Consumer Attitudes towards Genetically Modified Foods in Europe: Structure and Changeability

Joachim Scholderer

Dissertation zur Erlangung des Grades *Doctor rerum politicarum*

Universität Potsdam
Wirtschafts- und Sozialwissenschaftliche Fakultät
Mai 2004

Tag der Disputation: 13. Januar 2005

Erstgutachter: Prof. Dr. Ingo Balderjahn, Universität Potsdam

Zweitgutachter: Prof. Dr. Klaus G. Grunert, Aarhus School of Business

Author's Address

Joachim Scholderer

MAPP, Aarhus School of Business, Haslegaardsvej 10
DK-8210 Aarhus V, Denmark. Tel.: +45 89 486452. Fax: +45 86 150177
E-mail: sch@asb.dk. WWW: http://www.mapp.asb.dk

Acknowledgements

I would like to thank all colleagues and friends who have contributed to the work presented here, either through valuable comments, through their patience, or simply through being there. I am particularly indebted to my supervisors, Prof. Dr. Ingo Balderjahn, University of Potsdam, and Prof. Dr. Klaus G. Grunert, Aarhus School of Business.

The empirical research presented here was conducted within large, cross-national collaboration projects. The data for Studies 1 and 2 were collected as part of the project "Consumer Attitudes and Decision-making with Regard to Genetically Engineered Food Products" (CADE-GENTECH), funded by the European Commission under the 4th Framework Programme through contract number FAIR-PL96-1667. The project was coordinated by Klaus G. Grunert, MAPP, Aarhus School of Business, Denmark. The participating organizations were MAPP, Aarhus School of Business, Denmark; VTT Biotechnology and Food Research, Finland; Oy Panimolaboratorio-Bryggerilaboratorium, Finland; Chr. Hansen A/S, Denmark, University of Potsdam, Germany; ISIDA, Italy; and the Institute of Food Research, United Kingdom.

The data for Study 3 were collected as part of the project "Consumers and Biotechnology", funded by the Nordic Industrial Fund through contract number P98098. The project was coordinated by Dr Liisa Lähteenmäki, VTT Biotechnology and Food Research, Finland. The participating organisations included MAPP, Aarhus School of Business, Denmark; Matforsk, Norway; SIK, Sweden; and VTT Biotechnology and Food Research, Finland. I would like to thank the participants in both projects for a pleasurable and inspiring experience.

Aarhus, May 2004

Joachim Scholderer

Contents

List of Figures

List of Tables

1. Introduction

Genetically modified foods have gone through troubled times in Europe. First they were hailed as a triumph of modern science, then abandoned as a threat to consumer health and the environment, now resurrected and about to enter European food markets. During the twenty years in which favors have been shifting this way, decision-makers have come to realize that consumers will have the final word over the success or failure of these foods. At the time of writing (May 2004), the five-year moratorium on the marketing of GM foods in Europe has just been lifted. With the roads re-opened, the aim of the research presented here is to show how European consumers can be convinced that these foods are acceptable products. To set the stage, we will start with a short history of the GM-foods debate in Europe. After this, we will identify the research problem and characterize the paradigmatic orientation of the research to be presented. The introductory chapter will conclude with an outline of the research that will be presented.

1.1. The GM Foods Debate in the EU

The debate on the introduction of genetically modified foods in Europe has a long and complex history. The debate has been led on multiple levels, including diverse frames of reference such as freedom of research, environmental risk, food safety, consumer protection, bioethics, economic policy, and international trade. The frames of reference have shifted over the years in terms of the degree to which they dominated the debate. In the following, we will try to trace the events in broad terms. The coverage cannot be complete here, of course. The history of the GM debate deserves attention in its own right, and a number of colleagues have devoted considerable effort to this task. The early years of the debate, for example, are covered in depth by Busch, Lacy, Burkhardt and Lacy (1991), Cavalieri (1985), and Krimsky (1991).

In the 1970s and 1980s, the debate was very much led among scientists themselves, with little divergence between Europe and the US. This changed noticeably in the 1990s, when different regulatory frameworks emerged that caused a major transatlantic divide. The events of these years have been studied in depth by Torgersen, Hampel, Bergmann-Winberg, Bridgeman, Durant *et al.* (2002), Joly and Assouline (2001), and Levidow, Carr and Wield (2000). The debate since 2000 has not been the subject of an in-depth historical analysis yet. A preliminary overview can be found in ENTRANSFOOD Network (in press).We will base our summary of the key events on the texts cited above, supplemented by a number of analyses of the events in specific EU member states.

1.1.1. Phase 1 (1973-1980): Science and Self-regulation

Gene technology (or recombinant DNA technology, as it was called at the time) was born in 1973, when a US laboratory first managed the *in vitro* transfer of a gene from one species to another. Although this was a scientific sensation and caused much euphoria around the world, it also prompted concern among scientists about possible dangers (Krimsky, 1991). In 1974, the geneticist Paul Berg and a number of colleagues published a letter to the editor in *Science*, calling for a moratorium on the use of the new technique until potential biohazards had been evaluated (Berg *et al.*, 1974). A year later, in 1975, the scientists lifted the self-imposed moratorium again at the famous Asilomar Conference, concluding that the technology did not pose any inherent dangers that were beyond conventional risk assessment procedures. In 1976, the US National Institutes of Health issued technical guidelines for laboratory safety that were adopted in similar forms throughout the world. In most EU countries, such guidelines for laboratory safety were adopted on a self-regulatory basis, following best practice in scientific risk assessment. Only Sweden and the UK introduced actual regulation at the time (both in 1978; see Torgersen *et al.*, 2002; Levidow & Carr, 2000).

1.1.2. Phase 2 (1980-1990): Commercialization of the Technology

In the 1980s, the technology began to yield industrial applications on a massive scale (Cavalieri, 1985; Busch *et al.*, 1995). It was heavily adopted throughout the pharmaceutical industry, followed by certain branches of the industrial chemicals industry, including the production of enzymes, vitamins and other food additives for use in food processing. The industrial-scale production of chymosin (an enzyme used in cheese fermentation) by means of genetically modified microorganisms was the first application that received major attention in the food industry. Arguably, cheese produced with the help of such chymosin was the first consumer product that would nowadays be seen as a GM food. Whilst these were contained-use applications and did not generate much public concern, the first deliberate release of a genetically modified organism (GMO) into the environment in 1986 prompted widespread attention. After years of litigation, the US company Advanced Genetic Science released the first transgenic microorganism into the environment (a microbe resistant to low temperatures). Apocalyptic imagery went through the media, showing scientists in protective clothing that looked like space suits. These events prompted a shift in the public debate, both in terms of the actors involved and in terms of the frames of reference of the debate (Galloux, Mortensen, de Cheveigne, Allansdottir, Chatjouli & Sakellaris, 2002; Torgersen *et al.*, 2002).

Non-governmental organizations took up the issue and introduced other perspectives into the debate. Whilst the discussion had until then mainly been led in terms of laboratory safety, a shift occurred towards new issues such as environmental risk and bioethics, where science-based risk assessment and value judgments had no clear boundaries any more (Krimsky, 1991; Nielsen, Jelsøe, & Öhmann, 2002; Renn, 1998b). A number of the new actors also demanded a shift in the paradigmatic orientation of risk assessment and management: absence of risks should be proved, and uncertainty in risk assessment should be accounted for through application of the precautionary principle (Levidow *et al.*, 2000).

The response by governments was a somewhat two-sided strategy (Bauer & Gaskell, 2002). Countries with large chemical and pharmaceutical industries had already identified biotechnology as a strategic research area. These countries sought to take up public concerns, although in a way that would not hinder further growth of the strategically important industries. Usually, this took the form of technology assessment exercises that focused on socio-economic consequences such as potential changes in industry and labor market structure, but also on public opinion. These early technology assessments were the birth of consumer attitudes towards GM foods as a research field (e.g., Borre, 1989; Hamstra & Feenstra, 1989; see Chapter 2).

Besides, the debate became more institutionalized. The styles differed somewhat between EU member states. France, Germany and the UK set up expert advisory committees (Roy & Joly, 2000; Dreyer & Gill, 2000; Levidow & Carr, 2000), whilst Sweden and the Netherlands established stakeholder fora (Togersen *et al.*, 2002) and Denmark held a consensus conference (Einsiedel, Jelsøe & Breck, 2001; Klüver, 1995; Toft, 2000). Emerging from these consultations, the first national regulations emerged that approached gene technology horizontally (e.g., the genetic engineering laws of Denmark, 1986, and Germany, 1990). In other EU member states, relatively little happened at the time, possibly because these countries did not possess significant industries with a strong stake in biotechnology (Motherway, 2000; Todt & Lujan, 2000; Torgersen *et al.*, 2002; Torgersen & Seifert, 2000).

1.1.3. Phase 3 (1990-1999): Failing Attempts at European Harmonization

The emergence of diverse national efforts at regulation prompted activity on intergovernmental and EU levels. The OECD as well as the European Parliament and the European Commission sought to safeguard the emerging biotechnology industries against a revival of national barriers that would hinder the development of the common European market. After initial skepticism, industrial lobbies joined the effort in order to protect their members from complicated cross-national litigation risks (Torgersen *et al.*, 2002; Levidow *et al.*, 2000; Joly & Assouline, 2001). The result was Directive 90/220/EEC on the deliberate release and placing on the market of GMOs. The directive, administered by the European Commission's Directorate General for the Environment, applied to the deliberate release of all live GMOs regardless of their field of application (with live vaccines exempted).

The regulation was generally received in terms of a lowest-common-denominator solution that did not really solve the conflicts between governments, industry and NGOs. In the word of Torgersen *et al.* (2002, p. 49), it "acknowledged the dual nature of the biotechnology problem – technical as well as a matter of public perception – without openly addressing issues beyond risk that could not be dealt with by scientific experts. This artistic and delicate balancing act attempted to bridge a gap between the different regulatory styles and public attitudes in various European countries, in order to provide a unifying framework for future technological innovations. Since the stakes were set so high, it was no wonder that difficulties later arose." The regulation had the scope of granting EU-wide approval for commercialization and marketing of products, but delegated responsibility for small, experimental releases of GMOs to national regulatory framework and was followed up by an additional regulation on the contained use of GMOs.

Implementation into national regulation was substantially delayed in a number of countries, caused by inter-departmental conflicts within governments (e.g., Torgersen & Seifert, 2000) as well as conflict between governments and important stakeholders. Denmark and Germany, for example, had to relax their existing regulations in order to accommodate the EU directives, whereas other countries such as France had to tighten regimes which had until then been based on voluntary codes of practice (Torgersen *et al.*, 2002). The directives prompted transatlantic repercussions too; the US interpreted the horizontal, process-based EU regulations as barely disguised attempts at protectionism because they deviated in their legal principles from the vertical, sector-specific regulation in the US.

The public debate remained relatively calm in the following years. 1996 saw the launch of the first genetically modified food product in Europe that was explicitly labeled. This was a puree from genetically modified tomatoes which Sainsbury's and Safeway introduced in the UK market in a joint venture. Sainsbury's and Safeway had embarked on an extensive promotion campaign prior to the product launch in February 1996, distributing information leaflets and product samples among opinion leaders. A public information program by the Institute of Grocery Distribution accompanied the pre-launch and launch activities. The product was sold approximately 10 per cent below the average market price. Although the public remained calm, experiences were rather mixed – market shares increased quickly, but declined rapidly after the promotion activities had been stopped. The product was taken off the market after a relatively short period.

In the meantime, potential for conflict was building up elsewhere. The BSE scandal in the UK and the successful cloning of the sheep "Dolly" had prompted another shift in the frames of reference in which the debate was conducted between European governments, the food industry and other stakeholders. Food safety and bioethics began to figure largely on public agendas. At the same time, the cultivation of GM crops in the US had expanded on a massive scale. The situation escalated in November 1996 when the first shipments of that year's soybean harvest arrived in European harbors. Monsanto's genetically modified Roundup Ready variety was mixed up in these shipments with conventional soybeans, but this fact had not been indicated to trading partners in Europe. Monsanto's strategy was widely interpreted as an attempt to "create a fait accompli" for selling Roundup Ready soybeans in Europe (Torgersen *et al.*, 2002, p. 63). However, the ploy was discovered quickly and made public. NGOs showcased the incident, prompting widespread media attention and public outcry (Lassen *et al.*, 2002). Retailers, in particular, were worried that their customers might distrust any consumer product that might contain (unlabelled) genetically modified soybeans or their derivatives.

The incident brought the labeling issue to the center of the discussion (Frewer, Lassen, Kettlitz, Scholderer, Beekman & Berdal, 2004). The European Commission was under pressure to finalize the novel foods regulation that had been in the pipeline since 1992. A hot debate ensued on the EU level, where the European Parliament demanded much stricter regulation than the Council of Europe and the European Commission, as well as between European Commission and national governments, who differed markedly in their proposals concerning what should be labeled and how the labeling should be carried out (Levidow & Carr, 2000; Lassen *et al.*, 2002). Food manufacturers and retailers, on the other hand, almost panicked at the prospect that their products might have to carry a "genetically modified" label on the package.

Much effort was devoted to finding the best possible way to communicate the fact to consumers that a product or one of its ingredients had been genetically modified, and at the same time to convince them that these were still perfectly acceptable products. Some stakeholders assumed that consumers had to be "educated" about the nature of modern biotechnology, others thought they should merely be informed about the characteristics of particular products, others again thought consumers should be actively persuaded that gene technology had enormous benefits to offer, and that genetically modified food products would carry these benefits as well (Scholderer & Balderjahn, 1999; Scholderer, Balderjahn & Will, 1998; Scholderer, Balderjahn, Bredahl & Grunert, 1999). Much of the consumer research conducted in the late 1990s was prompted by the need to find an appropriate strategy (see Chapter 2). At the time, the aim was not accomplished though, and the accelerating pace of events that led up to the moratorium prevented that any of the suggested strategies could be implemented in the real world.

Regulation 258/97 concerning novel foods and novel food ingredients was passed by the European Parliament and the Council in January 1997, making the labeling of novel foods compulsory in the EU, including genetically modified soy and maize, which had already been approved for marketing in the EU a number of years before. However, the regulation was implemented into national law only with considerable delay. In Germany, for example, it entered into force on 1 September 1998. On that very day, Nestlé re-launched their US brand "Butterfinger" in Germany as a test case, probing the responses that a clearly labeled GM food would evoke in the public. Originally, the Butterfinger launch had been planned to be coordinated with the launch of similar GM products by two other large food manufacturers (Dirk-Arie Toet, former biotechnology coordinator at Nestlé, personal communication, 2002). These withdrew in the last moment, causing the Butterfinger to be the only product in the market at the time that was labeled as a GM food.

The stakeholder reactions were colossal. The environmental group Greenpeace immediately started systematic picketing of supermarket outlets that sold the Butterfinger. The protest campaign was enacted simultaneously in a number of larger German cities. In the course of that week, most European retail chains issued declarations to the effect that they would not sell GM foods before the safety of the foods had been ensured, and even then only if there were a clear message from consumers that they really wanted these foods. A number of large food manufacturers issued similar non-GM policies, effectively blocking the commercialization of all GM foods for the time being.

Shortly before and after that event, two other incidents had sparked the attention of media and stakeholders. In August 1998, the scientist Arpad Pusztai of the Rowett Research Institute in Aberdeen had issued a press release claiming that feeding studies with rats in his laboratory had proved the increased toxicity of genetically modified potatoes. The results immediately became front-page news in the international media until it turned out that publication had been premature and the data did not actually support that conclusion. Pusztai was immediately suspended by the Rowett Research Institute and a committee was set up to investigate the possibility of fraudulent research.

