 1996), perceived knowledge of the use of genetic modification in food production (Frewer, Howard & Shepherd, 1997), actual knowledge about food production and involvement in environmental issues.

Sixteen beliefs concerning risks and benefits of using genetic modification in food production were elicited as well, as were nine outcome beliefs, two control beliefs, two difficulty beliefs and three moral beliefs for each product. The beliefs are shown in Appendix A.

Self, family, future generations and the environment were elicited as salient outcome groups. Likewise, family was elicited as the only normative referent in the case of yoghurt, while friends were elicited as the only salient normative referent for the purchase of beer.

Generally, results of the qualitative study strongly suggested that consumer attitudes towards the use of genetic modification in food production were unlikely to be a result of such elaborate cognitive effort as is suggested in the attitude model (see figure 1). Specifically, the results did not provide support for the anticipated existence of separate process and product-related attitudes. Likewise, no differences in beliefs regarding risks and benefits of using genetic modification in food production could be identified depending on which outcome group was considered.

Questionnaire design

The preamble of the questionnaire was an introduction to the applied response scales along with a brief description of gene technology and a definition of our use of the term 'genetically modified food products'. The description was kept as neutral as possible, and went as follows:

> 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 instance whether a child will have 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 organism, to move hereditary characteristics from one organism to another, or to take away a specific hereditary characteristic from an organism.
>
> When we use the term 'genetically modified food products' in this study, we mean foods where gene technology has been applied at some stage in the production process.

The questionnaire was then divided into two sections: one section with items to estimate the attitude model, and one section with items to estimate the purchase intention model.

Apart from the omission of belief weighing measures, the formulation of items and the applied measurement scales generally complied with the recommended structures for empirical research based on Fishbein's attitude model and The Theory of Planned Behavior.

Items were listed in a randomized order in each section. The items are outlined below with corresponding scale end-point labels in italics. Unless otherwise noted, 7-point Likert-type scales were used.

Questionnaire items: Attitude model

As a consequence of the qualitative study, separate measures of attitudes towards product and process were omitted and beliefs were not specified for individual outcome groups. Instead, measurements of perceived risks and benefits were complemented by global measures of perceived overall risks and benefits related to all elicited outcome groups.

Attitude towards genetic modification in food production was measured globally by the three items 'Applying gene technology in food production is *extremely bad – extremely good*', 'Applying gene technology in food production is *extremely foolish – extremely wise*', and 'I am *strongly against – strongly for* applying gene technology in food production'.

Perceived overall benefits were measured by 'Overall, applying gene technology to produce food products will prove beneficial to the environment, myself and other people that are important to me', alternatively '.. will offer great benefits..' and '.. will prove advantageous..'. Perceived overall risks were measured along the same lines by 'Overall, applying gene technology to produce food products involves considerable risk to the environment, myself and other people that are important to me', alternatively '.. will prove harmful..' and '.. will prove disadvantageous..'. The items were assessed on *strongly disagree – strongly agree* scales.

The elicited beliefs about risks and benefits of using genetic modification in food production were each measured on *strongly disagree – strongly agree* scales as well.

Measurement of general attitudes and knowledge domains was as far as possible based on already established measurement instruments. Attitude to nature was measured by a subset of items from Dunlap and Van Liere's 'New Environmental Paradigm' scale (1978), which has been used by Steger, Pierce, Steel and Lovrich (1989) with results similar to those obtained by using the complete scale. Attitude to technology was measured by a scale which Hamstra (1991) has used successfully. The scale contains a modified subset of items from a scale which was originally developed to measure technocratic attitudes among scientists (Meertens & Stallen, 1979). Food neophobia was measured using a subjectively selected subset of items from the scale developed by Pliner and Hobden (1992). Allison (1978) developed a 35-item scale for measuring consu-

mer alienation from the marketplace, and the dimensionality and validity of the scale was further investigated by Bearden, Lichtenstein and Teel (1983), who identified a three-factor structure. Here, we used a subset of items from the identified 'business ethics' factor. These items were also selected on a subjective basis, where items which were clearly not relevant in the context of food issues were excluded. Perceived knowledge of the use of gene technology in food production was attributed both to self, the average person, government, science and industry, and were each measured by one purpose-made item. All of the above items were rated on *strongly disagree – strongly agree* scales. Knowledge of food production was measured by eight items developed by Frewer (1997). The items were all rated on dichotomous *true – false* scales. Environmental involvement was measured by a number of self-reported environment-related behaviours, rated on dichotomous *yes – no* scales.

In addition, it was decided to include a two-item measure of perceived personal control over choosing whether or not to purchase and eat food produced by means of genetic modification. The formulation of these items was inspired by previous research on the 'perceived behavioural control' subconstruct of The Theory of Planned Behavior (eg East, 1993). The items were measured on *strongly disagree – strongly agree* scales.

Items used to measure the general attitudes and knowledge domains are listed in Appendix B.

Questionnaire items: Purchase intention model

The section on purchase intentions was developed in two versions, one targeting genetically modified yoghurt and one targeting genetically modified beer. All global measures were substantially identical in the two versions, as were measured control, difficulty and moral beliefs. In addition, there was some overlapping between measured outcome beliefs concerning perceived risks and benefits of having applied genetic modification to produce yoghurt/beer.

Intention to purchase genetically modified yoghurt/beer, attitude towards purchasing the product, perceived behavioural control, perceived difficulty, and perceived moral obligation were each measured globally by three items, while subjective norm was measured by two items. Unless otherwise indicated, the items were measured on *strongly disagree – strongly agree* scales. The purchase intention items were variations of 'If this yoghurt/beer were available in the shops, I would intend to' with response scales anchored *definitely avoid it* and *definitely buy it*. Attitude towards purchasing the product was measured by two semantic differentials, namely *extremely bad – extremely good* and *extremely unpleasant – extremely pleasant*, and 'I am *strongly for – strongly against* buying this yoghurt/beer'. Subjective norm was measured by 'Most people who are important to me think that I should *definitely avoid* this yoghurt/beer – *definitely buy* this yoghurt/beer, alternatively '... who influence what I do...'. Perceived behavioural control was measured through 'Whether I will eventually buy this yoghurt/beer is entirely up to me', 'If this yoghurt/beer were available in the shops, nothing would prevent me from buying it', and 'How much control do you have over whether you will eventually buy a yoghurt/beer like this one?', the latter measured on a scale with end points marked *absolutely no control* and

complete control. Perceived difficulty measured the perceived ease of avoiding the product by 'Even if I should want to avoid this yoghurt/beer, I do not think I would ever be able to do so', 'If this yoghurt/beer was available in the shops, I could easily avoid buying it if I wanted to', and by 'How difficult would it be for you to avoid buying this yoghurt/beer?' measured on scales anchored *extremely difficult* and *extremely easy*. Perceived moral obligation, finally, was covered through 'I consider buying this yoghurt/beer morally wrong', 'I would feel guilty if I bought this yoghurt/beer', and 'Buying this yoghurt/beer goes against my basic principles'.

The elicited beliefs were also measured on *strongly disagree – strongly agree* scales.

Questionnaire translation

The questionnaire was developed in English and was then translated into Danish, German and Italian by bilingual researchers. The translated versions were cross-checked by another group of bilingual researchers and were pretested in each country (n=30 per country) to allow final adjustments before the full-scale applications. The adjustments were harmonized across the four languages.

Data collection

Data were collected by personal in-home interviews in Denmark, Germany and Italy and at central research facilities in the United Kingdom[2]. In all countries, respondents completed the questionnaire themselves in the presence of an interviewer who could be consulted with questions relating to usage of the response scales and other technical matters.

The data were collected in the autumn of 1998.

DATA ANALYSIS

Initial statistics

For the attitude data, the global measures of attitudes towards genetic modification in food production, perceived overall risks and perceived overall benefits were first combined into sum scales, and scale reliabilites, mean scores and extreme score frequencies were calculated for each country. These mean scores were considered an indication of the external validity of the data, because they allowed a first impression of the acceptance levels in the four countries, which could be substantially compared with acceptance levels found in surveys such as the Eurobarometer.

Since the scales that were used to measure the general attitudes and knowledge domains had not previously been cross-culturally validated, the calculation of

2 In-home interviews were not considered a valid option in the United Kingdom at the time of collecting the data.

item-total correlations for the pooled data was first used as a basis for detecting poor items. Items with item-total correlations of at least .30 were then subjected to principal components analysis, separately for each scale, to further investigate the unidimensionality of the scales. Finally, the retained items were combined into sum scales and scale reliabilities and means were calculated.

Similar procedures were applied to the purchase intention data, separately for each product. Thus, sum scales were constructed and scale reliabilities were calculated for the global measurements of purchase intentions, attitude towards purchasing the product, subjective norm, perceived behavioural control, perceived difficulty and perceived moral obligation. Mean scores and extreme score frequencies were calculated for the established purchase intention scales as well.

After this the cross-cultural validity of the data was investigated.

Assessment of cross-cultural validity

Cross-cultural validity refers to the extent to which data collected by the same measurement instrument are comparable across different cultural environments. In this case, the collection of data in four countries made it particularly crucial to pay attention to this aspect. Indeed, if the data collected were not cross-nationally valid, it would make no sense to look for universal models of attitudes and purchase intentions or even to look for cross-national differences or similarities in the responses.

Factor invariance has often been suggested as a criterion of cross-cultural validity in cross-cultural research. Here, we have used the framework by Grunert, Grunert and Kristensen (1994), who suggest using the degree of factor congruence across samples as a basis for discriminating among several levels of cross-cultural validity, based on multi-sample confirmatory factor analyses.

The lowest level of comparability they suggest is when the pattern of factor loadings is the same across the samples. They call this *minimal cultural comparability*. If the matrices of factor loadings are in fact identical across the samples, a higher level of comparability is obviously achieved, which is what they call *weak cultural comparability*. In both of these instances the correlations of the various factors (subconstructs) are free to vary among the samples as are measurement errors and actual scores on the individual items. Thus, in cases where minimal and weak cultural comparability have been obtained we can infer that we are tapping on the same cognitive categories in the various cultures, but we cannot be sure that cognitive processes and structures are identical. If the factors also correlate in the same way across the cultures investigated, the data fulfil the conditions of *strong cultural comparability*. The fourth level is *weak cultural identity*, which is when the measurement errors of the individual items are also the same across the cultures investigated. The only thing that can then differ is individual item scores. According to Grunert, Grunert and Kristensen, strong cultural compability is normally the highest level of comparability that can be achieved in cross-cultural research involving different languages, as translation of questionnaire items will inevitably influence the distribution of measurement errors.

Here, the framework was used to assess the cross-cultural validity of the attitude and purchase intention data with the aim of confirming at least weak cultural comparability across the countries. For each set of data, the cultural comparability of the globally measured subconstructs was analyzed first. Then underlying belief factor structures were detected by means of principal components analyses (with the number of factors determined by the Kaiser criterion), and the cross-cultural validity of the resulting belief factors was analysed as well. In all cases, multi-sample confirmatory factor analyses were run for the first three levels of cultural comparability.

Model estimations

Attitude and purchase intention models were estimated by structural equation modelling using latent constructs. In all cases, measurement models were constructed first, using the results of the initial statistics, including the elicited belief factor structures. After this, structural relations were investigated with Bredahl, Grunert and Frewer's original models as starting points.

In the results sections, the final results are depicted as structural models excluding statistically insignificant relationships.

Software, input matrices and estimation method

The cross-cultural validity of the data and the models were both estimated in LISREL version 8.30, upgraded with six 1999 patches.[3]

Covariance matrices were used as input matrices. Approximately twenty per cent of the cases in all countries had at least one missing value. Values for cases with a single empty cell were imputed based on responses to the remaining items. Remaining cases with missing values were excluded by the applied listwise deletion procedure. In this way we achieved total effective sample sizes of 468 in Denmark, 504 in Germany, 501 in Italy, and 487 in the United Kingdom.

The data were generally quite skewed, suggesting that the data did not follow a multivariate normal distribution. One way of analyzing non-normal data is to use the weighted least squares (WLS) method, which has been developed by Browne (1984) as a procedure that is insensitive to the distribution of the observations. However, WLS requires very large sample sizes and was therefore not applicable to our data.[4] Instead, the data were analyzed by maximum likelihood (ML) estimation which has been shown to be fairly robust to moderate violations of normality, provided that the sample exceeds either about 100 (Boomsma, 1982; Sharma, Durvasula & Dillon, 1989) or 200 (Hoogland & Boomsma, 1998). At the same time, ML is recommended by Jöreskog, Sörbom, du Toit & du Toit (1999) as a reasonable compromise for the analysis of non-normal data in

3 The six patches were launched during 1999 to correct a number of errors in the programme. Among other things the patches correct an original miscalculation of R square values which overestimated the strength of relationships in non-recursive models (Jöreskog, 1999). Some of the models presented may therefore differ slightly from earlier versions of the models presented at conferences and seminars before the patch upgrading.
4 If the number of items exceeds 12, WLS requires sample sizes of 1.5q(q+1), where q denotes the number of items (Jöreskog & Sörbom, 1986).

cases where the sample size requirement for WLS cannot be met, particularly if the non-normality of the data can be reduced by normalizing the variables before the analysis. In this case, the distribution of the variables was improved somewhat by this procedure, and the results presented are therefore based on normalized data.

In cases where latent constructs were measured by single items, the reliability of the item was set to .85.

Evaluation of model fits

The applicability of each level of cross-cultural validity and of the estimated attitude and purchase intention models were evaluated by measures of fit provided by LISREL.

All fit measures available are basically functions of the chi-square value, which measures the distance between the sample matrix and the fitted matrix. The chi-square value is in itself sensitive to sample size and therefore not very appropriate for evaluating models. In multi-sample analyses the standardized root mean square residuals (RMR) and the goodness of fit index (GFI) are provided for each sample. These measures of fit were used here to evaluate the cultural comparability of the data based on the multi-sample confirmatory factor analyses. In addition, we have used the chi-square for the entire data set divided by degrees of freedom, called the normed chi-square, which has been recommended as a measure of fit which reduces the dependence of the chi-square value on sample size (Carmines & McIver, 1981). For each level of cultural comparability to be accepted, the normed chi-square should as a rule of thumb be below 3 and GFI should be at least .90, while the standardized RMR should be low (Bagozzi & Baumgartner, 1994; Carmines & McIver, 1981). In addition, none of the fit measures should change significantly between the compared models, ie between any two consecutive levels of cultural comparability.

In the evaluation of the established causal models the root mean square error of approximation (RMSEA) was used as the primary fit measure. It is generally agreed that values below .05 indicate a close fit, while values of up to .08 also are reasonable (Browne & Cudeck, 1993).

Below, results concerning the formation of attitudes towards the use of genetic modification in food production overall are presented first, followed by results relating to consumers' purchase intentions.

RESULTS I: THE FORMATION OF ATTITUDES TOWARDS GENETIC MODIFICATION IN FOOD PRODUCTION

The mean scores of the summed measure of attitude towards genetic modification in food production show that the average support of genetic modification in food production was generally quite low. The means and extreme score frequencies are given in table 2.

The results are, however, not without cross-national variation. Danish and German consumers generally had the least favourable attitudes, and Italian consumers were the least sceptical of the four populations, with British consumers somewhere in between. The attitude differences become even more obvious when the share of consumers with extremely negative attitudes is observed. Thus, at the one end, one fourth of the Danish consumers apparently held extremely negative attitudes towards genetic modifiation in food production, while, at the other end, this was the case for only about four per cent of the Italian consumers.

Table 2. Attitude to genetic modification in food production – means and extreme score frequencies (min. score 3; max. 21)

	Denmark	Germany	The UK	Italy
Mean score	8.41[a1]	8.83[a]	10.40[b]	11.71[c]
Extremely negative attitude (ie a score of 3)	25.4%	16.7%	8.9%	4.3%
Extremely positive attitude (ie a score of 21)	0.8%	1.4%	0.6%	1.0%

1 Mean scores with different letters are significantly different (Scheffe's test, p<.01)

The analyses of the internal validity of the general attitude and knowledge scales confirmed the unidimensionality of the items used to measure *attitude to nature, attitude to technology* and *food neophobia*. With the exclusion of two items because of low item-total correlations, a unidimensional scale was also obtained for the scale used to measure *alienation from the marketplace*. Severe problems were, however, found for the scales used to measure *knowledge of food production* and *involvement with environmental issues*. Item-total correlations were here below .25 for all items, and with no guidelines for which items to retain, it was decided to omit these scales from the subsequent analyses. For knowledge of food production it was considered to proceed with the three-factor solution that resulted from the principal components analysis. However, this option was not chosen because the factors were thought to be too issue specific.