The final trigger event was the publication of a research report in *Nature* in May 1999 in which US scientists reported data that suggested that pollen from GM crops might be toxic to larvae of the Monarch butterfly, thus posing a threat to biodiversity. The piece immediately became front-page news again and caused a heated argument within as well as between the different stakeholder groups. In June 1999, five EU member states (Denmark, France, Greece, Italy, and Luxembourg) declared that "in accordance with the precautionary principle, new marketing authorizations shall be suspended" (ENTRANSFOOD Network, in press, p. 25). The declaration called for the adoption of a more rigorous and transparent regulatory framework that, among other improvements, should set out provisions for monitoring requirements of transgenic crops. The consequence, although not officially declared, was a de-facto moratorium on the commercial cultivation of transgenic crops in the EU. Since then, no approvals for marketing of GM foods were granted in the EU until the final lifting of the moratorium in May 2004.

1.1.4. Phase 4 (1999-2004): The Years of the Moratorium

During the years of the moratorium, the debate was conducted in a relatively quiet manner for most of the time. Following the announcement of the quasi-moratorium by five member states (see above), the European Commission began a huge stakeholder dialogue to ensure the formulation of a coherent biotechnology strategy (ENTRANSFOOD Network, in press). Based on this consultation, a set of legal instruments was then developed to replace the much-contested Directive 90/220/EEC on the deliberate release and placing on the market of GMOs. The legislation includes the following instruments:

- Environmental release is now regulated under Directive 2001/18/EC on the deliberate release into the environment of GMOs and repealing Council Directive 90/220/EEC.
- GM food and feed are regulated under Regulation (EC) No 1829/2003 on GM food and feed.
- Contained use of GM microorganisms is regulated under Council Directive 90/219/EEC on the contained use of GM microorganisms and Council Directive 98/81/EC amending Directive 90/219/EEC on the contained use of GM microorganisms.
- Labeling of GM food and feed is regulated under a host of different instruments, including Council Regulation (EC) No 1139/98 concerning the compulsory indication of the labelling of certain foodstuffs produced from GMOs of particulars other than those provided for in Directive 79/112/EEC, Commission Regulation (EC) No 49/2000 amending Council Regulation (EC) No 1139/98 concerning the compulsory indication on the labelling of certain foodstuffs produced from GMOs of particulars other than those provided for in Directive 79/112/EEC, Commission Regulation (EC) No 50/2000 on the labelling of foodstuffs and food ingredients containing additives and flavourings that have been genetically modified or have been produced from GMOs, Regulation (EC) No 1830/2003 concerning the traceability and labelling of GMOs and the traceability of food and feed products produced from

GMOs and amending Directive 2001/18/EC (see ENTRANSFOOD Network, in press, p. 27).

Despite continued resistance from some of the member states who had declared the quasi-moratorium, Regulations (EC) 1829/2003 on genetically modified food and feed and 1830/2003 concerning their traceability and labeling entered into force on April 19, 2004. Finally, on 19 May 2004 the European Commission approved the import and marketing of a type of genetically modified sweet corn, thus ending the moratorium.

1.2. The Unresolved Problem

During the years of the moratorium, the commercial stakeholders in the debate – agribusiness companies, food manufacturers, and retailers – have made little effort to prepare themselves for the marketing of actual GM products to European consumers. Considerable research was conducted in the1990s, when the moratorium was not yet an issue. However, as we will argue in Chapter 3, this research has not solved the fundamental problem:

- Given that we *know* that consumers have critical attitudes towards gene technology, how can we convince them that products resulting from an application of the technology will still be acceptable foods?

Arguably, the situation in 2004 is very much the same as in 1998, immediately before the moratorium. Then as now, new regulation had just been introduced that was expected to solve conflicts on the stakeholder level, finally opening the road to consumer markets. Back then, all expectations came to nothing in the end. After a break of half a decade, the same challenges are posed again. The work presented here understands itself as a constructive contribution to the issue, trying to find a way in which renewed failure in the commercialization of GM foods can be prevented.

1.3. Paradigmatic Orientation of the Research

The research reported in the following is consumer research. As a discipline, consumer research is relatively young and interdisciplinary in nature. Consumer researchers, in particular in the food area, tend to have highly heterogeneous backgrounds such as social psychology, perceptual psychophysiology, economics, marketing science, nutrition, sociology, and even cultural studies. Paradigms have slowly been evolving though. In their review of paradigmatic orientations in consumer research, Simonson, Carmon, Dhar, Drolet and Nowlis (2001) identify three schools of thought: behavioral decision theory, social cognition, and the postmodern approach.

The present research understand itself as social cognition research, applying theories and methodologies developed in cognitive and social psychology to social problems (Fiske & Taylor, 1991; Kunda, 1999). The central concept in our research will be the concept of attitude. For the time being, we shall define an attitude in a relatively broad manner as “a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor” (Eagly & Chaiken, 1993, p. 1). A broad working definition will help organize existing research on consumer attitudes to GM foods, where confusion is often caused by the synonymous use of terms like “attitudes”, “beliefs”, “opinions”, “public perceptions”, “public concerns”, “risk perception”, “trust”, and so on. In terms of the above working definition, these concepts will all be understood as special cases of attitudes.

Our methodology will be an undogmatix mix. We will present qualitative research in those contexts where the *content* aspects of consumer attitudes are the object of inquiry. Survey research will be presented when static aspects of attitudes are to be investigated. Experimental research will be presented when dynamic aspects of attitudes are to be examined.

1.4. Structure

We will begin with a review of existing research. Chapter 2 will discuss previous research that has been conducted on consumer attitudes towards GM foods in Europe.

In the end of that chapter, we will identify a number of points where existing evidence converges, and a number of questions that remain unresolved. The unresolved questions will then be re-framed in theoretical terms in Chapter 3. In Chapter 4, we will narrow this down to a number of distinct research questions. Chapter 5 will develop the methodology required for their empirical investigation. In the following three chapters, empirical research will be presented. In particular, Chapter 6 will provide a comprehensive assessment of the structure and function of consumer attitudes towards GM foods. Chapter 7 will investigate how consumers resist persuasive communication, and Chapter 8 will investigate the effects which actual product experience has on consumers' attitudes. Chapter 9 will present conclusions from the research and outline its implications, trying to answer the question posed above: given that we *know* that consumers have critical attitudes towards gene technology, how can we convince them that products resulting from an application of the technology will still be acceptable foods?

2. Previous Research on Consumer Attitudes towards Genetically Modified Foods

2.1. Overview

Consumer attitudes towards GM foods are a relatively new field of social-scientific inquiry. Historically, the roots of the field can be traced back to a series of technology assessments that were begun in the late 1980s (Bauer, 1995; Hamstra, 1992, 1998). In those years, it had become apparent that the emerging field of modern biotechnologies would have wide-ranging impact on the operation of several industry sectors, including agriculture, food manufacturing, and food processing (Busch, Lacy, Burkhardt, & Lacy, 1991; Cavalieri, 1985; Krimsky, 1991). In several EU member states, governmental bodies commissioned social-scientific research in order to help them formulate coherent public policy towards these technologies.

In Germany, the Office of Technology Assessment at the German Parliament began monitoring public opinion about modern biotechnology as early as 1985 (Büro für Technikfolgen-Abschätzung beim Deutschen Bundestag, 1993). The Dutch Ministry of Education and Science started in the same year with a number of small-scale qualitative studies (Ministerie van O&W, 1985), whilst the Ministry of Agriculture commissioned its first consumer survey in 1988 (Hamstra & Feenstra, 1989). Denmark began in 1987, when the Board of Technology commissioned a panel survey on behalf of the Danish Parliament (Borre, 1989, 1990).

In the UK, these political processes started substantially later. In 1991, the UK Department of Trade and Industry commissioned a first research project on "The release of GMOs: Public attitudes and understanding" (Martin & Tait, 1992). None of the remaining EU member states undertook comparable technology assessment exercises before 1998. The European Commission, on a supra-national level, started the Special Eurobarometer series on "Europeans and Modern Biotechnology" in 1991 (for a detailed discussion of the results, see below). Since these early days, research has diversified remarkably. Altogether, six different types of research can be distinguished. These differ in the primary objects of their inquiry and are associated with distinct methodologies (for other classifications, see Frewer, Lassen, Kettlitz, Scholderer, Beekman, & Berdal, in press; Hamstra, 2000; Hansen, Holm, Frewer, Robinson, & Sandøe, 2003).

The first two types of research, *public opinion surveys* and *comparative risk perception studies*, tend to focus on attitudes towards GM foods as a technology. In other words, the attitude object about which consumers are questioned is the process of genetically modifying plants, microorganisms, or animals for use in agriculture or food processing. The methodology differs between the two types: whilst public opinion surveys aim to gauge the absolute level of attitudes within the general public, mainly using descriptive univariate techniques, comparative risk perception studies try to identify the relative position of the technology within a larger set of other technologies, using descriptive multivariate techniques, in particular perceptual mapping methods. Both types of research do not take individual differences into account, and both types tend to ignore the systems of beliefs with which the overall attitudes are associated (for detailed methodological reflections, see Bauer, Petkova & Doyadjjewa, 2000; Gaskell, 2001; Fischhoff, 1995; Slovic, 1992, 2000).

The third type of research tries to compensate for this blind spot, investigating the *contents of consumers' belief systems*. The object of this research is to qualitatively describe systems of beliefs with which the technology is associated in consumers' thinking, reasoning, and conscious experience. The methodology is qualitative, using in-depth interviewing techniques in data collection, and content analysis in data processing. Often, these studies are part of larger research programs, providing content-valid input to the development of measurement instruments, which are then used in one of the other types of research (Einsiedel, 2000; Frewer, Howard, Hedderley, & Shepherd, 1998; Hansen *et al*., 2003).

The fourth type of research comprises *models of attitude structure*. The aim is to develop quantitative models of the relationship between beliefs and other beliefs, between beliefs and attitudes, and furthermore, to relate these to other attitudes as well as behavioral intentions and behaviors. The methodology in these studies tends to be quantitative, using survey questionnaires in data collection, and regression analysis, path analysis, or structural equation modeling in data processing.

Closely related to this is the fifth type of research, *attitude change studies*. These studies focus on the dynamics of attitudes, in particular on whether they can be changed by means of persuasive communication. The methodology is experimental, using consumer information with manipulated message or source characteristics as stimulus materials, questionnaire items as attitude measures, and in some instances, think-aloud protocols as process-monitoring measures. Of the six types of research on consumer attitudes to GM foods which are distinguished here, these two types are the only ones with "academic" ambitions: they try to develop and test hypotheses involving theoretical constructs and their relationships, whilst all other approaches merely aim to measure and describe (also see Bredahl, Grunert & Frewer, 1998; Frewer *et al.*, in press; Peters, 2000; Sjöberg, 1998; Urban & Hoban, 1997).

Finally, the sixth type of research aims to *predict product choice*. The object of inquiry in these studies is to measure the extent to which consumer choices among competing products are influenced by the fact that a product contains genetically modified ingredients or was produced with the help of gene technology. The methodology is experimental. For data collection, factorial designs of several product attributes (only one of which is the GM attribute) are used to generate realistic product concepts that function as stimuli, which respondents are then asked to rank or rate. Conjoint analysis is used in data processing to estimate the relative influence of the GM attribute (e.g., Frewer, Howard, Hedderley, & Shepherd, 1997).

In the following, previous research will be reviewed, grouped according to the six types of research on consumer attitudes towards GM foods that were identified above. A number of the studies aimed to accomplish multiple objectives, for example to provide benchmarks of public opinion and to investigate attitude structure. In such cases, the respective studies will be discussed under more than one type of research. The literature review does not attempt to be exhaustive. Rather, studies were selected on the basis of the following criteria: first, the studies had to deal with consumer attitudes towards GM foods. Therefore, all research dealing exclusively with biomedical applications or environmental biotechnology was excluded. Second, the consumers participating in the studies had to be Europeans.

Although most research on consumer attitudes towards GM foods has indeed been conducted within the EU, this is a criterion of utmost importance because, unlike American, Canadian, Brazilian or Singaporean consumers, Europeans do not have a history of experience with tangible GM products (Gaskell, Bauer, Durant & Allum, 1999; Hoban, 2003; Zechendorf, 1998). Third, studies with insufficient documentation of research methods were discarded. Most public opinion surveys were screened out for this reason. Finally, studies with highly inconclusive results (e.g., where only fourth-order interactions were significant), serious errors in the processing of data, or with miniature samples were only considered to the degree that their results could be judged highly original.

2.2. Public Opinion Surveys

Numerous "opinion poll"-like surveys have been conducted on national and cross-national levels, using a variety of different example applications, question formats, and response formats. Zechendorf (1994) and Hamstra (1998) undertook attempts to provide overviews of public opinion surveys on biotechnology. Still, it is impossible to fully integrate these studies, especially because documentation of the survey methodology used in these studies is usually lacking.

Within the EU, the most inclusive and best-documented opinion survey is the Special Eurobarometer series on "Europeans and Modern Biotechnology", supplementing in three-year intervals the Standard Eurobarometer, which is the official public opinion instrument of the European Commission. Like all public opinion instruments, the Eurobarometer attempts to gauge the overall level of attitudes towards a group of issues in the general public. For a variety of reasons, the validity of such measurements can never be fully ascertained. Even minor changes in the wording of attitude items, the selection of response scale labels, or the order and thematic context of the questions can lead to relatively large changes in the level of reported attitudes towards the issue at hand (Schwarz & Sudman, 1996).

The Eurobarometer is no exception to this; however, it uses the same question and response format to measure attitudes towards a variety of different biotechnology applications, and it maintains a core of attitude items over time. Hence, comparisons of attitudes towards different applications and over time become possible. The cross-cultural validity of the instrument (see below, Section 5.4) is still unknown. Therefore, statistics derived from aggregation over the different national sub-samples within the Eurobarometer survey should be interpreted with a certain degree of caution.

2.2.1. Attitudes towards Different Types of GM Foods

Five special Eurobarometers have been conducted in the last two decades to gauge the overall level of consumer attitudes towards biotechnology in the EU (Eurobarometers 35.1 in 1991, 39.1 in 1993, 46.1 in 1996, 52.1 in 1999, and 58.0 in 2002; INRA Europe, 1992, 1993; European Commission, 1997; INRA Europe, 2000; Gaskell, Allum & Stares, 2003). The latest survey, Eurobarometer 58.0, asked approximately 16,000 EU consumers to indicate their attitudes towards different types of GM applications.

In addition to a number of biomedical applications such as prenatal genetic testing, cloning of human stem cells and xeno-transplantation, these types included pest-resistant crops, a typical example of the “first generation” of GM foods (“Taking genes from plant species and transferring them into crop plants to make them more resistant to insect pests”) as well as processed foods with altered protein content, a typical example of the “second generation” of GM foods (“Using modern biotechnology in the production of foods, for example to give them a higher protein content, to be able to keep them longer, or to change the taste”).

Consumers were asked to indicate their attitudes on four dimensions, including usefulness, risks, moral acceptability, and whether the application should be encouraged, using a response scale ranging from 1 (totally disagree) over 2 (mostly disagree) and 3 (mostly agree) to 4 (totally agree).