The reliabilities of the retained multi-item scales used to estimate the attitude model are shown in table 3. As can be seen, the internal consistencies of the scales are, with a few exceptions, quite high. The mean scores for the general attitude and knowledge scales are enclosed in Appendix C.

Table 3. Scale reliabilities – attitude data

	Cronbach's alpha			
	Denmark	Germany	The UK	Italy
Attitude to genetic modification in food production	.93	.92	.92	.83
Perceived overall benefits	.88	.89	.86	.65
Perceived overall risks	.85	.81	.79	.78
Attitude to nature	.67	.64	.66	.79
Attitude to technology	.75	.80	.81	.79
Food neophobia	.61	.77	.75	.45
Alienation from the marketplace	.72	.68	.68	.71

The cross-cultural validity of the scales was then assessed for all four countries using Grunert, Grunert and Kristensen's factor analytic framework. Results are shown in table 4.

The normed chi-square values generally support the cross-cultural validity of the data. However, even at the weakest level of cultural comparability standardized RMR is quite high and GFI is unacceptably low for the Italian data, which suggests that the Italian data generally are not comparable with the data of the other countries. The GFI values for the Danish, German and British data do not change much between the different levels, whereas the standardized RMR values increase considerably among the different levels for the German and British data. Generally, the GFI values are not impressively high, however. The modification indices provided by LISREL allowed us to detect the problem, which seemed to be primarily a lack of discriminant validity between measurements of perceived overall benefits and attitude towards genetic modification in food production. Since this inflates the fit measures, it seems that weak cultural comparability may hold for the Danish, German and British data. In the subsequent analysis, it was therefore decided to proceed with the aim of estimating attitude models for the pooled Danish, German and British data and separately for the Italian data.

Table 4. Tests of cross-cultural validity of the attitude data
(based on all globally measured subconstructs and the retained general attitude and knowledge scales)

Degree of cultural comparability	Denmark		Germany		The UK		Italy		Normed chi-square (χ2/df)
	GFI	St. RMR	GFI	St. RMR	GFI	St. RMR	GFI	St. RMR	
Minimal	.89	.067	.89	.060	.89	.061	.83	.092	3773/1337 =2.82
Weak	.89	.068	.89	.067	.89	.074	.82	.10	3945/1400 =2.82
Strong	.88	.077	.88	.079	.88	.082	.76	.12	4438/1463 =3.03

Hence, factor structures of the measured risk and benefit beliefs were investigated for the pooled Danish, German and British data and separately for the Italian data. Results show that, in Denmark, Germany and the United Kingdom, consumers distinguished between welfare and shopping-related benefits of applying genetic modification in food production, whereas perceived risks were so highly correlated that they constituted only one underlying factor. In Italy, the measured benefit beliefs grouped into two factors, one a combination of shopping and welfare-related benefits and one covering perceived family and health-related benefits. Perceived risks also constituted two factors, one dealing with health and environmental aspects and one dealing more with control-related risks. Neither of the analyses pointed to a cognitive distinction between process and product-related beliefs as hypothesized. However, the different Italian factor structures confirm the dissimilarity of the Italian respondents with the respondents of the three other countries. The resulting factors are shown in tables 5 and 6.

Table 5. Factor structures of benefit beliefs

	Pooled Danish, German and British data		Italian data	
Factor labels	Perceived welfare benefits	Perceived shopping benefits	Perceived shopping and welfare benefits	Perceived family and health benefits
Items				
Healthier than other food products (p)[1]	.87			.88
Better quality foodstuffs (p)	.84		.69	
Increase own and family's standard of living (p)	.80			.88
Improve the standard of living of the future generations (p)	.74		.67	
Necessary activity (c)	.72		.49	
Solve environmental problems (c)	.67		.59	
Reduce the price of food products (c)		.82	.47	
Increase the choice of food products (c)		.75	.74	
Variance explained	53%	13%	45%	12%

[1] (p) denotes that the belief is product-oriented, and (c) denotes that the belief is process-oriented.

Table 6. Factor structures of risk beliefs

Factor labels / Items	Pooled Danish, German and British data	Italian data	
	Perceived risks	Perceived health and environ-mental risks	Perceived control-related risks
Cause environmental hazards (c)	.80	.80	
A threat to human health (p)	.79	.84	
Only benefits the producer (c)	.73		.57
Unnatural (c)	.72		.69
Likely to interfere with wild species in nature (c)	.65		.57
Nobody knows the long term consequences (c)	.63		.80
Causes allergy in human beings (p)	.59	.78	
Variance explained	50%	37%	19%

The cross-cultural validity of the belief factors of the pooled Danish, German and British data was also investigated by multi-sample confirmatory factor analyses. The analyses generally confirmed that at least weak cultural comparability could be accepted. As a consequence, a joint attitude model was estimated for the pooled Danish, German and British data, using the pooled data belief factors, along with estimations of a separate attitude model for the Italian data, using the Italian belief factors.

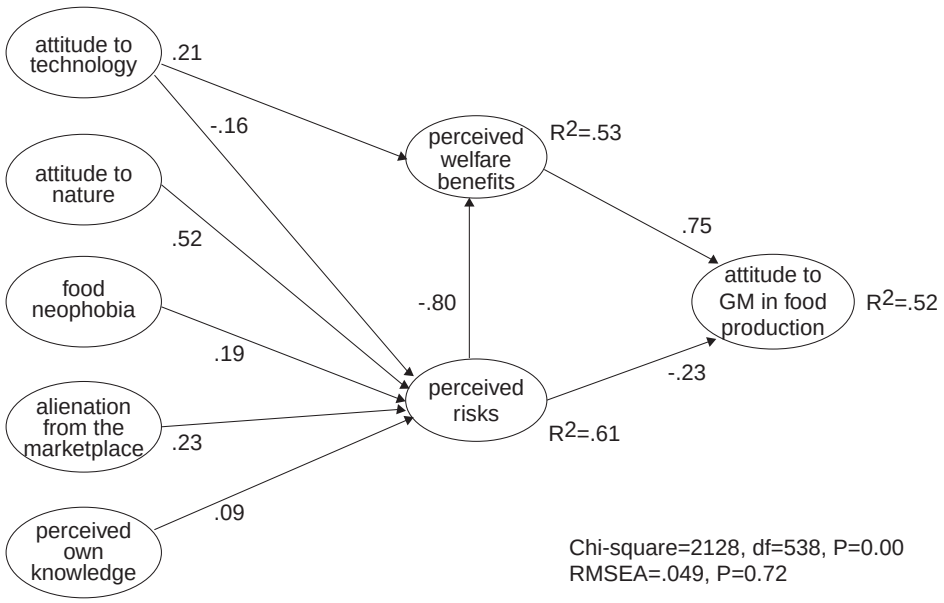
In estimating the models, the subconstructs 'perceived overall benefits' and 'perceived overall risks' were omitted due to extremely high correlations with some of the risk and benefit factors. The correlations, using latent contructs, are shown in table 7. Causal links from the general attitudes and knowledge domains were initially directed both to the belief factors and directly to attitude towards genetic modification in food production, in separate models. Generally, significantly better model fits were obtained when the general attitudes and knowledge domains were considered determinants of beliefs rather than directly of attitudes. Since this option was also theoretically sound, this version of the models was chosen.

The final attitude model estimated on the pooled Danish, German and British data shows that attitudes to genetic modification in food production are indeed a function of perceived risks and benefits, but that perceived shopping-related benefits apparently cannot explain differences in attitudes. Perceived welfare benefits have the highest direct impact on attitudes, but, importantly, perceived risks are a crucial determinant of how these benefits are perceived. Thus, the more risks consumers associate with the use of genetic modification in food production, the less benefits do they also perceive. The structural model is shown in figure 3.