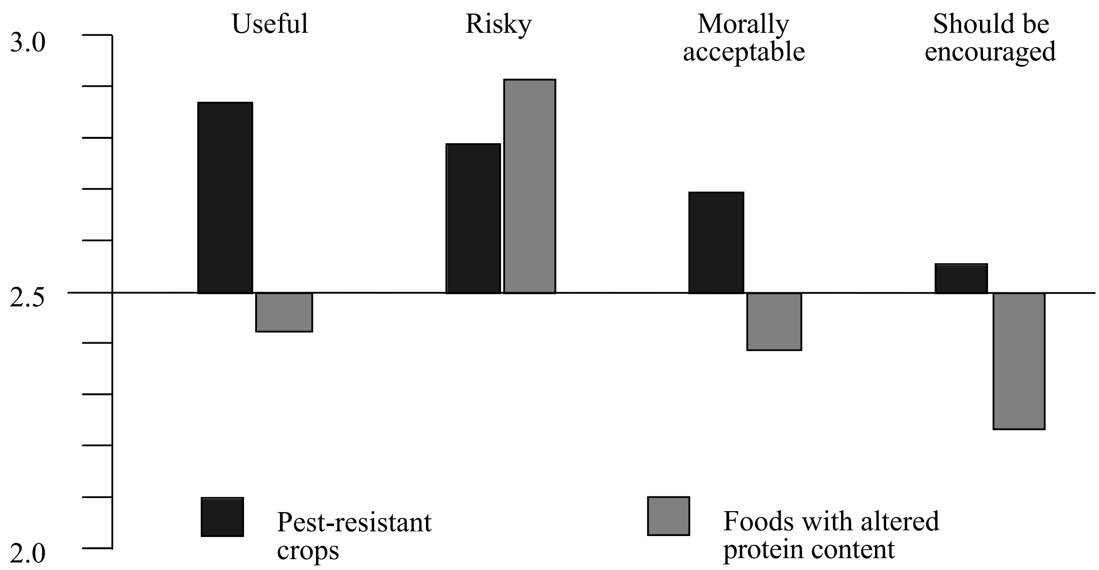

Figure 2.1. Average attitude of EU consumers towards different types of GM foods (scale minimum = 1 "totally disagree"; scale maximum = 4 "totally agree"; adapted from Eurobarometer 58.0; Gaskell, Allum & Stares, 2003, p. 13).

In the latest survey (data were collected in 2002), the first-generation GM-foods example scored slightly above the scale midpoint (which was 2.5) when evaluated for usefulness, moral acceptability, and whether it should be encouraged (see Figure 2.1). The second-generation GM-foods example, on the other hand, scored slightly below the scale midpoint when evaluated for usefulness, moral acceptability, and whether it should be encouraged. Both scored slightly above the midpoint when evaluated for risks. The biomedical applications, on the other hand, were generally seen in a more positive light. All of these, surprisingly including the cloning of human stem cells, scored clearly above the scale midpoint when evaluated for usefulness, moral acceptability, and whether they should be encouraged, but also above the scale midpoint when evaluated for risks.

Although since 1991, the Eurobarometer survey has been conducted in regular three-year intervals, and was always based on population-representative samples from all EU member states, a huge number of smaller studies have been conducted that replicated the Eurobarometer findings on a smaller scale. Often, these studies even involved survey questions adapted from the Eurobarometer, but were usually based on small convenience samples or nationally representative ones from only one EU member state (e.g., Frewer & Shepherd, 1995; Hampel & Pfenning, 1999; Heijs, 1995; Hursti,, Magnusson & Algers, 2002; Magnusson & Hursti, 2002; Morris & Adley, 2001; Saba, Rosati & Vassallo, 2000; Smink, Hanning & Homann, 1998 Sparks, Shepherd & Frewer, 1994; Urban, 1999).

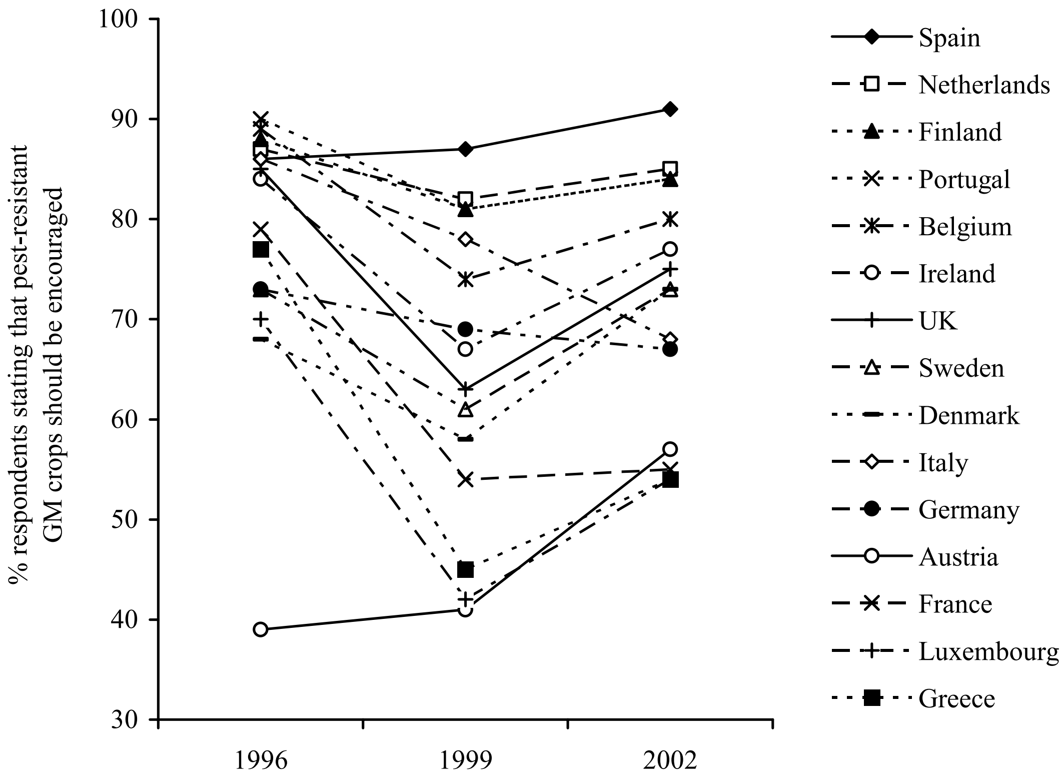

Figure 2.2. Trends in overall support of first-generation GM foods in different EU member states (percent responding with "totally agree" or "agree" to the question whether the application should be encouraged. Adapted from Eurobarometer 58.0; Gaskell *et al.*, 2003, p. 18).

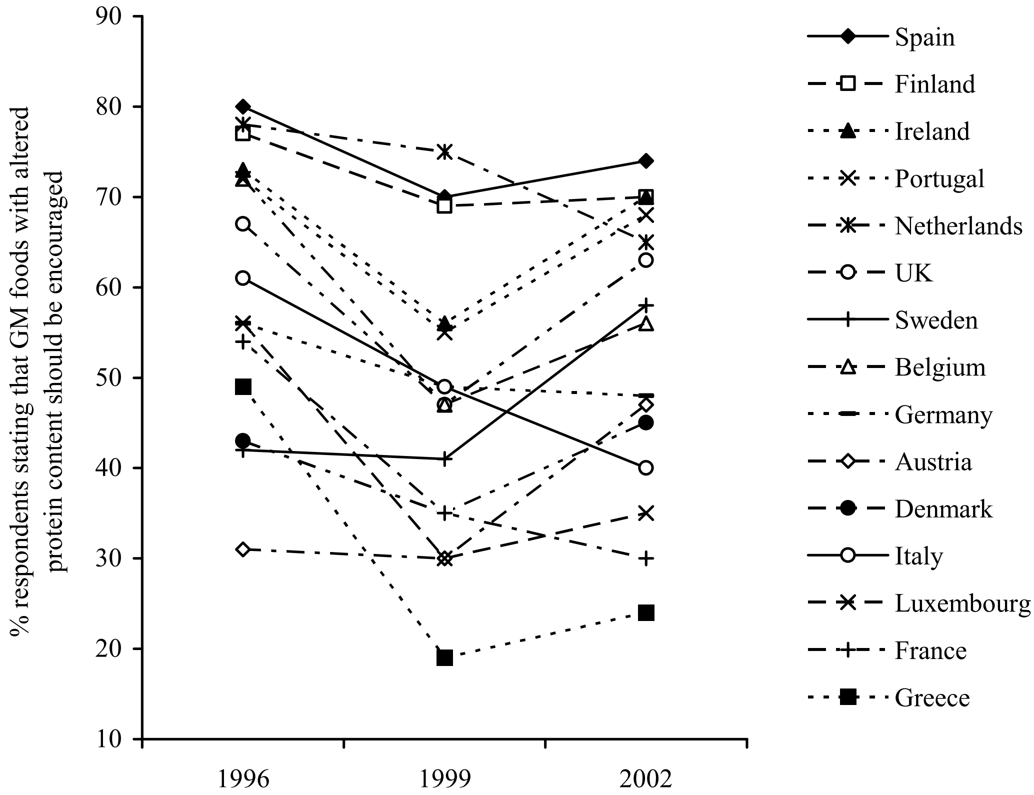

Figure 2.3. Trends in overall support of second-generation GM foods in different EU member states (percent responding with "totally agree" or "agree" to the question whether the application should be encouraged. Adapted from Eurobarometer 58.0; Gaskell *et al.*, 2003, p. 18).

2.2.2. Trends over Time

To the extent that the Eurobarometer results can be trusted, given the methodological limitations of opinion polls, EU consumers currently seem to have relatively neutral attitudes to GM foods as a technology, with slight variations upwards or downwards depending on the particular type of GM foods. Moreover, there appears to be a U-shaped trend over time. When compared to the results of the two previous Eurobarometer surveys (46.1 in 1996 and 52.1 in 1999), consumer attitudes towards both generations of GM foods seem to have passed through a period of increased negativity around 1999, but become more positive again in 2002 (see Figure 2.2 and Figure 2.3). Similar results were observed by Frewer, Miles and Marsh (2002) in a longitudinal survey that was conducted in the UK only.

Notable exceptions to the general trend across EU member states are Germany, Finland, France and the Netherlands, where attitudes appear to have more or less stabilized, and Italy, where attitudes have become consistently more negative over time. As noted by the authors of the study (Gaskell *et al*., 2003, p. 18), it is striking that France and Italy, two of the large EU member states in which attitudes of the general public have stabilized or become more negative over time, also form the core of a group of member states (consisting of France, Italy, Greece, Denmark, Austria and Luxembourg) who called for an extension of the de-facto moratorium on the commercial exploitation of GM crops (see Chapter 1, above). Political positions in these member states appear to some degree to reflect attitudes within the general public on this issue.

2.2.3. Effects of Demographic Characteristics

A consistent finding in all Eurobarometer surveys was that attitudes towards GM foods were dependent on two demographic background variables: gender and age. Younger Europeans tended to have more positive attitudes towards all types of GM foods than older Europeans, and men tended to have more positive attitudes than women (Gaskell *et al.*, 2003, p. 41). According to logistic regression results reported by the authors, both effects were relatively strong: the odds that a respondent would state overall support for GM foods of the different types included in the survey increased between 22% and 25% as a function of age group (when respondents aged 15 to 39 were compared to respondents aged 40 and above), and between 18% and 29% as a function of gender (when male respondents were compared to female respondents). Formal education, on the other hand, did not have significant effects on the overall levels of respondents' attitudes, and neither did the dominant religious denomination (protestant vs. catholic) of the respective EU member state respondents were residents of.

2.2.4. Knowledge about Biotechnology

Beginning with Eurobarometer 39.1 (INRA Europe, 1993), the Eurobarometer surveys have included a “knowledge quiz”, measuring objective knowledge about biotechnology and related natural science issues. The quiz includes items like, for example, “There are bacteria which live from waste water” and “Ordinary tomatoes do not contain genes while genetically modified tomatoes do not” which are answered on a correct-incorrect scale. In the absence of a gold standard, it is not possible to define what number of correct responses in this quiz would constitute little, medium, considerable, or detailed knowledge.

On a global average, EU citizens seem to be able to answer a little more than half of the knowledge items correctly, with slight variations upwards and downwards depending on the member state they are citizens of. Citizens of Northern member states such as Sweden, Denmark, the Netherlands and Finland tend to have above-average numbers of correct responses, whereas citizens of Southern member states such as Portugal, Greece, and Spain (plus Ireland, as a geographical exception) tend to have below-average numbers of correct responses. Despite ongoing efforts to inform the general public about modern biotechnology, the average level of knowledge appears to remain relatively static across all EU member states (European Commission, 1997, p. 25; INRA Europe, 2000, p. 25; Gaskell *et al*., 2003, p. 22).

2.2.5. Trust in Institutions

All special Eurobarometers on Europeans and Modern Biotechnology included items that asked the respondents to indicate whether they trusted different actors and institutions involved in the development, commercialization, regulation, and public debate of biotechnology (European Commission, 1997; Gaskell *et al*., 2003; INRA Europe, 1992, 1993, 2000). The ranking of the different actors remained relatively static over time: consumer organizations and environmental organizations were judged most trustworthy by Europeans, followed by Universities, animal welfare organizations, and finally, national governmental bodies, particular industries and political parties (Figure 2.4).

It is interesting to note that, in the period 1996 to 1999, *all* actors declined in their trustworthiness levels. The heated public debate of the years 1998 and 1999 may have been responsible for this (see above, Chapter 1). It appears that the mutual allegations of scientific misconduct, pursuit of vested interest, and deliberate distortion of facts, which have been exchanged between the different pressure groups during and after the Pusztai and Monarch-butterfly affairs, may have harmed the reputation of all actors and institutions that were involved in the controversies at the time.

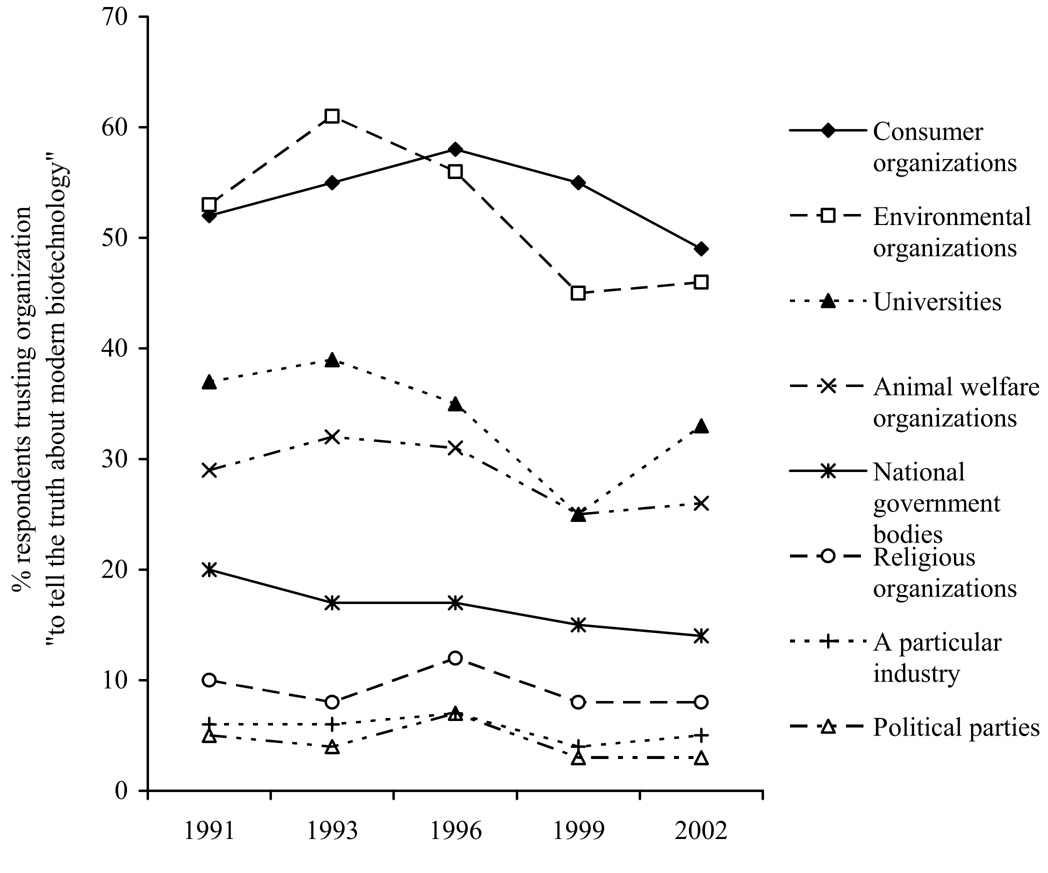

Figure 2.4. Average trust of EU consumers in different actors involved in biotechnology (adapted from Eurobarometer 58.0; Gaskell, Allum & Stares, 2003, p. 33).

2.3. Comparative Risk Perception Studies

Genetic modification of foods is not the first technology that has met problems of public acceptance – neither in Europe, nor in other parts of the world (Bauer, 1995; Buttel, 2000; Fischhoff, 1995; Jungermann, 1997). Seminal research on the driving forces behind public opposition to new technologies focused on the structure of consumers' comparative risk judgments, unsettled by the observation that members of the general public appeared to systematically overrate the risk associated with some technologies, whilst at the same time, they systematically underrated the risk associated with others.

2.3.1. The Psychometric Model of Perceived Risk

Slovic, Fischhoff and Lichtenstein (1980) laid the foundations to what is nowadays referred to as the "psychometric" model of perceived risk. They asked their subjects to evaluate altogether 90 hazards on 18 dimensions. The set of hazards in their initial study included technologies (such as nuclear power, gene technology, aviation), life-style activities (skiing, smoking), chemical substances (alcohol, pesticides, dynamite), and social problems (crime, terrorism). The judgmental dimensions included, among others, voluntariness of exposure, immediacy of effect, knowledge about the risk by those exposed, scientific knowledge, control over the risk, newness, chronic vs. catastrophic, common vs. dread, and severity of the consequences, and so. The authors found that, when aggregated over subjects and subjected to principle components analysis, the dimensions could be reliably represented by two factors: (a) a dread factor, and (b) a familiarity factor. Notably, only the dread factor was a reliable predictor of subjects' overall risk judgments.

The basic structure turned out to be remarkably stable across many replications conducted around the World (for a recent review, see Slovic, 2002). Under a variety of different labels (such as gene technology, DNA technology or genetic engineering), GM technology was included in many of these. Although for any hazard, its relative position in the perceptual space defined by the two axes of the model depends on the set of potential hazards over which the analysis is being conducted, GM technology was usually positioned in the quadrant defined by above-average scores on the dread factor, and below-average scores on the familiarity factor (see Rohrmann, 1999, for a detailed review of all risk perception studies conducted up until 1998).

Despite its intuitive appeal, the psychometric model of perceived risk has recently been subjected to harsh and far-reaching critique (for an overview, see Sjöberg, 2002a; 2002b, 2002c; Wåhlberg, 2001). The first problem is that the model is based on between-hazards comparisons. Strictly speaking, there is no evidence whatsoever that people engage in such comparisons when encountering a given hazard in their daily lives. The second problem is the pre-selection of judgmental dimensions. Research using open-ended methods has found that many consumers spontaneously use dimensions that are not included in the standard set (e.g., tampering with nature), whilst other dimensions that figure prominently in the standard set (e.g., risk to future generations) are hardly ever used spontaneously (Sjöberg, 2000b, 2000c).

2.3.2. Comparative Perception of Food-related Hazards

A number of relatively recent studies have used sets of hazards that are specific to the food domain. Fife-Schaw and Rowe (2000) asked 2000 British consumers in 1995 to rate eleven different food hazards on ten judgmental dimensions that had been selected on the basis of qualitative pilot work and extensive validation (Fife-Schaw & Rowe, 1996, Sparks & Shepherd; 1994), thereby accommodating one of the major points of criticism raised against the psychometric model of perceived risk. The position of the different hazards in perceptual space, defined by their scores on the familiarity and dread factors, is shown in Figure 2.5. Compared to the other food hazards included in this study, "genetically altered" scored substantially below average on the familiarity dimension, but average on the dread dimension.

The study was replicated by Kirk, Greenwood, Cade, and Pearman (2002) in a longitudinal design. They surveyed the same 1200 British consumers three times in 1998 and 1999, with 6-month intervals between the respective measurements. The initial relative position of GM foods was comparable to the one observed by Fife-Schaw and Rowe (2000), and did not change significantly over time. Considering that the period over which the panel study was conducted saw a heated and polarized debate about GM foods in the British media (see above, Section 1), the stability of consumers' perceptions of GM foods relative to other food hazards has to be judged as high. Unfortunately, no comparable studies have been conducted in other EU member states than the UK. Therefore, generalizations to other consumer populations should only be made cautiously.

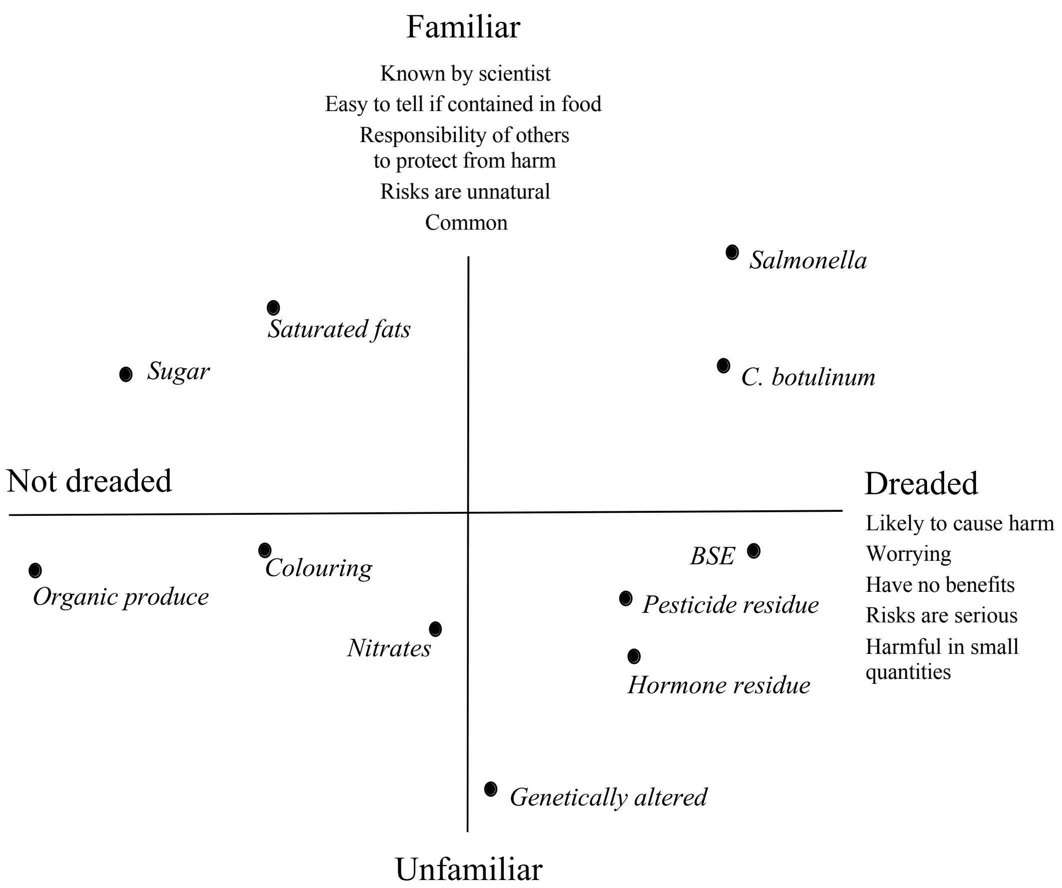

Figure 2.5. Relative position of the potential food hazard "genetically altered" in perceptual space, compared to other food-specific hazards (adapted from Fife-Schaw & Rowe, 2000).

2.3.3. Comparative Perception of Different Gene Technology Applications

Frewer, Hedderley, Howard and Shepherd (1997; Study 2) report the results of a relatively small risk perception survey, involving 320 consumers from the UK who were asked to evaluate descriptions of altogether 30 general and specific application of gene technology, developed in a pilot study (see Frewer, Howard & Shepherd, 1997; for a replication of the pilot study in Italy, see Saba, Models & Frewer, 1998). The applications ranged from genetic modification of microorganisms for the production of foods over genetically modified animals in agriculture to medical applications such as xeno-transplantation of organs from genetically modified animals.

In contrast to most other risk perception studies, the authors collected responses to just one item, objection to the application, from each respondent regarding each application, and then used internal preference mapping to model distances between the "objection scores" for the different applications. The perceptual maps are displayed in Figure 2.6. In both perceptual maps the respective first, stronger dimension appeared to contrast plant and microorganism applications with human and animal applications, whilst the second, weaker dimension appeared to contrast contained use (in food processing or in medical research laboratories) with uncontained use (in agricultural production or in the actual medical treatment of patients).

The results concerning the first dimension are broadly in line with results from public opinion surveys (see above) concerning different target organisms. Results concerning the second dimension are somewhat similar to the results of a qualitative study reported by Grunert, Lähteenmäki, Nielsen, Poulsen, Ueland and Åström (2001; see below), who found that a "psychological distance" dimension, that is, the degree to which a GM application is removed from the final consumer product, was of high explanatory value for consumers' objections.

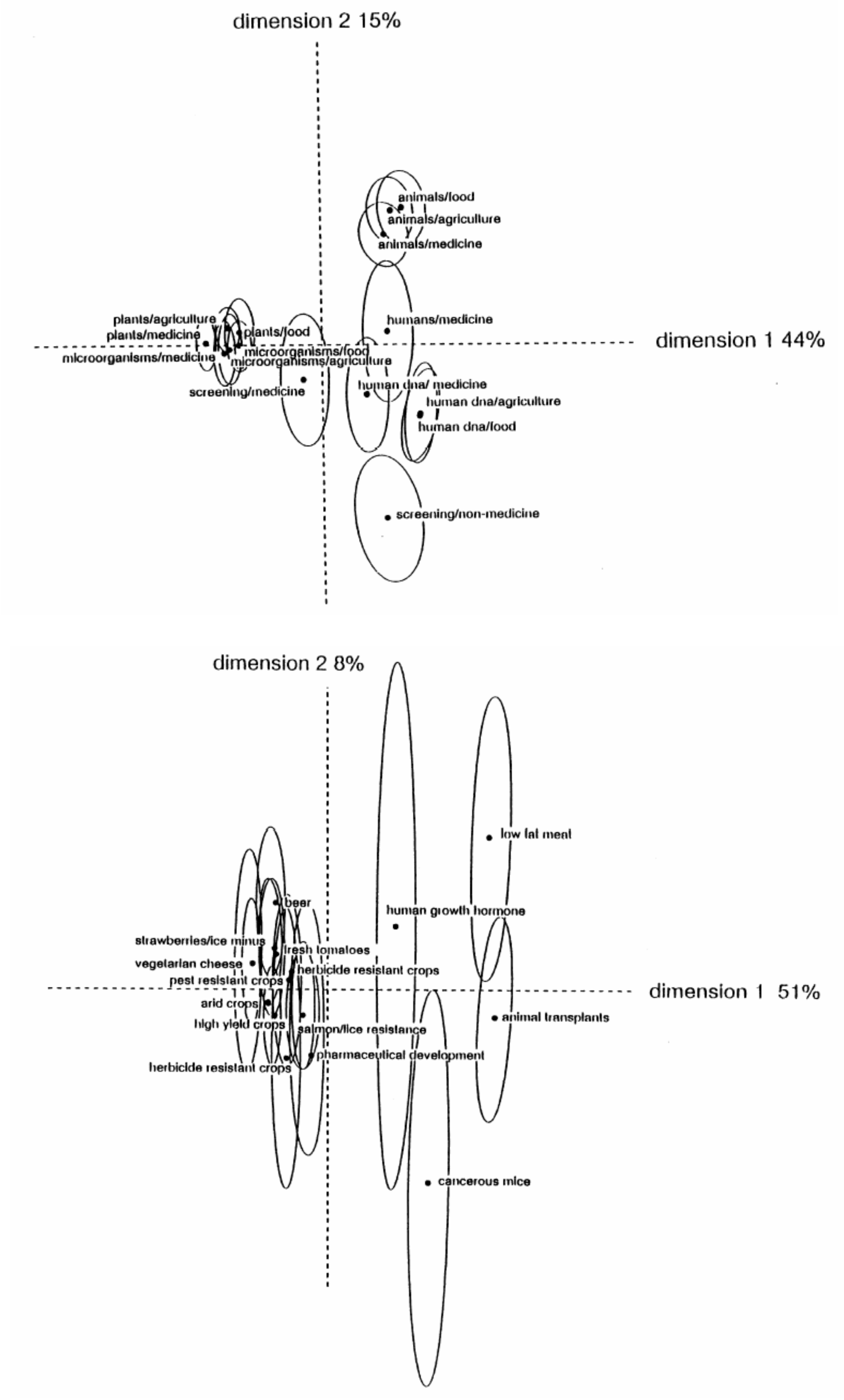

Figure 2.6. Perceptual maps for different general (upper figure) and specific applications (lower figure) of gene technology, derived from objection scores collected from UK consumers (adapted from Frewer, Hedderley, Howard & Shepherd., 1997, p. 71 and p. 74).

2.4. Qualitative Investigations of the Content of Consumers' Belief Systems

The research reviewed up until now, including public opinion surveys and risk perception studies, was based on standardized data collection methods. With few exceptions, the attitude statements used in the surveys, and the semantic differential dimensions used in the risk perception studies, had been selected by researchers *without* input from qualitative pilot research. This strategy has been heavily criticized in recent years (e.g., Frewer, Lassen, Kettlitz, Scholderer, Beekmann, & Berdal, 2004; Hansen, Holm, Frewer, Robinson, & Sandøe, 2003; Lassen, Madesn & Sandøe, 2001; Levidow & Marris, 2001; Marris, 2001; Purdue, 1995; Sjöberg, Truedsson, Frewer, & Prades, 2000), sparked by the hindsight realization that many of the issues investigated in those studies turned out not to be the ones the public were actually worried about.

Prompted by seminal research conducted in the Netherlands in the late 1980s (Hamstra & Feenstra, 1989; see below), a marked if somewhat delayed shift can be observed in the mid-1990s in the research strategies applied in the field: the qualitative content of the belief systems held by consumers became a research topic in its own right. The different studies inn this group can roughly be subdivided into those that elicited consumers' beliefs by confronting them with relatively abstract concepts like "genetic engineering", "gene technology", "biotechnology" or "GM foods", and those that used concrete product examples as stimuli in the interview situations.

2.4.1. Studies Focusing on Beliefs about the Technology

Hamstra and Feenstra (1989) were the first to conduct a detailed qualitative investigation of the contents of consumers' beliefs about modern food biotechnology. The design of their study consisted of focus group-like workshops, involving altogether 34 lay participants. The group discussions were enriched with elements typically found in consensus conferences. Every workshop started with a general discussion of modern food production issues. After a while, concepts of modern food biotechnology were introduced (including genetic modification), and spontaneous reactions were elicited from the participants.