Table 7. Correlations among perceived overall benefits and risks and underlying belief factors

Global measures	Perceived overall benefits		Perceived overall risks	
Belief factors	Pooled Danish, German and British data	Italian data	Pooled Danish, German and British data	Italian data
Perceived welfare benefits	.97			
Perceived shopping-related benefits	.52			
Perceived shopping and welfare benefits		1.00		
Perceived family and health benefits		.59		
Perceived risks			.97	
Perceived health and environmental risks				1.03
Perceived control-related risks				.41

Figure 3. Estimated attitude model – pooled Danish, German and British data



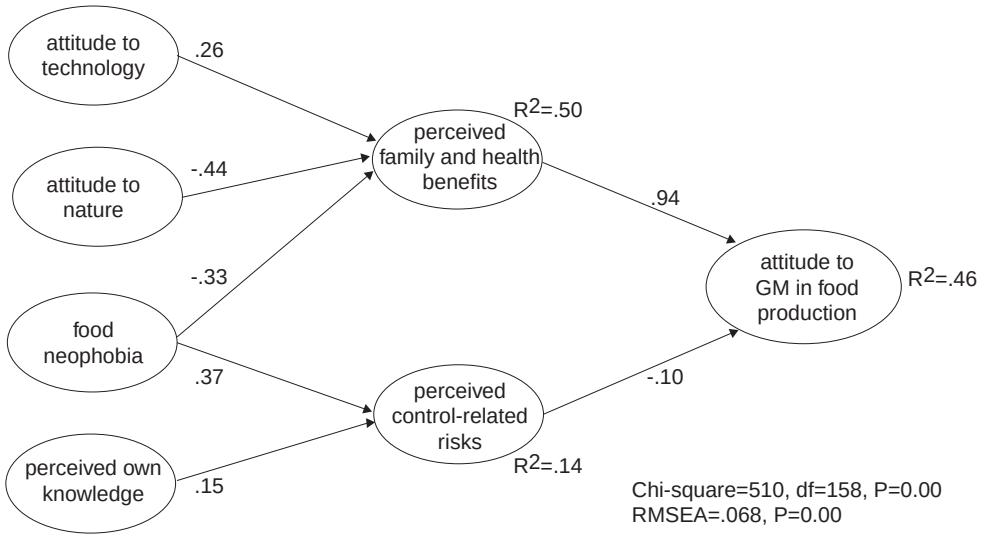
The model also shows that the risks and benefits that consumers associate with genetic modification in food production are strongly influenced by more general attitudes, notably attitude to nature, attitude to technology, alienation from the marketplace, food neophobia, and, to a lesser extent, perceived own knowledge about the use of genetic modification in food production. Generally speaking, the more favourable attitudes consumers hold towards nature, ie the less consumers believe that man has a right to rule over nature for instance, the more risks do they associate with the use of genetic modification in food production. Likewise, more risks are associated with the use of genetic modification in food production the less consumers trust those in charge of the food markets, the less keen they are on trying out new food products, and the less they believe to know

about the use of genetic modification in food production. On the other hand, less risks and more benefits are perceived the more favourable consumers are towards technology in general. The embedment of perceived risks and benefits in these more general attitudes and knowledge domains indicates that the consumers' attitudes towards genetic modification in food production are fairly strong. The analyses showed no effects of perceived personal control or perceived knowledge of the average person, industry, government or science of the use of genetic modification in food production.

To investigate country-specific variations, the model was complemented with country-specific models. As can be seen in Appendix D, these country-wise estimations generally confirmed the structure found in the joint model and revealed only minor cross-national differences. Among these are that in the resulting Danish model, food neophobia was not a significant determinant of perceived risks and in the German model perceived risks influenced attitudes only through perceived benefits.

To a certain point, the best fitting Italian model resembles the model that was estimated on the Danish, German and British data. Again, attitudes are well explained by perceived benefits and risks, which are, in turn, explained by more general attitudes and perceived own knowledge of genetic modification in food production. Perceived benefits are also again the primary direct determinant of attitudes, but, importantly, perceived benefits are here not influenced by perceived risks, and only perceived control-related risks apparently influence attitudes to genetic modification in food production. This indicates that risks generally play a far smaller role among Italian consumers than among Danish, German and British consumers for attitudes towards genetic modification in food production. Moreover, the measured general attitudes and knowledge domains do not explain the perceived risks and benefits as well as in the three other countries. Again, however, attitude to technology, attitude to nature, food neophobia and perceived own knowledge have significant impact, and food neophobia even seems to play a larger role here than among Danish, German and British consumers.

Figure 4. Estimated attitude model – Italian data



RESULTS II: THE FORMATION OF PURCHASE INTENTIONS WITH REGARD TO GENETICALLY MODIFIED YOGHURT AND BEER

Means and extreme score frequencies for the aggregated purchase intention scales show that consumers were generally not very inclined to purchase any of the two genetically modified food products presented. Again, Danish and German consumers were more adverse, whereas apparently Italian and British consumers were relatively more willing to purchase the products. The results are shown in table 8.

Table 8. Purchase intentions – means and extreme score frequencies (min. score 3; max. 21)

	Denmark	Germany	The UK	Italy
YOGHURT				
Mean score	8.14[a1]	7.56[a]	10.70[b]	11.67[b]
Extreme avoidance intention (ie a score of 3)	37%	35%	14%	7%
Extreme purchase intention (ie a score of 21)	2%	35%	1%	2%
BEER				
Mean score	8.76[a]	9.05[a]	10.65[b]	11.46[b]
Extreme avoidance intention (ie a score of 3)	23%	23%	8%	4%
Extreme purchase intention (ie a score of 21)	3%	1%	1%	2%

1 Mean scores with different letters within the same row are significantly different (Scheffe's test, $p<.01$)

Assessment of the internal validity of the data showed quite high scale reliabilities across products for the scales applied to measure purchase intentions, attitude towards purchasing the product and perceived moral obligation, however, with consistently lower scale reliabilities in the Italian data. The scale for perceived behavioural control performed quite poorly in all data sets. For perceived difficulty there were major problems with the scale in Denmark, and scale reliabilities were not impressively high in the three other countries either. The scale reliabilities are shown in table 9.

By inspecting the correlations among the items of the difficulty scale, it was clear that the same two difficulty items were highly correlated in all countries and for both products, and they were generally not correlated with the third item. Since the pattern of correlations of a scale of these two difficulty items with the remaining subconstructs also came out as expected, it was decided to proceed with this perceived difficulty scale in the subsequent analyses. For perceived behavioural control, however, there were no clear indices for which items to retain, due to generally low inter-item correlations. All perceived behavioural control items were therefore retained and treated separately in the subsequent model estimations.

Table 9. Scale reliabilities – purchase intention data

	Cronbach's alpha			
	Denmark	Germany	The UK	Italy
Purchase intention	.95/.95[1]	.94/.91	.93/.90	.89/.86
Attitude to behaviour	.94/.91	.94/.92	.93/.87	.69/.75
Perceived behavioural control	.22/.32	.13/.14	.24/.22	.44/.12
Perceived difficulty	.34/.15	.68/.55	.61/.64	.56/.54
Perceived moral obligation	.84/.83	.87/.84	.87/.75	.53/.67

1 yoghurt data/ beer data

The analysis of the cross-cultural validity of the subconstructs indicated once again that the Italian data generally were not comparable with the data from the three Northern European countries. Results are shown in tables 10 and 11.

Table 10. Tests of cross-cultural validity – yoghurt data (based on all globally measured subconstructs)

Degree of cultural comparability	Denmark		Germany		The UK		Italy		Normed chi-square (χ2/df)
	GFI	St. RMR	GFI	St. RMR	GFI	St. RMR	GFI	St. RMR	
Minimal	.84	.053	.86	.091	.90	.096	.71	.16	1850/590 = 3.14
Weak	.84	.056	.85	.087	.90	.10	.69	.17	1911/620 = 3.08
Strong	.83	.060	.85	.085	.90	.10	.68	.17	1940/641 = 3.03

Table 11. Tests of cross-cultural validity – beer data (based on all globally measured subconstructs)

Degree of cultural comparability	Denmark		Germany		The UK		Italy		Normed chi-square (χ2/df)
	GFI	St. RMR	GFI	St. RMR	GFI	St. RMR	GFI	St. RMR	
Minimal	.87	.067	.89	.11	.88	.078	.69	.17	1781/590 = 3.02
Weak	.87	.072	.89	.10	.88	.083	.66	.19	1835/620 = 2.96
Strong	.87	.075	.89	.10	.87	.084	.65	.18	1892/641 = 2.95

As can be seen, the fit measures of the Italian data are generally quite poor, even at the lowest level of cultural comparability. The fit measures of the three other countries are much more reasonable, but GFI values are again slightly lower than recommended. Again, however, due to high correlations among a number of the subconstructs, the criteria of discriminant validity among the factors were often not fulfilled. Since this invalidates the fit measures, it was again considered reasonable to proceed with the aim of analysing the Danish, German and British data jointly and the Italian data separately, for each product. The correlations, using latent constructs, are shown in table 12.