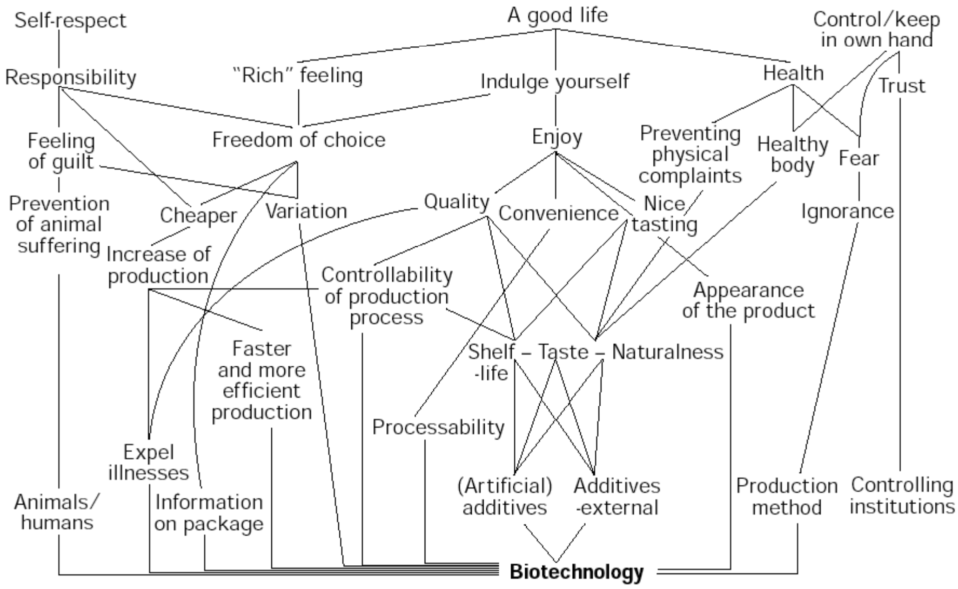

Figure 2.7. Hierarchical value map obtained from group laddering interviews with Dutch consumers (adapted from Hamstra & Feenstra, 1989; reproduced in Hamstra & Smink, 1996, p. 34).

After a first round of discussions, participants were invited to listen to three presentations: a speaker from a consumer organization, a speaker from a company developing GM foods, and a videotape with general background information about modern food biotechnology.

After this, discussions were continued, using a group-laddering protocol to probe more deeply into consumers' beliefs about biotechnology in general and its application in food production in particular. A content analysis of consumers' responses during the group laddering interviews yielded the hierarchical value map shown in Figure 2.7. Judged with the benefit of hindsight, it is interesting to note that the issues uncovered in this early study are virtually identical to those uncovered in most subsequent qualitative studies. Aspects of uncertainty figured prominently in consumers' responses, indicated by associations of with ignorance, fear, control, and trust.

Also apparent in this early study was the persistent association of modern food production methods with perceived losses in terms of taste, naturalness and healthiness. Finally, a whole range of consumer policy issues was raised that are still at the center of the public debate, including freedom of choice, labeling, the trustworthiness of regulatory institutions, and allegations of purely economic motives underlying producers' choice of ingredients and processing methods. On the other hand, participants in this study also recognized the potential of modern biotechnology to provide advances in terms of convenience, prolonged shelf-life of products, and lower prices for consumers. Hence, it could already at this early stage be expected that some degree of ambivalence would be present in consumers' belief systems.

In the initial study by Hamstra and Feenstra (1989), genetic modification was but one of a range of biotechnical processes which consumers were confronted with. Subsequent studies focused more narrowly on genetic modification, the biotechnical process that was regarded as most problematic by stakeholders in terms of consumer acceptance. Miles and Frewer (2001), for example, conducted individual laddering interviews with 130 UK consumers (in 1997) and obtained a hierarchical value map that was somewhat similar to the Hamstra & Feenstra (1989) results, albeit clearly biased towards negative associations (Figure 2.8).

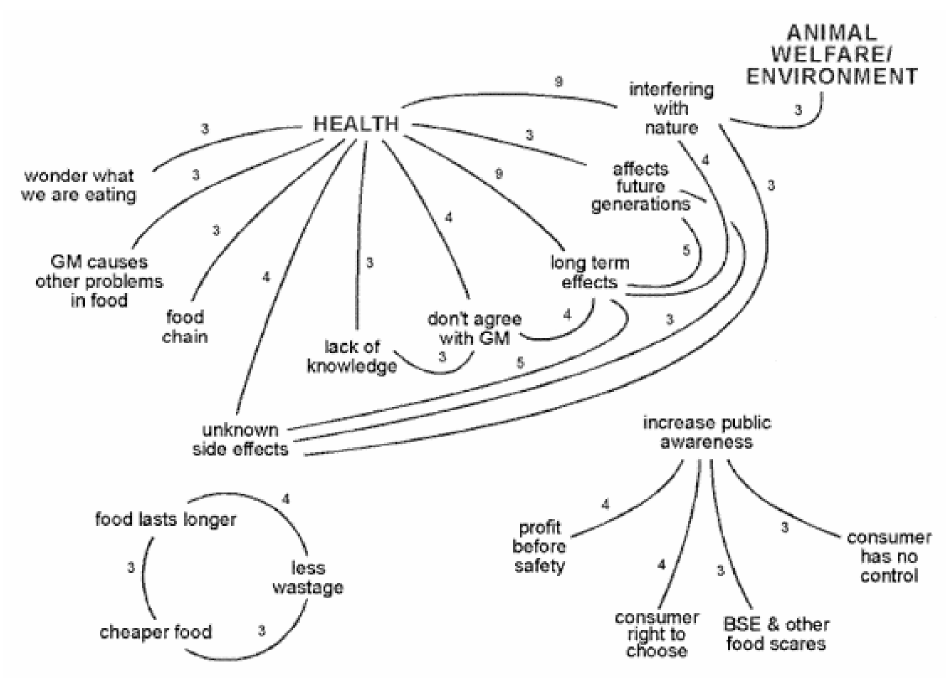

Figure 2.8. Hierarchical value map obtained from individual laddering interviews with UK consumers (adapted from Miles & Frewer, 2001, p. 52).

Reflecting the research questions underlying early public opinion surveys (see above), several studies investigated whether different beliefs were associated with different target organisms. Frewer, Howard and Shepherd (1997) elicited personal constructs representing genetic modification of different types of organisms from a small sample of British consumers. Modification of animals or human genetic material was associated with attributes like causing ethical concern, being unnatural, harmful, and dangerous. Modification of plants and microorganisms was more often associated with attributes like being beneficial, progressive, and necessary.

2.4.2. Studies using Naturalistic Product Examples

Bredahl (1999; also see Bredahl, 1998; Scholderer, Balderjahn, Bredahl & Grunert, 1999) used laddering interviews to investigate the risks and benefits that European consumers associate with two different types of concrete product examples, including beer brewed from genetically modified yeast, and yoghurt produced with the help of genetically modified starter cultures. Altogether 400 consumers from Denmark, Germany, Italy, and the UK participated in the study. The hierarchical value maps obtained from a content analysis of the interviews were relatively similar between the two product examples. Both for yoghurt and beer, the attribute "genetically modified" yielded more negative than positive associations. In all four countries, the focus was on beliefs relating to unhealthiness and a lack of trustworthiness (an example is shown in Figure 2.9).

Notably, most of these associations did not relate to the particular genetic modification in the respective example product. Instead, they focused on somewhat nebulous consequences consumer perceived the general technology to have, including issues related to the integrity of nature ("harms nature", "morally wrong"), uncertainty ("unfamiliar", "cannot trust product"), the power balance between different actors in the marketplace ("only benefits producer"), and a general expectation that modern food processing methods as such would render a product unhealthy ("unwholesome and artificial").

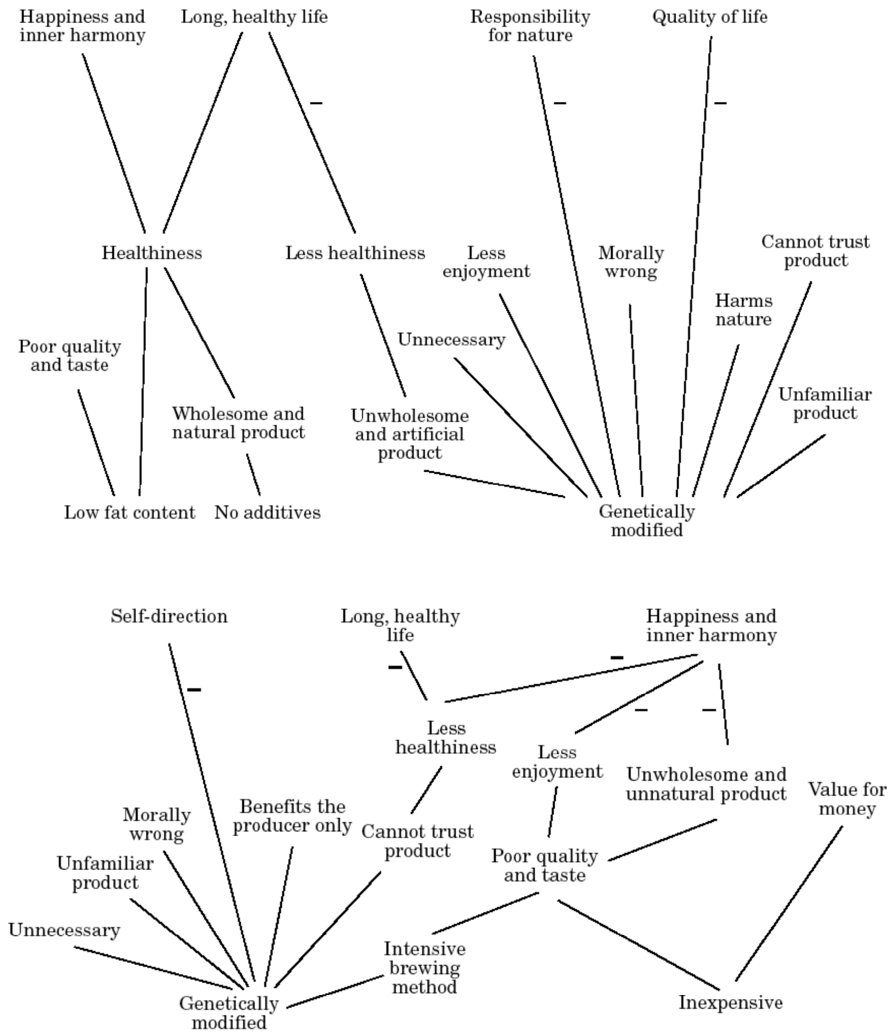

Figure 2.9. Hierarchical value maps obtained from individual laddering interviews with German consumers (upper figure: yoghurt example, lower figure: beer example; adapted from Bredahl, 1999).

These consequences were generally seen to inhibit the attainment of individual life values such as happiness and inner harmony, a long healthy life, quality of life, security, and the social values responsibility for nature and responsibility for the welfare of other people.

Grunert, Lähteenmäki, Nielsen, Poulsen, Ueland and Åström (2001) report the results of another, very detailed laddering study involving approximately 300 consumers from Denmark, Finland, Norway and Sweden. Consumers received product descriptions of cheese, candy and salmon products representing different types of GM applications. The GM applications varied along a "psychological distance" dimension and a "what is modified" dimension, and were presented along with conventionally produced product variants. In general, consumers appeared to regard the absence of genetic modification as a value in itself and associated the use of the technology with a broad range of negative consequences, but predominantly with uncertainty and unhealthiness.

Benefits of the use of GM were regarded as relevant, but could not compensate for the negative associations. In all product categories, the major distinction respondents made was between GM and non-GM products. The conventional products were consistently preferred most, even though these were the only product variants that were not explicitly described in terms of their benefits. Hence, as expected, the major benefit consumers saw in the conventional products was simply that they were not genetically modified. The absence of GM was, in turn, mainly associated with safety and healthiness, whilst any kind of GM application was associated with uncertainty and unhealthiness, along with a range of other, more specific negative associations.

Within the GM product variants, the "psychological distance" dimension turned out to be particularly important. In almost all cases, the average preference ranks were identical to the ranks of the products on the "psychological distance" dimension, with products where GM material was absent in the final product ranking highest, and products where the material was present and active, ranking lowest. Results concerning the other factor varied in the design, whether the GM application referred to raw material, enzyme production or microorganisms, were less clear. In the cheese case, no apparent differences could be detected. In the candy case, modifying processing aids (enzyme production or microorganisms) was more acceptable than modifying the raw material. In the salmon case, modifying soybeans for use as feed was more acceptable than feed containing modified microorganisms.

By design, the three products had differed in terms of the particular risks and benefits attributed to them. In none of the cases were the benefits able to compensate for the negative associations with genetic modification. However, the degree to which the benefits figured in respondents' perception varied. In the candy example in particular, relatively remote societal benefits (like benefits to the environment) and personal hedonic benefits (like a smooth taste) did not seem to be good promoters of GM acceptance, whereas a benefit combining societal relevance and personal health benefits (low calories/can be consumed by diabetics) seemed to work best, partly compensating for the negative associations.

2.5. Models of Attitude Structure

In a way, the qualitative research reviewed above can be understood as in-depth probing of the internal structure of consumers' beliefs systems. In the hierarchical value maps derived in studies using laddering interviews (Bredahl, 1999; Miles & Frewer, 2001; Hamstra & Feenstra, 1989; Grunert *et al.*, 2001), there seems to be a common pattern. The ladders tend to start with the attribute "genetically modified", then pass through a consequence level of somewhat higher variability but equally high abstraction, and end up at more or less the same set of general values across studies. But even on the consequence level, the variation between the different studies is relatively narrow. Hence, a common core of associations with the attitude object "GM foods" can be assumed to exist.

The studies to be reviewed in the following sections were mainly quantitative and often had the explicit aim to develop causal models of the structure of consumer attitudes towards GM foods. Whilst qualitative studies focus on the nature and content of consumers' beliefs, attitude structure models aim to establish quantitative relationships between different beliefs, between beliefs and attitudes, between attitudes and other attitudes, and between attitudes and purchase intentions. We will start with the few studies that have assessed the level of generality (or abstraction) on which beliefs and attitudes operate.

2.5.1. Abstraction Level of the Attitude Object

Brüggemann and Jungermann (1998) report an interesting investigation into the level of abstraction on which consumer attitudes towards gene technology are represented. The level of representation was operationalized in their experiment in terms of the effects which different levels of abstraction in the description had on consumer evaluations of risks and benefits. Besides other biotechnology applications, their stimuli included genetically modified foods. These were described to the same participants (100 German consumers) on a high level of abstraction ("gene technology"), a medium level of abstraction ("gene technology in agriculture"), and a low level of abstraction ("genetically modified tomatoes" and "genetically modified rape"), whilst identical descriptions of risks and benefits were included in the texts.

The authors found that consumers' evaluations of risks as well as benefits were significantly higher on higher levels of abstraction. The more concrete the descriptions became, the less extreme became consumers' evaluations, whilst trade-off values for risk versus benefit remained constant. The results point to an attenuation effect in the concretization process: consumers appear to form their evaluation mainly on the abstract level of the general technology, whilst, when more concrete applications of the technology are to be evaluated, mere random variation appears to be added, resulting in a process not unlike regression towards the mean.

2.5.2. Abstraction Level of Beliefs

Schütz, Wiedemann and Gray (1999; also see Gray & Wiedemann, 1998) investigated a similar question. The target of their analysis, however, was not the level of abstraction on which the attitude object is represented, but the level of abstraction on which the consequences are represented which consumer associate with the object. They conducted a number of focus groups and individual face-to-face interviews with altogether 110 German consumers, using a relatively unstructured protocol that gave participants the opportunity to elaborate their responses as much as they felt inclined to. The participants were asked to explain the risks and benefits they associated with a number of gene technology applications. After the interviews had been transcribed, the authors coded each response according to the level of specificity on which the belief had been expressed.

Of the altogether 169 statements about risk that respondents had spontaneously generated when asked to explain their critical attitude towards gene technology, 25% contained neither a cause nor a consequence of the concept "risk". Instead, consumers generated re-phrasings and tautologies such as "because it's so risky" when asked to explain their attitudes. Only 8% of the statements contained a causal specification of risk (related to misuse and safety aspects during production processes). 67% of the risk statements contained a consequential, but no causal specification. Of the consequential specifications, by far the most (78%) were related to humans, and few to the environment (13%), animal welfare (7%) or societal issues (4%).

Substantially more benefit beliefs were voiced during the interviews than risk beliefs, and they also they tended to have a higher degree of specificity. Of the altogether 257 benefit statements, only 4% contained no causal and no consequential specifications. 21% of the benefit statements contained a causal specification (most of them related to lower cost for producers or consumers, followed by safety benefits and better product qualities). Finally, the remaining 75% of benefit statements contained a consequential, but no causal specification. Again, most of the consequences were related to humans (49%), followed by economic benefits (26%), abstract statements about health (18%), environment (3%), science (2%), and society in general (1%).