Table 12. Correlations among subconstructs – pooled Danish, German and British data

	Beha-vioural inten-tion	A	AB	SN	PC1	PC2	PC3	PD
Attitude to genetic modi-fication in food production (A)	.78/ .67[1]							
Attitude to purchasing the product (AB)	.99/ .99	.82/ .72						
Subjective norm (SN)	.86/ .87	.70/ .60	.89/ .92					
Perceived behavioural control - item 1 (PC1)	-.19/ ns[2]	-.15/ ns	-.18/ ns	-.18/ ns				
Perceived behavioural control - item 2 (PC2)	.77/ 77/	.60/ .57	.77/ .77	68/ .67	-.14/ ns			
Perceived behavioural control - item 3 (PC3)	.09/ .11	ns/ ns	.10/ .12	.11/ ns	.40/ .29	ns/ .13		
Perceived difficulty (PD)	.10/ ns	ns/ ns	ns/ ns	ns/ .10	-.50/ -.46	ns/ ns	-.73/ -.73	
Perceived moral obligation (PMO)	-.89/ -.85	-.82/ .76	-.92/ -.90	-.80/ -.81	.10/ ns	-.70/ -.69	-.10/ -.11	ns/ ns

1 yoghurt data/ beer data

2 ns=non-significant at the 5% level

Accordingly, belief factor structures were investigated separately for these groups of data. Results show that for all data sets, measured control beliefs constituted one underlying factor, as did the measured normative beliefs, difficulty beliefs and normative beliefs, respectively. For both yoghurt and beer, however, outcome beliefs grouped into several factors. These factors are shown in tables 13 and 14.

Table 13. Factor structure s of outcome beliefs regarding the purchase of genetically modified yoghurt

	Denmark, Germany and the UK (pooled data)		Italy		
Factor labels	Perceived trust-worthi-ness of product	Perceived quality	Perceived trust-worthi-ness and usability	Perceived quality	Perceived natural-ness and healthi-ness
Items					
No confidence in the product	.75			-.50	
Do not know the long term consequences of consuming product	.72		.77		
Unfamiliar product	.69		.62		
Unnatural product	.67				-.76
Benefits nature	-.63			.71	
Nice texture		.80	.70		
Good quality and taste		.77		.80	
Easy to handle and use		.77	.77		
Wholesome product		.59			.83
Variance explained	42%	16%	25%	24%	14%

Table 14. Factor structures of outcome beliefs regarding the purchase of genetically modified beer

	Denmark, Germany and the UK (pooled data)		Italy		
Factor labels	Perceived quality	Perceived trust-worthi-ness of product	Perceived trust-worthi-ness of product	Perceived quality	Perceived product benefits
Items					
Good value for money	.75				.75
Suitable for drinking with others	.74			.78	
Good quality and taste	.73			.84	
No confidence in the product	-.72		.77		
Only benefits the producer	-.68		.60		
Benefits nature	.65				.80
Unfamiliar product		.86	.66		
Do not know the long term consequences of consuming product		.58	.65		
Unnatural product		.48		-.70	
Variance explained	43%	12%	28%	21%	12%

As can be seen, for both yoghurt and beer and in all four countries, a separate factor covers aspects of the perceived quality of the product. In the Danish, German and British data, this factor covers both direct beliefs about perceived quality and taste and the concrete attributes which were mentioned in the product descriptions and which were due to the use of genetic modification. The second factor in these three countries is for both products concerned with the perceived trustworthiness of the product. This factor deals more explicitly with the perceived consequences of having used genetic modification to create the product.

In Italy, the factors which deal with the perceived quality of the product do not cover exactly the same items as the pooled data factors, but since the primary beliefs loading on these Italian factors are identical with the items that load on the 'perceived quality' factors in the pooled data, the factors were given the same names. The same argument goes for the factor in the Italian beer data that deals with the perceived trustworthiness of the product. The two remaining factors in the Italian yoghurt data are quite dissimilar to those of the pooled Danish, German and British data. Thus, one factor covers aspects of the perceived familiarity and usability of the product and one factor deals with the perceived naturalness and healthiness of the product. The third factor in the Italian beer data is also quite different from the factors of the pooled data, as it covers the two benefits of having applied genetic modification, as they were described in the product labels presented.

Again, inspection of the cross-cultural validity of the factors generally confirmed the cross-cultural validity of the Danish, German and British data. Model estimations therefore once again aimed at estimating joint models for the pooled data of these three countries and separate models for the Italian data.

In all models, including the overall attitude towards genetic modification in food production as a direct determinant of attitude towards purchasing the genetically modified product along with the factors of product-specific beliefs yielded quite poor model fits. In all cases, significant improvements of the fit measures were achieved when the overall attitude towards genetic modification in food production was considered a determinant of product-specific beliefs instead. Since this did not give rise to any basic theoretical conflicts and generally complied with the structure found in the attitude data (see Results I), this modification was introduced in all estimated models. The resulting structural models based on the pooled Danish, German and British data are shown in figures 5 and 6, and the final estimated models for the Italian data in figures 7 and 8.

Results reveal quite similar patterns across products. Thus, in both models for the pooled Danish, German and British data, the attitude towards purchasing the product is the only significant determinant of purchase intentions, and in both cases these attitudes are well explained by product-specific beliefs held by the consumer, which are, in turn, influenced by the consumers' overall attitudes towards genetic modification in food production.

Figure 5. Estimated purchase intention model for genetically modified yoghurt. Pooled Danish, German and British data

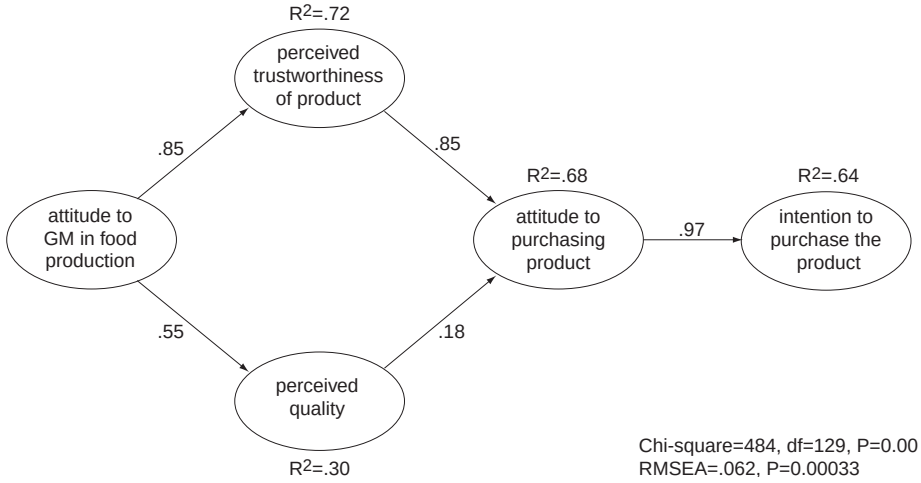


Figure 6. Estimated purchase intention model for genetically modified beer. Pooled Danish, German and British data

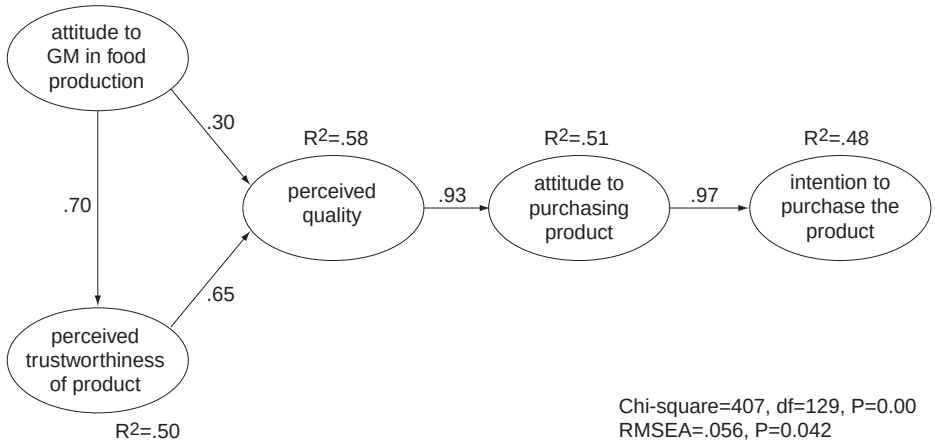


Figure 7. Estimated purchase intention model for genetically modified yoghurt. Italian data

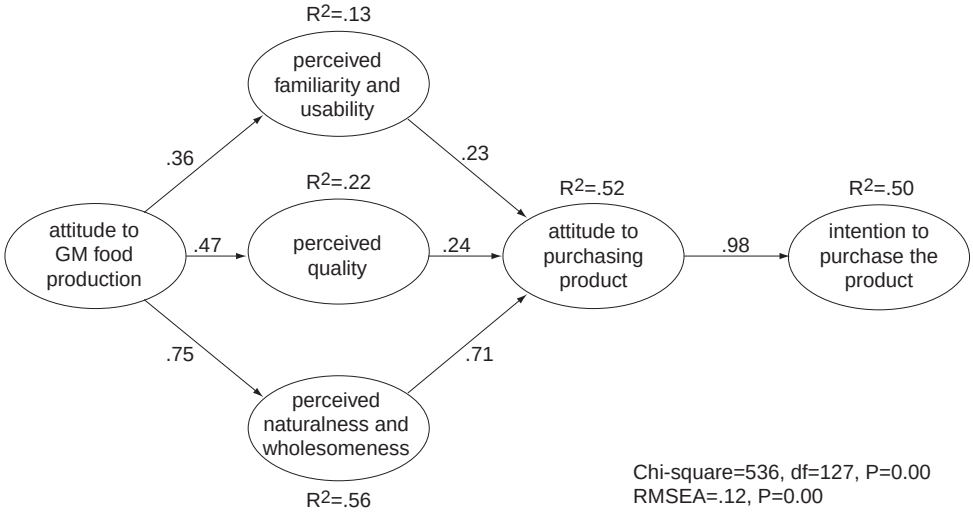
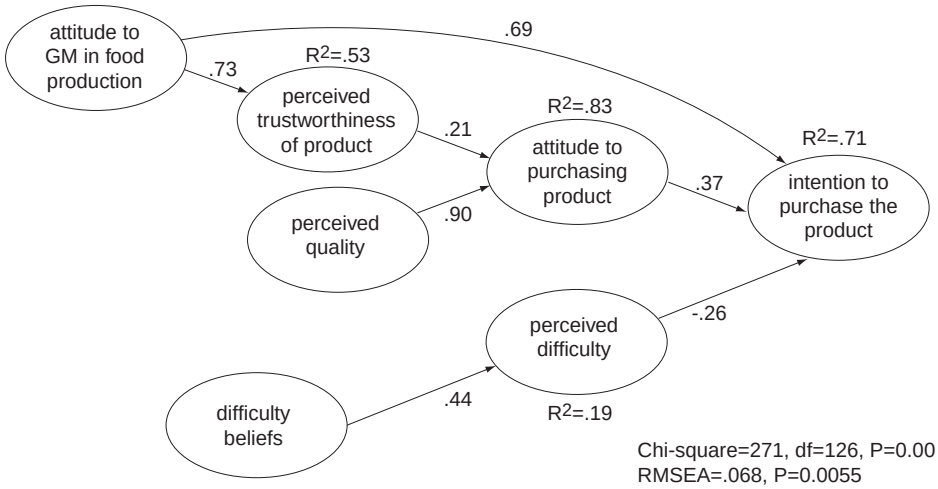


Figure 8. Estimated purchase intention model for genetically modified beer. Italian data



However, some differences also exist. The attitude towards purchasing the genetically modified yoghurt is determined directly, and in a compensatory relationship, by beliefs about the trustworthiness of the product and beliefs about the quality of the product, with perceived trustworthiness as the primary antecedent of attitudes. In the case of beer, the attitude towards purchasing the product is determined directly by the perceived quality of the product, but only indirectly by the perceived trustworthiness of the product through the perceived product quality. Presumably this is the case because product quality dimensions were not the target of the genetic modification of the beer and therefore not elaborated upon in the product description. Product quality is nevertheless a crucial determinant of consumers' purchase decisions, and in the absense of other perceived suitable cues, consumers have therefore apparently based their quality evaluations on their degree of trust in the product and on their overall attitude towards genetic modification in food production.

To complement the models based on the pooled data, country-wise estimations were also carried out. The resulting models are enclosed in Appendix E. As can be seen, none of these models deviate significantly from the models on the pooled data. The country-wise estimations therefore primarily work to provide additional support of the cross-cultural validity of the results.

The basic structure of the Italian model for yoghurt resembles the model based on the pooled Danish, German and British data. Here, purchase intentions are also nearly synonymous with attitudes towards purchasing the product, and attitudes towards purchasing the product are determined by additive belief factors, which are to some extent explained by the overall attitude towards genetic modification in food production. In this case, however, attitudes towards purchasing the yoghurt are primarily determined by beliefs about the naturalness and wholesomeness of the product and only secondarily by beliefs about the trustworthiness and usability properties of the product and beliefs about the quality of the product, and these product-specific beliefs are generally not as thoroughly influenced by the consumers' overall attitudes towards using genetic modification to produce foods as in the pooled Danish, German and British data.

The Italian model with regard to the purchase of genetically modified beer is somewhat different. Here, purchase intentions are determined directly by both the overall attitude towards genetic modification in food production, the attitude towards purchasing the product and the perceived difficulty of distinguishing the product from other beers available. The impact of perceived difficulty in this case but not in the case of yoghurt may reflect the fact that the yoghurt product was marked 'genetically modified' on the front label, whereas the beer was not. Moreover, the perceived trustworthiness of the product and the perceived quality of the product show separate effects on attitudes towards purchasing the product, with beliefs about the quality of the beer as the primary influencing factor, whereas the factor covering the claimed benefits of having applied genetic modification can apparently not explain attitude differences.

DISCUSSION AND CONCLUSIONS

The study employed two products made with genetically modified microorganisms to investigate consumer attitudes and purchase decisions with regard to genetically modified foods in four countries. Results show general low levels of acceptance of genetic modification in food production and indicate intentions to largely avoid resulting products.

In general, attitudes towards the use of genetic modification in food production were found to be determined both by perceived risks and perceived benefits of applying genetic modification in food production. Results suggest, however, that consumers do not distinguish between risks and benefits pertaining to the technology itself and risks and benefits related to resulting products, but rather infer their perceptions of these risks and benefits from the same underlying dimensions. Thus, consumers' beliefs about risks and benefits were found to be strongly embedded in more general attitude domains such as attitude towards nature and attitude towards technology. The fact that at present consumer attitudes are not experience-based may partly explain the lack of cognitive division between process and product beliefs and the strong links between higher-order attitudes and perceived risks and benefits. The strength of the links to more general attitudes and knowledge domains nevertheless suggests that consumers' attitudes towards modern food biotechnology are quite strong and not very susceptible to change.

Purchase intentions with regard to individual products were found to be determined almost exclusively by attitudes towards purchasing the product, which were, in turn, strongly influenced by overall attitudes towards genetic modification in food production through perceived attributes and consequences of consuming the products. The strong relation between the overall attitude to genetic modification in food production and product-specific attitudes suggests that at present consumers do not differentiate much among different applications of genetic modification, but rather reject the technology overall. Results also show, however, that beliefs about the products are not exclusively determined by the overall atttitudes towards genetic modification in food production, but are also, at least to some extent, derived from other cues available to the consumer.

Importantly, consumers' lack of experience with foods produced by means of genetic modification is likely to have had an impact on the results. As more

genetically modified food products become available, it seems that atttitudes may well become more sophisticated with product evaluations taking place more on a case-by-case basis. However, as the results show, this is not the present picture, and the open question is still whether more genetically modified food products *will* enter the markets with consumers being so negative.

A number of cross-national differences were also identified. First of all, attitude formation and decision-making with regard to genetic modification in food was found to be more comparable among Danish, German and British consumers than with Italian consumers, which points to a possible north-south divide in consumer perceptions of genetic modification. Interestingly, in Denmark, Germany and the United Kingdom perceived risks were identified as a barrier to the perception of benefits of using genetic modification in food production. This inherently makes the formation and communication of benefits to increase consumer acceptance of genetic modification in food production a more difficult task in these countries than in Italy where perceptions of risks and benefits are in a clearcut compensatory relationship.