Taken together, the results suggest that consumers do not actually have beliefs about GM foods in the sense, as beliefs are commonly understood in consumer research (Fishbein & Ajzen, 1975; see Chapter 3.2). First of all, the statements generated by the participants of the study were largely evaluative, rather than cognitive, as which a belief is commonly defined (Bagozzi, 1978). Moreover, the risk statements in particular tended not to have any specifications of causes or consequences, suggesting that the evaluative judgment is categorical and made on the level of the attitude object itself, rather than on the level of the object's attributes, as a belief-based model of attitude structure would require (Hackman & Anderson, 1968; Pratkanis, 1989). Finally, even in those instances where attribute-like consequence specifications were made, these referred in many instances to even more abstract entities ("the environment", "health") rather than more concrete ones, as a belief-based model would assume (Heddy & LaBarbera, 1985).

2.5.3. Interrelationships between Beliefs

The complexity of an attitude can often be assessed by examining the interrelationships between different beliefs (Chaiken, Pomerantz & Giner-Sorolla, 1995). A complex belief system that is based on many and highly diverse attributes of and experiences with an attitude object, should exhibit little systematic covariation across individuals. If beliefs show strong covariation, on the other hand (i.e., low complexity), this is often taken as an indicator that these beliefs are *derived* from overall attitudes, rather than the other way around.

Only few studies have been reported in the literature that examined the covariation between belief statements about gene technology. Bredahl (2001) used 15 belief items in a standardized survey, constructed from the beliefs identified in the laddering study by Bredahl (1999; see above). The survey involved 2000 consumers from Denmark, Germany, Italy and the UK. Using principal components analysis, she explored the dimensionality of the belief data and found that two principal components were sufficient to represent the covariation between the beliefs: a risk dimension, and a benefit dimension. Saba and Vassallo (2002) used six belief statements in a sample of 1000 Italian consumers. Exploring the dimensionality of the belief set, they found that two principal components were sufficient to represent their data as well.

Midden, Boy, Einsiedel, Fjæstad, Liakopoulas, Killer, Öhmann and Wagner (2002) report a factor analysis of the attitude statements in the Eurobarometer (1996) data, i.e. of the altogether 24 questions asking respondents to evaluate the usefulness, risk, moral acceptability, and overall support of the six prototypical biotechnology applications included in the Eurobarometer survey (see Chapter 2.2.1, above). Although the items were not actually belief statements but overall evaluations, the authors found a two-dimensional structure as well. The first factor comprised all evaluations of usefulness, risk, moral acceptability, and overall support, whilst the second factor comprised the risk statements. Very similar results had already been obtained by Hamstra (1991) in a similar analysis of overall evaluation data gathered from 810 Dutch consumers.

The results indicate a rather low degree of complexity in consumers' beliefs, both concerning gene technology in general as well as GM foods in particular. Two dimensions were found sufficient in all studies where belief complexity was investigated. As pointed out by Bredahl (2001) and Scholderer, Bredahl and Frewer (2001), this finding does not exactly come as a surprise as European consumer simply do not have any experiences with GM foods (see Chapter 1). Furthermore, the debate in the media has largely been conducted on the level of the general technology, rather than on the level of particular products (Bauer & Bonfadelli, 2002; Gutteling, Olofsson, Fjæstad, Kohring, *et al.*, 2002). Hence, a lack of differentiation could only be expected.

2.5.4. The Role of Factual Knowledge

A key concept in the public understanding of science literature is the so-called "deficit model" (Hansen *et al.*, 2003). The model refers to technocratic elites who adopted the perspective that the public was in some way ignorant about notions of risk and probability and saw it therefore as desirable to rectify the knowledge gap between the originators of scientific information and its recipients. As a result, it was thought that educating the public would resolve all problems of technology acceptance (Hilgartner, 1990). In the case of GM foods, adopters of the deficit model assumed that if only consumers recognized the benefits in the same way as those developing and promoting the technology, then they would finally accept the resulting products (Peters, 2000; Scholderer, 2000).

As already mentioned, the Eurobarometer surveys included a "knowledge quiz", measuring factual knowledge about biotechnology and related natural science issues. In the Eurobarometer 46.1 report (European Commission, 1997) the authors related factual knowledge (as measured by the knowledge quiz) to the different attitude dimensions discussed above (usefulness, risk, moral acceptability, and overall support). Quite surprisingly, they found that knowledge was positively related to *all* of these dimensions. Unfortunately, the authors only report correlations between knowledge and attitude indices obtained by averaging over all biotechnology applications for which attitude measures had been included. The correlations were $r = .26$ with usefulness, .10 with risk, .24 with moral acceptability, and .22 with overall support.

In the Eurobarometer 46.1 report, the authors interpret this finding as an effect of attitudes becoming more "crystallized" at higher levels of knowledge (i.e., stronger and more extreme), independent of whether these attitudes are positive or negative (i.e., independent of their the valence). In Midden *et al.*'s (2002) reanalysis of the Eurobarometer 1996 data, the correlations have somewhat changed although the data should actually be the same. Here, the correlations are reported as $r = .21$ with usefulness, .20 with risk, .20 with moral acceptability, and .18 with overall support.

In the reports about the three subsequent Eurobarometer surveys, the authors have shown a marked reluctance to repeat these analyses. The reasons can only be speculated about. Still, it is striking that not even the possibility of regressing attitudes on knowledge is mentioned in the Eurobarometer 52.1 (INRA Europe, 2000) and 58.0 (Gaskell *et al*., 2003) reports. In a refereed journal paper re-analyzing data from the Eurobarometer 52.1 survey, the Eurobarometer working group stresses that their "present interest is on an effect that lies outside the domains of trust and knowledge" (Gaskell, Allum, Wagner, Kronberger, Torgersen, Hampel, & Bardes, 2004, p. 191). Although knowledge is included as a predictor in their regression analyses, the authors do not report the sufficient statistics that would allow an estimation of the effect size associated with knowledge.

A number of other studies have attempted to replicate knowledge effects similar to those identified in the Eurobarometer 46.1 report, but failed to find them. These studies included Bredahl (2001) who used data from altogether 2000 Danish, German, Italian, and British consumers, Koivisto-Hursti and Magnusson (2003), who used data from 800 Swedish consumers, and Frewer, Shepherd and Sparks (1994), who used data from 60 British consumers. In light of the evidence, the relatively bold conclusions from the Eurobarometer 46.1 report (European Commission, 1997), claiming that increased knowledge leads to increased attitude extremity irrespective of the attitude's valence, should be regarded with skepticism. Evidence from studies published in peer-reviewed journals (Bredahl, 2001; Koivisto-Hursti & Magnusson, 2003; Frewer et al., 1994) as well as the absence of follow-up analyses in subsequent Eurobarometer reports (INRA Europe, 2000; Gaskell *et al*., 2003) suggests that there may be little relation after all between factual knowledge about biotechnology and attitudes towards GM foods.

2.5.5. Risk-benefit Trade-offs

A very thorny issue in all areas of consumer policy is the question about the rationality of consumer choice. As Scholderer, Balderjahn and Will (1997) have shown in their study of international biotechnology experts, the stakeholder elite tends to presuppose a model of technical rationality in consumers. Interestingly, this presupposition can be found on all sides of the debate, even among professional consumer researchers. The bias usually takes the form of a particular causal direction which is imposed on the statistical models without even considering alternative representations.

Virtually all studies which aimed to describe the structure of consumer attitudes to gene technology on a medium level of generality – that is, in terms of the interrelationship between overall evaluations of gene technology and evaluations of risk and benefits – have assumed that overall evaluations of the technology are formed on the basis of a risk-benefit trade-off. Hampel (1999), for example, reports multiple regression analyses on the basis of the Eurobarometer 1996 data, pooled over the different EU member states. His model is shown in Figure 2.10 (coefficients are standardized).

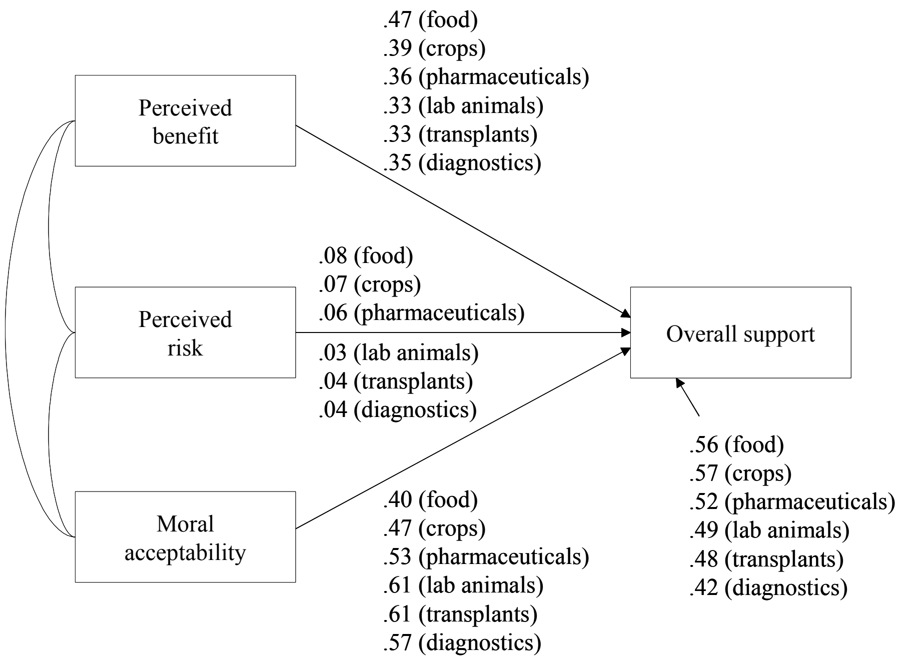

Figure 2.10. Overall support for different biotechnology applications as a function of perceived risk, perceived benefit, and moral acceptability (adapted from Hampel, 1999, p. 31).

The same basic model, assuming that the basis of consumer attitudes towards gene technology is a risk-benefit trade-off, can be found in all re-analyses of Eurobarometer data (e.g., Hampel & Pfenning, 1999; Gaskell *et al.*, 2004; Midden *et al.*, 2002; Pardo, Midden & Miller, 2002), sometimes with added, sometimes with omitted variables, sometimes aggregated over the six applications in the Eurobarometer, sometimes not, sometimes based on national sub-samples, sometimes based on the pooled data.

Often, the idea of a risk-benefit trade-off also forms an inherent part of more complex models. For example, it reappears in most consumer surveys that have investigated the inter-attitudinal structure of consumer attitudes towards GM foods, i.e. how these attitudes are related to more general socio-political attitudes on the one hand, and to purchase intentions on the other hand. These surveys include the one conducted by Bredahl (2001) in four different EU member states, McCarthy and Vilie (2002) in Ireland, which was a replication of Bredahl's (2001) survey, Saba, Rosati and Vassallo (2002) and Saba and Vassallo (2000) in Italy, Siegrist (2000) in Switzerland, and Sparks, Shepherd and Frewer (1995) in the UK. The results of these studies are reported in more detail in the next section (see below). The regression coefficients reported by the different authors are of similar size as the ones reported by Hampel (1999).

Judged from the omnipresence of the idea of a risk-benefit trade-off in these models, there appears to be a consensus in the scientific community to consider the existence of this trade-off self-evident. However, the assumption has never actually been put to an empirical test in *any* of the studies reviewed here. In all instances, the respective model structure was specified a priori. Considering the results of studies in which the complexity of beliefs and belief systems was explicitly investigated (notably Schütz *et al.*, 1999; see above), the assumption of a rational choice process appears highly questionable.

2.5.6. Dependence on General Socio-political Attitudes

Consumer attitudes towards genetically modified foods cannot be fully understood in isolation from attitudes towards other social issues. In the qualitative investigations reviewed above, it already became obvious that even broader issues like environmental policy or technologies in general provide the template by which gene technology is judged and evaluated.

The broadest investigation of the relationship between consumer attitudes towards GM foods and more general socio-political attitudes has been the already mentioned survey by Bredahl (2001) which involved altogether 2030 consumers from Denmark, Germany, Italy and the UK. In this study, consumer were asked to respond to a whole battery of attitude scales, measuring attitudes towards the environment, technology, consumer alienation from the marketplace (i.e., anti-capitalist attitudes; Allison, 1978), food neophobia (i.e. the habitual tendency to reject unfamiliar foods as such; Pliner & Hobden, 1992), subjective knowledge, as well as the already discussed risk and benefit items which had been constructed on the basis of qualitative pilot research (see Chapter 2.5.3, above). The results of Bredahl's structural equation analysis are shown in Figure 2.11.

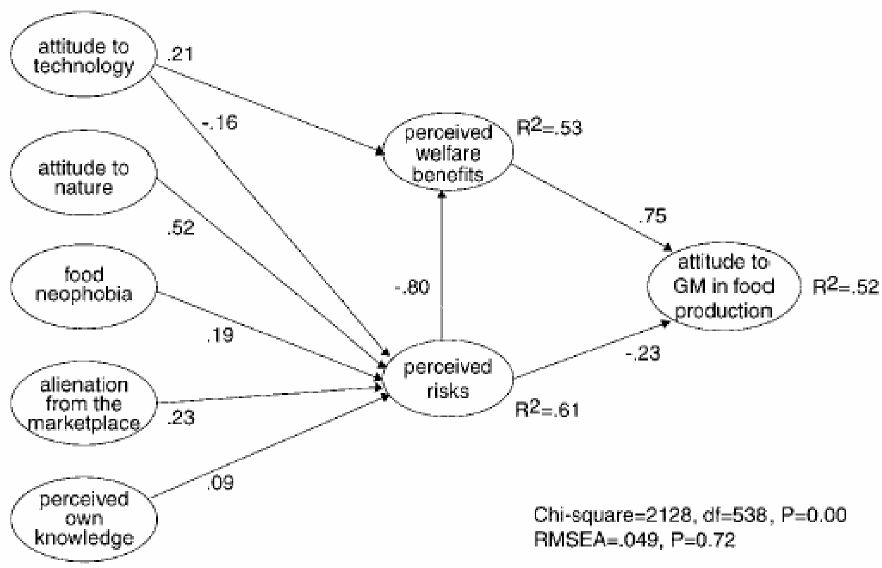

Figure 2.11. Risk-benefit trade-off based on confounded risk and benefit perceptions, in turn determined by a battery of general socio-political attitudes (adapted from Bredahl, 2001, p .42).

The battery of socio-political attitudes could explain more than half of the variance in perceived risk (53%) and benefit (61%), respectively, indicating a strong dependence. Risk and benefit had been measured by the set of beliefs already discussed above. Furthermore, it had been assumed in this study that overall attitudes would be the outcome of a risk-benefit trade-off. Interestingly, the residuals in the risk and benefit construct were so highly correlated that a direct path had to be added from risk to benefit in order to obtain a reasonable fit. The now confounded risk-benefit trade-off model could then explain a mere 52% of the variance in overall attitudes.

In a way, the Bredahl (2001) study effectively synthesized preliminary results that had been gathered in many smaller-scale studies. Attitudes towards environment and nature, for example, had already been found to be negatively correlated to consumer attitudes towards GM foods in the preference mapping study by Frewer *et al*. (1997; see above) as well as by Hamstra (1995) in a survey of 420 Dutch consumers. Attitudes to science and technology had already been found to be positively correlated to attitudes towards GM foods in a survey of 1500 Danish consumers reported by Borre (1990a). The same result had been obtained in the already mentioned surveys by Hamstra (1991) in the Netherland and Sparks *et al*. (1994) in the UK.