As indicated, the major results were quite stable across the two product examples. However, in Denmark, Germany and the United Kingdom, the perceived quality of the genetically modified yoghurt depended not only on the overall attitude towards genetic modification in food production, but also on the perceived trustworthiness of the product. This is contrary to the other models, where the effects of the product-specific beliefs on attitudes towards purchasing the products were entirely additive. The reason for this is likely to be found in the nature of the product examples used, with the yoghurt example focusing on quality dimensions and the beer example focusing on environmental and cost dimensions. In addition, the impact of perceived difficulty on purchase intentions with regard to genetically modified beer in Italy but not on purchase intentions with regard to genetically modified yoghurt may reflect the fact that the yoghurt example was explicitly labelled 'genetically modified' whereas the beer example was not.

The product examples also differed in that only the yoghurt still contained the genetically modified material. It was expected that this difference could in itself perform a basis for attitude formation differences. The fact that it did not, only verifies that at present consumers reject the technology overall, regardless of quality impact or the presence or non-presence of live genetically modified microorganisms in the final products.

SUGGESTIONS FOR FURTHER RESEARCH

The study was conducted with examples of genetic modification of microorganisms, and neither were very controversial applications. Previous research has shown consumer acceptance of genetic modification in food production to vary with the type of organism that is modified, with genetic modification of microorganisms generally being more acceptable to consumers than genetic modification of plants or animals (eg Hamstra, 1995; Heijs & Midden, 1995). Our research does not give reason to anticipate that attitude formation and decision-making with regard to products where plants or animals have been modified should differ significantly. However, this still remains to be document-

ed and is therefore an obvious subject for future research on consumer acceptance of genetic modification in food production.

Furthermore, the four-country study pointed to a possible North-South division in attitude formation and decision-making. This possible division between consumers in the Northern and Southern parts of Europe has also been found in previous research (European Commission, 1997; Saba, Moles & Frewer, 1998). However, the possible reasons for such a division have not been investigated systematically, though it has been put forward that it may be due to the fact that the entire debate on genetic modification is more advanced and more in focus in Northern European countries than in many Southern European countries (Durant, Bauer & Gaskell, 1998; Saba, Moles & Frewer, 1998). Likewise, the extent of this possible division deserves further investigation by including more, particularly Southern European, countries in future research.

Finally, a possible growth in the marketing of genetically modified foods would call for replications of this study to investigate the stability of the attitude and decision formation processes identified in the research presented.

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APPENDIX A. LIST OF ELICITED BELIEFS

Attitude model

Product-related benefits

Genetically modified food products will improve the standard of living of the future generations.

Genetically modified food products will increase my own and my family's standard of living.

Genetically modified food products are healthier than other food products.

Genetically modified food products are better quality foodstuffs than other food products.

Process-related benefits

Applying gene technology in food production will increase the product choice in supermarkets.

Applying gene technology in food production can be used to solve environmental problems.

Applying gene technology in food production will reduce the price of food products.

Applying gene technology in food production is a necessary activity.

Product-related risks

Genetically modified food products will cause allergy in human beings.

Genetically modified food products are a threat to human health.

Process-related risks

Applying gene technology in food production will cause environmental hazards.

Genetically modified organisms are likely to interfere with wild species in nature.

Nobody knows the long term consequences on the environment and human health of applying gene technology in food production.

Applying gene technology in food production will only benefit the producer.

Applying gene technology in food production is unnatural.

Purchase intention model - beer

Outcome beliefs

This beer is an unnatural product.

This beer is an unfamiliar product.

I have no confidence in this beer.

I do not know the long term consequences of consuming this beer.

I expect this beer to have a good quality and taste.

The genetic modification of this beer benefits nature.

This beer is likely to be good value for money.

This beer is suitable for drinking with other people.

Genetic modification of this beer only benefits the producer.

Normative belief

My friends would think I should definitely avoid this beer.

Control beliefs

This beer would probably be too expensive for me.

This beer will never be available where I usually buy beer.

Difficulty beliefs

I could easily distinguish this beer from other beer products where I usually buy beer.

If I saw this beer where I usually buy beer, I am sure I would notice that it is produced by means of gene technology.

Moral beliefs

Genetic modification of this beer is morally wrong.

The genetic modification of this beer goes against my basic principles.

The genetic modification of this beer interferes with nature.

Purchase intention model - yoghurt

Outcome beliefs

This yoghurt is an unnatural product.

This yoghurt is a wholesome product.

This yoghurt is an unfamiliar product.

I have no confidence in this yoghurt.

I do not know the long term consequences of consuming this yoghurt.

I expect this yoghurt to have a good quality and taste.

The genetic modification of this yoghurt benefits nature.

I expect this yoghurt to have a nice texture.

I expect this yoghurt to be easy to handle and use.

Normative belief

My family would think I should definitely avoid this yoghurt.

Control beliefs

This yoghurt would probably be too expensive for me.

This yoghurt will never be available where I usually do my shopping.

Difficulty beliefs

I could easily distinguish this yoghurt from other yoghurt products in the supermarket.

If I saw this yoghurt in the supermarket, I am sure I would notice that it is produced by means of gene technology.

Moral beliefs

The genetic modification of this yoghurt is morally wrong.

The genetic modification of this yoghurt goes against my basic principles.

The genetic modification of this yoghurt interferes with nature.

APPENDIX B. ITEMS FOR MEASUREMENT OF GENERAL ATTITUDES AND KNOWLEDGE DOMAINS

Attitude to nature

The balance of nature is very delicate and easily upset by human activities.

The earth is like a spaceship with only limited room and resources.

Plants and animals do not exist primarily to be used by humans.

Modifying the environment for human use seldom causes serious problems. (R)

There are no limits to growth for nations like Denmark/Germany/the United Kingdom/Italy. (R)

Mankind was created to rule over the rest of nature. (R)

Attitude to technology

The degree of civilisation of a people can be measured from the degree of its technological development.

New technological inventions and applications make up the driving force of the progress of society.

In Denmark/Germany/the United Kingdom/Italy and in the rest of Europe we are probably better off than ever, thanks to the tremendous progress in technology.

Throughout the ages, technological know-how has been the most important weapon in the struggle for life.

Because of the development of technology we will be able to face up to the problems of tomorrow's society.

Food neophobia

I am constantly sampling new and different foods. (R)

I don't trust new foods.

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

I am afraid to eat things I have never had before.

I will eat almost anything. (R)

Alienation from the market place

Most companies are responsive to the demands of the consumer. (R)

Unethical practices are widespread throughout business.

Stores do not care why people buy their products just as long as they make a profit.

Harmful characteristics of a product are often kept from the consumer.

Most claims of product quality are true. (R)

Perceived knowledge of genetic modification in food production

I personally am very knowledgeable about the use of gene technology in food production.

The average person in this country is very knowledgeable about the use of gene technology in food production.

Science is very knowledgeable about the use of gene technology in food production.

The Government is very knowledgeable about the use of gene technology in food production.

The industry is very knowledgeable about the use of gene technology in food production.

Knowledge about food production

Enzymes are used in all foods. (f)

All bacteria found in food is harmful. (f)

Some protein found in foods can be toxic. (t)

'Natural' does not necessarily mean healthy. (t)

All processed foods are made using genetically modified products. (f)

We eat DNA everyday. (t)

To be healthy food should be sterile before it is eaten. (f)

There are no laws or regulations on the use of gene technology in food production. (f)

Involvement with environmental issues

I am a member of an environmental organization.

I am a financial supporter of an environmental organisation.

I have attended public panel discussions about environmental issues.

I regularly watch tv programmes about environmental problems.

Perceived control

I can decide whether or not to buy foods produced with gene technology.

I can control whether I eat foods made with gene technology.

APPENDIX C. MEAN SCORES FOR GENERAL ATTITUDES AND KNOWLEDGE DOMAINS

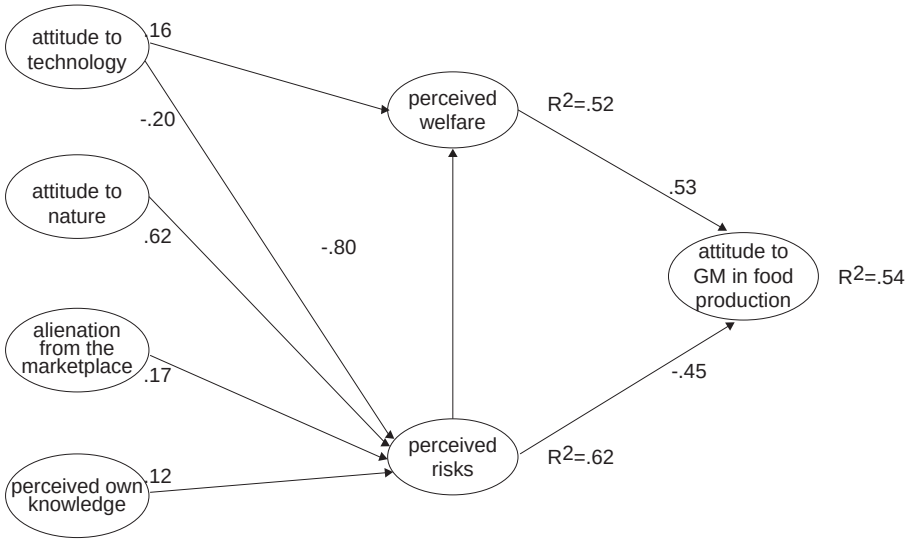
	Denmark	Germany	The UK	Italy
Attitude to nature (min. 6; max. 42)	34.86[d 1]	32.27[c]	30.30[b]	28.64[a]
Attitude to technology (min. 5; max. 35)	20.97[a]	24.93[d]	22.30[b]	23.42[c]
Food neophobia (min. 5; max. 35)	19.54[b]	18.93[b]	17.36[a]	21.20[c]
Alienation from the marketplace (min. 3; max. 21)	14.65[a]	16.58[b]	14.51[a]	15.08[a]
Perceived own knowledge (min. 1; max. 7)	2.90[a]	3.38[b]	2.80[a]	3.01[a]
Perceived knowledge of the average person (min. 1; max. 7)	2.22[a]	2.50[a]	2.30[a]	3.05[b]
Perceived knowledge of science (min. 1; max. 7)	4.08[a]	5.21[b]	4.25[a]	4.47[a]
Perceived knowledge of the Government (min. 1; max. 7)	2.63[a]	4.26[c]	3.61[b]	4.05[c]
Perceived knowledge of the industry (min. 1; max. 7)	3.70[a]	5.15[b]	3.89[a]	5.07[b]
Perceived control (min. 2; max. 14)	7.52[a]	8.66[b]	9.63[c]	7.53[a]

1 Mean scores with different letters within the same row are significantly different (Scheffe's test, $p<.01$)

Knowledge of food production and environmental involvement omitted because of low item-total correlations.

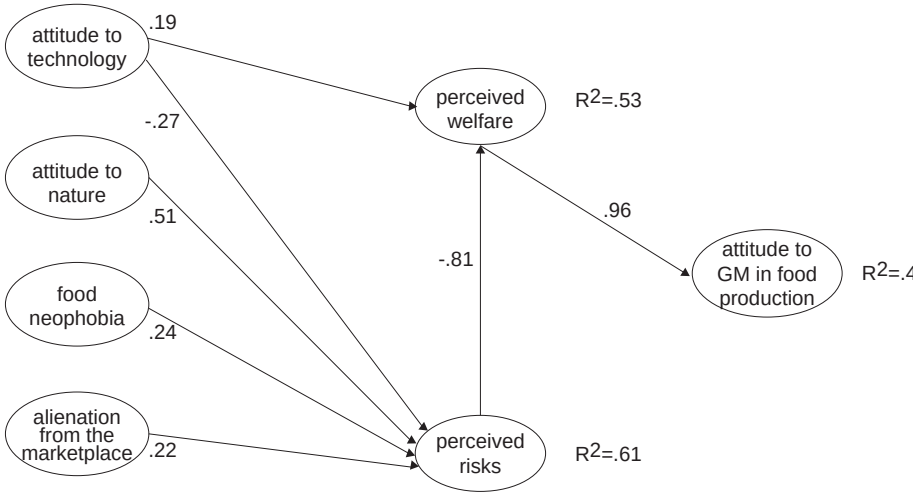
APPENDIX D. COUNTRY-SPECIFIC DANISH, GERMAN AND BRITISH ATTITUDE MODELS

Estimated attitude model – Danish data



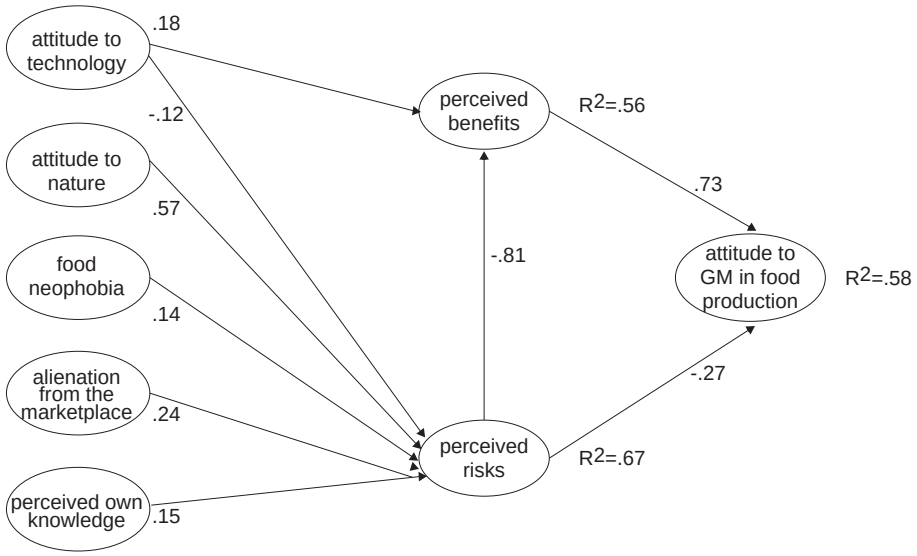
Chi-square=771, df=388, P=0.00
RMSEA=.046, P=0.92

Estimated attitude model – German data



Chi-square=1108, df=510, P=0.00
RMSEA=.049, P=0.63

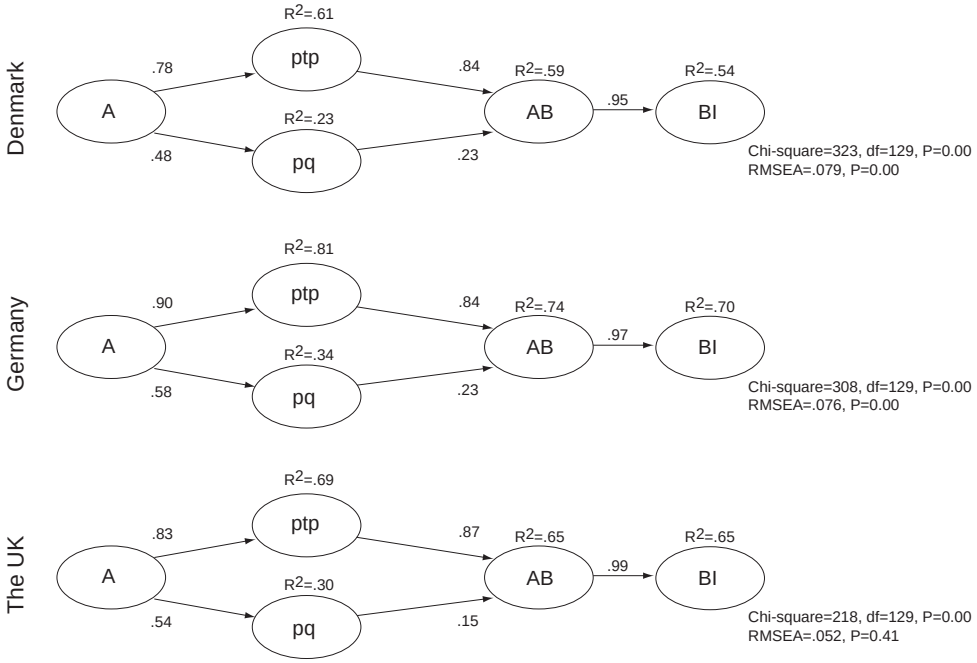
Estimated attitude model – British data



Chi-square=1121, df=538, P=0.00
RMSEA=.048, P=0.78

APPENDIX E. COUNTRY-SPECIFIC DANISH, GERMAN AND BRITISH PURCHASE INTENTION MODELS

Estimated purchase intention models – genetically modified yoghurt



Estimated purchase intention models – genetically modified beer