Siegrist (2000) conducted a survey involving altogether 1000 Swiss consumers. In this study, he focused on the concept of social trust (Earle & Cvetkovich, 1995) to explain perceived risks and benefits associated with gene technology. Social trust refers to people's willingness to rely on experts and institutions in the management of risks and technologies. In this tradition, trust is understood as a one-dimensional socio-political attitude that is generalized over particular issues and institutions. Using structural equation modeling, the author found that social trust was positively related to perceived benefit (explaining about 10% of the variance) and negatively related to perceived risk (explaining around 35% of the variance), which he specified as antecedents to the formation of overall attitudes towards gene technology (explaining about 50% of the variance).

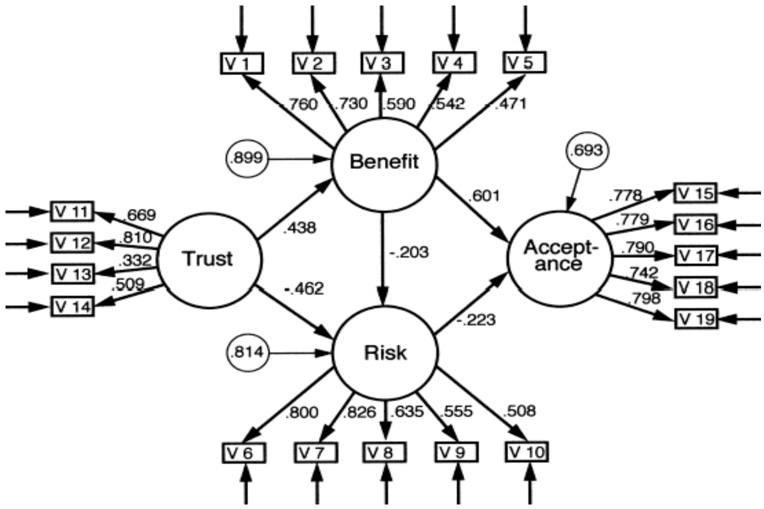

Figure 2.12. Risk-benefit trade-off based on confounded risk and benefit perceptions, in turn determined by social trust (adapted from Siegrist, 2000, p. 200).

Interestingly, the same problem of highly correlated residuals occurred here as in the Bredahl (2001) study. In this case, however, the author added a direct path from benefit to risk, i.e. in the *opposite* direction[1].

2.5.7. Relationship between Attitudes and Purchase Intentions

Sparks, Shepherd and Frewer (1995) examined attitudes toward gene technology in food production using a modified version of Ajzen's (1991) theory of planned behavior. 330 consumers from the UK completed a survey questionnaire that included ten risk and benefit belief statements which had been constructed ad hoc. For these, strength and evaluation scores were obtained from the participants and aggregated into a composite score following Fishbein's (1963) product-sum specification. In addition,

---

[1] The direction of such a path cannot actually be tested. The covariance matrices implied by the two competing models would be identical (see Chapter 5.3.4), hence the models are equivalent (Williams, Bozdogan & Aiman-Smith, 1996). It is interesting to observe though that both authors find very good arguments to justify a decision which *may* have been prompted by the fact alone that one of the two equally sized modification indices was printed before the other in the output file from the analysis.

measures for overall attitude, subjective norm, perceived behavioral control, perceived ethical obligation and environmental concern[2] were included.

These variables were then used jointly to predict whether participants expected to personally support the application of gene technology in food production within the next 15 years. When all variables were included simultaneously in the model, only overall attitude remained significant as a predictor. Apart from the environmental concern item, all other variables had shown significant pairwise correlations with the expectation to support gene technology. Hence, it appears that they were either completely mediated by overall attitude, or that overall attitude was their common cause[3].

Saba and Vassallo (2002) replicated the study in Italy. 1000 consumers answered the same questions as in the Sparks *et al.* (1995) survey, although with an important modification: all questions referred to a concrete product (genetically modified tomatoes) and not to the abstract object of gene technology, as the questions in the original study had done. The authors used structural equation modeling to analyze their data[4]. In contrast to the earlier study by Sparks *et al*. (1995), they found perceived behavioral control to be the strongest predictor of intention, whilst the other model variables had rather small effects.

The Bredahl (2001) survey, already reviewed above, contained a product-specific part as well. The Danish, German, Italian and British participants in the survey were asked to state outcome beliefs, normative beliefs, and control beliefs, along with purchase intentions, for two tangible product examples. These were a genetically modified beer with an environmental benefit and genetically modified yoghurt with a health benefit. Like the Sparks *et al*. (1995) and Saba and Vassallo (2002) studies, the model was based on the general framework of Ajzen's (1991) theory of planned behavior.

---

[2] For some reason, the authors referred to this item as "self-identity" in the paper.

[3] The statistical analysis reported in the paper is not very informative. It appears that no systematic attempt has been made to identify the particular mode of mediation. Furthermore, a number of the variables correlated around .80 with another on a single-item level; their discriminant validity is doubtful.

[4] As the model appeared to be quite ill fitting (an RMSEA computed from the chi-square and degrees of freedom reported in the paper would have been .16 and therefore unacceptable by common standards; see Chapter 5.2.3), it is highly questionable whether the results can be trusted at all.

The analysis indicated that consumers' purchase intentions were exclusively determined by their attitudes towards purchasing the products. In turn, these were significantly influenced by overall attitude towards genetic modification in food production, mediated by beliefs regarding the quality and trustworthiness of the products. Interestingly, the distinction between quality and trustworthiness had to be introduced as a replacement for the distinction between outcome, normative and control beliefs suggested by Ajzen's theory because the intercorrelations of the beliefs from the three subsets followed a completely different pattern.

2.6. Attitude Change Studies

Six studies have been published in the scientific literature to date that specifically investigated the effects of communication about GM foods on consumer attitudes. Four of these used laboratory-research designs, where participants were confronted with isolated messages that had been experimentally varied. Such designs allow separation of different factors contributing to communication effects (such as message type, argument quality, and source; see McGuire, 1985; O'Keefe, 1995; Petty & Cacioppo, 1986; Tesser & Scheffer, 1990) but suffer from low ecological validity. Another two studies used more naturalistic communication materials, where the different factors contributing to communication effects remain partially confounded.

2.6.1. Effects of Isolated Message Stimuli

Frewer, Howard and Shepherd (1998) presented 240 British consumers with a list of ten very simple messages about GM foods (e.g., "Fruit and vegetables can be genetically engineered to contain higher levels of certain nutrients – for example, vitamins C and E. This may offer protection against certain diseases like cancer"). All messages stressed the benefits of GM foods; they had been selected as the ten most persuasive messages from a larger pool of messages in a pilot study.

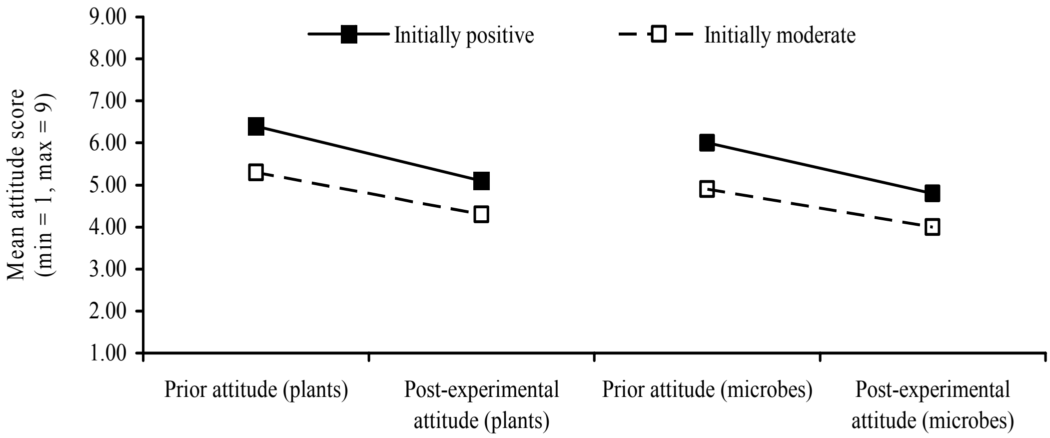

Figure 2.13. Partial depolarization effects in response to messages stating the benefits of genetically modified plants and microbes (data source: Frewer, Howard & Shepherd, 1998).

The authors observed an effect that can probably be best interpreted as partial depolarization[5]: consumers with initially positive attitudes became less positive, and so did consumers with initially moderately positive attitudes (see Figure 2.13).

Frewer, Howard, Hedderley, and Shepherd (1999) confronted another sample of British consumers with sets of messages that all stressed the benefits of GM foods, but varied in persuasiveness (which had been calibrated in a pilot study). The persuasiveness of the messages did not have a significant overall impact on attitudes towards realistic types of GM foods, but tended to slightly decrease the negativity of attitudes towards unrealistic, “shocking” types of GM applications such as transfer of human DNA into animals for agricultural purposes.

Furthermore, they found an interesting disordinal interaction effect on the degree of message elaboration between the sources to which the messages had been attributed (consumer organization versus government source) and the persuasiveness of the messages. Consumers generated more cognitive responses when information low in persuasiveness had been attributed to the more trustworthy than when it had been attributed to

---

[5] Since the authors had not applied a very a well-controlled design, there had been a strong self-selection effect in the recruitment of participants. This caused the problem that even those consumers who had been defined as the “initially negative group” after a median split showed average scores in the *positive* range of the attitude scale. Hence, we have re-labeled them as “moderate” here to clarify this.

the less trustworthy source, and also generated more cognitive responses when information low in persuasiveness had been attributed to the more trustworthy source than to the less trustworthy source.

Miles and Frewer (2002) investigated whether information about increased traceability of genetically modified ingredients through the food chain, as legally required by the new deliberate-release Directive 2001/18/EC (see Chapter 1, above), would have a positive effect on consumer attitudes towards genetically modified foods. Altogether 1150 consumer from Italy, Norway, and the UK participated in the study. The samples were split between two information conditions: participants in the traceability-information condition received a page of information about traceability of GM material, and new detection methods. Participants in the no-information condition did not receive this information. Contrary to the hypothesis, the authors could not observe an effect of receiving information about traceability or detection methods on consumer attitudes about risk, benefit, perceived control or trust.

2.6.2. Effects of Naturalistic Communication Materials

Peters (1998; also see Peters, 1999a, 1999b) used different kinds of media reporting as stimuli in an attitude change experiment involving a sample of altogether 400 German consumers. Participants were confronted with four different newspaper articles and four different television features, dealing with issues like labeling regulations, contained use of genetically modified microorganisms in industrial applications, the difficulties associated with field trials of GM potatoes, destruction of GM crop field trials by opponents of the technology, and prenatal testing. Analysis of think-aloud protocols gathered in this study showed that consumers generated substantially more negative cognitive responses than positive ones, and that the evaluative tendency in the cognitive responses was significantly correlated with the initial attitudes of consumers (at sizes around $r = .30$).

Although positive cognitive responses as such had higher effects on attitude change, the altogether higher number of negative responses neutralized this effect, resulting in an overall absence of attitude change. Furthermore, the author observed that the number of negative cognitive responses was higher when the evaluative tendency of the message was more positive. This suggests that communication that stresses only the benefits of biotechnology may provoke increased message scrutiny and active refutation of counter-attitudinal arguments in consumers when its evaluative tendency deviates substantially from the pre-existing attitudes held by consumers.

Scholderer and Frewer (2003) confronted 1650 consumers from Denmark, Germany, Italy and the UK with realistic communications materials of three different types: argumentatively balanced, general information about gene technology in food production (a glossy brochure), information about the modifications of a particular example product and the benefits arising from it (short product information sheets about a beer with environmental benefits and a yoghurt with health benefits), and conventional product advertising (print adverts promoting the same beer and yoghurt products, appealing either to consumers' innovativeness, or to their social values). Finally, a control group only saw the product examples without additional information. Compared to the control group, none of the information groups showed any changes in attitudes in response to the communication. No polarization or depolarization effects could be observed either.

In the above study, consumers received the product examples for visual inspection only. In a small-scale study, involving 60 participants from the UK, Frewer, Howard and Shepherd (1996) had already investigated whether visual expectation of product examples as such would have an effect on consumers' general evaluation of gene technology in food production. However, participants in the experimental group did not differ in their post-experimental attitudes from participants in a control group who had seen the same products without a GM label.

Taken together, the results of attitude change studies suggest that simple mass-communication techniques may not have enough persuasive power to actually change consumer attitudes towards genetically modified foods. Interestingly, the quality of the arguments put forward in the messages did not appear to have any influence at all in any of the studies. What did appear to matter, although not in terms of actual attitude change but in terms of cognitive elaboration, was the degree of counter-attitudinal arguing in the messages.

The Peters (1998) study, in particular, found that more negative cognitive responses were generated when the message was more positive. Purely benefit-oriented communications seemed to prompt a process of active refutation in the study participants, suggesting the possibility that in situations where not media reporting but communications from a stakeholder group with vested interests are the materials, induced active refutation of the message content might backfire on the communicator. In the existing studies by Frewer and colleagues (1998, 1999) where the communication source had been experimentally varied, trust was treated as an exogenous variable, making it impossible to test such a hypothesis. In the Miles and Frewer (2002) study, no *benefit* arguments had been used, hence no such effects could be expected.

2.7. Product Choice Experiments

The final group of studies to be reviewed here is the smallest group. In a way this is an interesting fact in itself as, from a "non-academic" marketing point of view, attitudes are not so much of interest in their own right but in their role as predictors of the behavior of consumers in the marketplace, i.e. the choices consumers are likely to make in the supermarket. Consumer choice of GM foods has been investigated in two ways, either using benefit segmentation methods, or experimental interventions. In addition to the mere three studies reviewed in detail below, some of the studies reviewed earlier in this chapter involved product choice tasks as well.

In the laddering studies reported by Bredahl (1999) and Grunert *et al*. (2001) the participants were asked to rank a set of product alternatives according to their personal preference. In both instances, the rationale of the procedure was mainly to provide a realistic starting point for the laddering task; hence, the authors did not report more formalized analyses of the rankings than average ranks alone. The genetically modified alternatives were ranked lowest by the participants in both of the studies.

2.7.1. Benefit Segmentation Studies

Frewer, Howard, Hedderley and Shepherd (1997) investigated the relative importance of production method and different benefit types in the product choices made by 120 British consumers among novel cheeses. The production methods included genetic modification, protein engineering (altering the characteristics of microorganisms without transferring genetic material), and traditional selective breeding. The benefits were directed towards the health of the consumer, product quality, the environment, animal welfare, or just the manufacturer. The authors conducted a benefit segmentation based on part-worths that had been estimated by means of conjoint analysis. A first segment of consumers (79% of the sample) made decisions based partly on production method, although tangible benefit was a more important factor. A second segment (19% of the sample) did not consider production methods as important, but tended to make decisions based on consumer benefits alone.

Deliza, Rosenthal, Hedderley, MacFie and Frewer (1999) used similar methods in a study where 120 British consumers had to choose between different kinds of vegetable oils, including oils that had been manufactured with the help of gene technology (the exact process was left unspecified). The product concepts had been generated from an incomplete factorial design including the factors brand familiarity, process technology, and price. The authors conducted benefit segmentation based on part-worths that had been estimated by means of conjoint analysis. Two consumer segments emerged. The first segment of consumers (20% of the sample) made decisions based mainly on the price of the oils. In this segment, the GM processing technology had a small negative part-worth, but due to the low relative importance (22%) of the attribute "processing technology", consumers in this segment could be judged GM-tolerant. The second segment (67% of the sample) made decisions based almost exclusively on processing technology (relative importance: 93%). In this segment, the GM processing technology had a large negative part-worth.

2.7.2. Intervention Studies

Scholderer and Frewer (2003) investigated whether different approaches to the communication of benefit (see section 2.6.2; above) would influence the probability of consumers' choosing a genetically modified product from among a set of alternatives that also included several conventional products. Whilst no attitude change had been observed in this study, the communication materials had a striking effect on consumers' choice behavior: all types of communication had a significant negative effect on the probability of consumers' choosing the genetically modified alternative, and the effect was uniform across all experimental conditions (see Figure 2.14). We interpreted the effect in terms of attitude activation: whilst the communication materials could not actually change consumers' attitudes towards GM foods, they appeared to make consumers more aware of actually having such attitudes, which then seemed to prompt increased consistency between attitude and product choice.

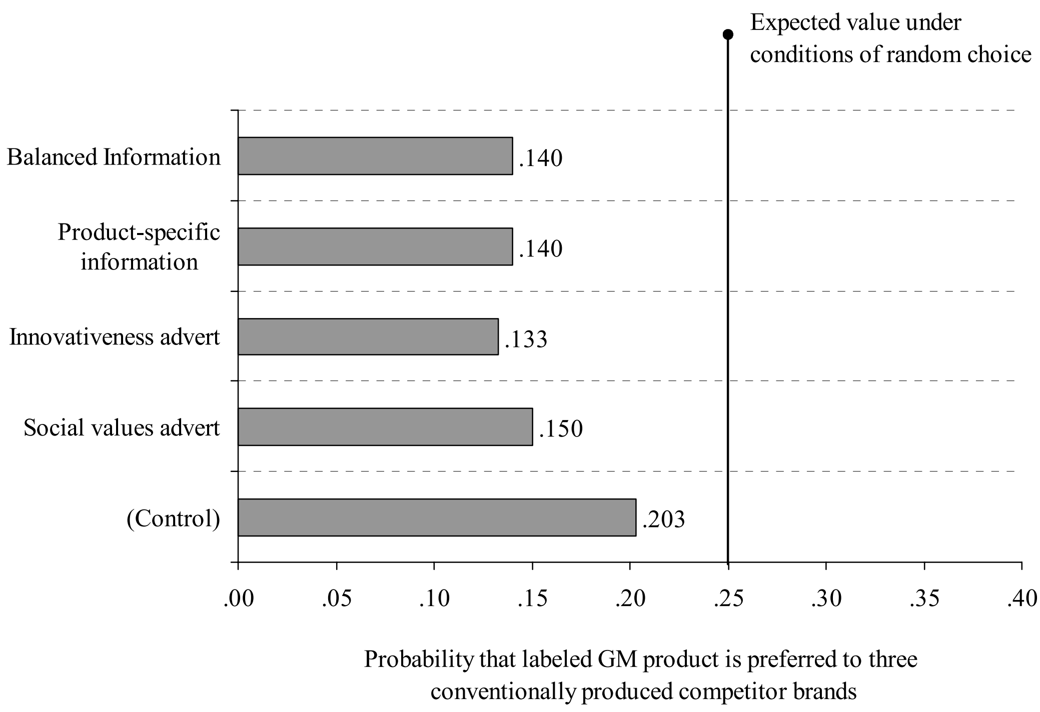

Figure 2.14. Uniform negative effect of different benefit communication strategies on consumers' product choices (adapted from Scholderer & Frewer, 2003, p. 146).

It is a bit questionable how much can be learned from the benefit segmentation studies reported first. A problem in such designs is always that the relative importance of a factor in a conjoint design is a function of the number of factors included in the design. If only two or three factors are varied in the design, as was the case in the Frewer *et al*. (1997) and Deliza *et al*. (1999) studies, the estimate of the relative importance of each factor must be inflated as compared to its "true" relative importance in the marketplace (Louvière, 1994). Furthermore, the samples in the two studies were convenience samples and so small that reliable estimates of segment sizes were impossible.

The intervention study by Scholderer and Frewer, on the other hand, was interesting in the way that the results suggested that purely benefit-oriented communication might indeed backfire on the communicator, possibly due to the mechanisms suggested in the previous section (see Chapter 2.6.2; above). We did not investigate the particular mechanics of the effect in that study though, hence more research about its nature will be part of one of the studies to be reported later in this volume (see Chapter 7; below).

2.8. Preliminary Conclusions and Unresolved Questions

In the beginning of this chapter, we outlined the historical roots of research on consumer attitudes towards genetically modified foods in Europe. Prompted by the realization that the emergence of modern biotechnology would have wide-ranging impacts on the operation of several industry sectors, including agriculture, food manufacturing, and food processing, the governments of the Netherlands, Germany and Denmark started a series of technology assessments in the late 1980s (see Bauer, 1995; Hamstra, 1992, 1998).

Since these early days, the field has virtually exploded. It is interesting to note, for example, that practically identical public opinion research has been funded in parallel on the EU level and on the national level, effectively duplicating the findings. This may be interpreted as the result of a legitimacy crisis in the governance of biotechnology (see Busch *et al.*, 1991; Jensen & Sandøe, 2002; Krimsky, 1991; Lassen *et al.*, 2002; Levidow & Marris, 2001; Torgersen *et al.*, 2002): governments have realized, although relatively late in the process, that the voice of those who are in the end supposed to actually buy and consume genetically modified foods, should be heard at some point in the process as well. This reflects a general trend towards more open and inclusive approaches to governance and policy-making in the political-administrative arena (European Commission, 2002; Frewer *et al.*, 2004; Renn, 1998a, 1998b; Salter & Frewer, in press; Wynne, 2001) and increased market orientation in agriculture and food manufacturing in the agribusiness sector (Grunert, Hartvig Larsen, Madsen & Baadsgaard, 1996).

In the review above, it became apparent that the paradigmatic orientation of research on consumer attitudes towards genetically modified foods has changed over the years. In the early days, virtually all research understood itself as technology assessment, and communication objectives were framed in terms of public understanding of science (Bauer & Bonfadelli, 2002). In current research, both terms have more or less disappeared. Interdisciplinary consumer research has become the new term of reference (Frewer et al., 2004). However, consumer research is as diverse as the disciplinary origins of the researchers who are active in the field. Hence, it is not surprising that a variety of methods has been used to investigate consumer attitudes towards genetically modified foods. Despite the different methodologies, however, a number of preliminary conclusions can be drawn.

The first point of convergence is the level of complexity on which genetically modified foods are cognitively represented by consumers. Qualitative research (e.g., Bredahl, 1999; Grunert *et al.*, 2001; Hamstra & Feenstra; 1989; Schütz *et al.*, 1999) as well as quantitative research (Bredahl, 2001; Brüggemann & Jungermann, 1998; Midden *et al.*, 2002) suggests that the object of consumers' attitudes is the technology as such, represented as an abstract concept, rather than as a variety of different products and applications.

The second point of convergence, related to the first, is the level of complexity on which evaluations are made. Actual beliefs as they are commonly understood in attitude research (see Fishbein, 1963, Fishbein & Ajzen, 1975) are rarely found in qualitative data. Instead of attributes of the object itself, as classical belief-based models of attitude would assume, consumer evaluations appear to be predominantly made through references to even more abstract attitude objects such as health, environment, animal welfare or producer power (Bredahl, 1999; Grunert, 2001, Miles & Frewer, 2001) where the particular implication between one and the other is left unspecified (Schütz *et al.*, 1999). Consistent with this, factor analyses of sets of beliefs usually find that just two dimensions are sufficient to represent the covariation among the beliefs (Bredahl, 2001; Hamstra, 1991; Midden *et al*., 2002; Saba & Vassallo, 2002), suggesting a fairly high level of redundancy in the belief sets.

The third point of convergence is that attitudes towards genetically modified foods are strongly related to other, more general socio-political attitudes, including attitudes towards environment and nature (Bredahl, 2001; Frewer *et al*., 1997; Hamstra, 1995; McCarthy & Vilie, 2002), attitudes to science and modern technology (Borre, 1990a; Bredahl, 2001; Hamstra, 1991; McCarthy & Vilie, 2002; Sparks *et al.*, 1994), and social trust, i.e. the willingness to rely on institutions that regulate emerging technologies and manage their risks (Siegrist, 2000). This is highly consistent with the conclusion made above about the level on which evaluations are made: the objects of these general socio-political attitudes are often the same as the abstract concepts to which gene technology is related in investigations of belief content.

The fourth point of convergence is that attitudes towards genetically modified foods appear utterly resistant to persuasion. None of the six attitude change studies reported in the literature have been able to change consumer attitudes through communication (Frewer *et al.*, 1996, 1998, 1999; Miles & Frewer, 2002; Peters, 1998; Scholderer & Frewer, 2003). The results even suggest that the more such communication relies on benefit arguments, the more active refutation of the arguments is prompted in consumers. Scholderer and Frewer's (2003) product choice experiments even suggest that this may backfire on the communicator in terms of non-attitudinal aspects of consumer behavior. In this particular instance, reduced purchase probabilities had been found in all groups where consumers had been exposed to benefit communication *although* no attitude change had occurred.

Despite these points of convergence, a number of unresolved questions remain. First of all, there is considerable inconsistency in virtually all published research regarding the interpretation of attitude structures. On the one hand, several studies explicitly conclude that the complexity of beliefs about and attitudes towards genetically modified foods is low (e.g., Bredahl, 2001; Frewer *et al.*, 1997; Saba *et al.*, 1998; Midden *et al.*, 2002; Schütz *et al.*, 1999). Although this clearly suggests a categorical judgment on the level of the general technology, the authors maintain *without exception* that consumers' overall attitudes are formed on the basis of a risk-benefit trade off. In the different studies, this is either assumed explicitly (e.g., Bredahl, 2001; Hampel, 1999; Midden *et al.*, 2002; Siegrist, 2000) or implicitly through the assumption of a compositional, belief-based attitude formation process (e.g., Sparks *et al.*, 1995; Saba & Vassallo, 2002). Even in those instances where the modeling results clearly indicated that risk and benefit were not operationally independent from each other (Bredahl, 2001; Siegrist, 2000), the authors did not question the viability of the assumption that such a risk-benefit trade-off exists.

Hence, the first unresolved problem that can be diagnosed from our review is that assumptions have been made on a-priori grounds that may have been wrong. This is somewhat surprising as bottom-up, belief-based models of attitude structure enjoy relatively little popularity among social psychologists. The most damning judgment of the belief-based approach is probably McGuire's (1989) famous invective that "its commonsensicality makes it easily understood, a characteristic welcome to the masses. It is easily quantified, a feature as welcome to the classes as simplicity is to the masses. Also, the model is easily elaborated by additional factors, and is easily applied to practical situations. With all these popular features, the model deserves to be true, but sadly, it is not. It typically accounts for a proportion of the variance that is statistically significant, but is paradoxically small in view of its a priori obviousness" (McGuire, 1989, p. 42). Hence, one of the research questions to be investigated here will be whether other models of attitude structure will provide a more accurate description of the way consumers evaluate GM foods.

The second unresolved question concerns the mechanics of the process through which consumers resist persuasive attempts. The available data suggest that an active refutation process is prompted when benefit-oriented communication argues against consumers' pre-existing attitudes. The surface consequences have been identified, including increased production of negative cognitive responses (Peters, 1998) and decreased probabilities that an actual GM product will be purchased (Scholderer & Frewer, 2003). How this affects the structure and dynamics of the underlying attitude system is as yet unknown. Hence, another research question to be investigated here will be how the wider system of attitudes to which consumers' attitudes to GM food are linked, is affected by benefit communication in dimensions *other* than attitude change.

Given that attitude change by means of persuasive communication appears to be a fruitless task, the third and managerially most troubling problem yet to be resolved is what else can be done to change consumers' attitudes towards genetically modified foods. As we will argue in the next chapter, the building of an alternative attitude system may be the only way to circumvent the effects observed by Peters (1998) and Scholderer and Frewer (2003). Such an attitude system, we will argue, should be based on direct experience with high-quality products, creating positive *hedonic* experience (Mela, 2001) in consumers.

Surprisingly, hedonic factors have never been investigated in any of the studies reviewed in this chapter. Given that the object of inquiry was food, this is extremely surprising as the experienced taste of a food (i.e., the evaluation of the overall hedonic experience gathered from ingesting it) is generally considered by far the most important factor in the formation and stabilization of consumer preferences for particular food products (Brunsø, Fjord & Grunert, 2002; Rozin & Vollmecke, 1986). Clearly, the joint investigation of such diverse influences as general socio-political attitudes on the one hand and hedonic experience on the other hand, will require an appropriate theoretical framework.

Although general classifications and typologies exist (e.g., the total food quality model, developed by Grunert *et al*., 1996), these are not theories in the sense that they predict unique outcomes, given a particular configuration of independent variables. As Shepherd (2001) has remarked, a theory that can be used for a joint analysis of the different types of influences on consumer's food choices does not exist. The following chapter does not attempt to solve this problem. However, we will outline a general theoretical framework in which several of these processes are embedded.

3. Structure and Dynamics of Systems of Attitudes: A Theoretical Reconstruction

3.1. Overview

Throughout the history of social psychology, the concept of attitude has been at the cornerstone of theory and research, both in the laboratory and in applied fields (Ajzen, 2001; Eagly & Chaiken, 1993; Greenwald, 1989; Petty, Wegener & Fabrigar, 1997; Wood, 2000). This is no different in the relatively young discipline of consumer research (Simonson, Carmon, Dhar, Drolet, & Nowlis, 2001). The final conclusion drawn from the previous chapter, where we reviewed existing research on consumer attitudes towards genetically modified foods in Europe, was that a viable theory has been lacking that could constructively guide research.

By far most of the studies we discussed had been conducted without any theoretical frame of reference. Other studies utilized approaches that are descriptive in nature, such as the psychometric approach to perceived risk (Slovic, Fischhoff & Lichtenstein, 1980), but do not include any of the hallmarks of genuine theory, such as definitions of variables, statements about their interrelationships, and predictions of observable consequences (see Sjöberg, 2002a; Wåhlberg, 2001). Finally, those few studies that actually made explicit references to a theoretical framework used the most commonsensical approaches, i.e. the Fishbein-Ajzen theories of reasoned action (Fishbein & Ajzen, 1975) and planned behavior (Ajzen, 1991).

Both are somewhat trivial in the sense that they provide little guidance as to how a modeling result can be acted upon (McGuire, 1989), in particular if the central concept of both theories, intention-behavior consistency, was not investigated because the designers of a study failed to measure actual behavior in their study. Other studies were concerned with attitude change, as opposed to attitude structure. These studies tended to use the eclectic framework of Petty and Cacioppo's (1986) elaboration likelihood model. The scope of this theory is communication which *is* indeed persuasive. It does not cover processes of resistance to persuasion (Eagly & Chaike, 1995) or the effects which failure to persuade may have on subsequent processes in the receiver of the communication, or the wide variety of non-communicative means of influencing some-one's attitude.

3.1.1. Guiding Principles

The aim of the following sections is to construct a more useful framework for the analysis of such phenomena. In the development of the theory, we will build on three guiding principles that have revitalized social-psychological attitude research after a long period of stagnation (Wood, 2000). The first of these principles is McGuire's programmatic statement that attitudes can only be properly understood when a systems perspective is adopted (McGuire, 1989, 1990; McGuire & McGuire, 1991). The main thread of McGuire's argument is that attitudes are evaluations of social objects. These objects are not monadic entities in a vacuum – on the contrary, they are intricately connected to a large number of other social objects, and so are their evaluations. Analyzing attitudes on a piecemeal basis, he concludes, makes therefore little sense if the aim of the analysis is to understanding the structure, function and dynamics of attitudes.

The second guiding principle is Eagly and Chaiken's (1993) suggestion that two levels of analysis should be distinguished when the structure of attitude systems is investigated: the level of inter-attitudinal structure, and the level of inter-attitudinal structure. Intra-attitudinal structure stands for the basic constituents of a single attitude: the attitude object, and the evaluation of that object. The aim of analysis on this level is to assess how the object and the evaluation are cognitively represented and organized. Inter-attitudinal structure stands for the interrelationships between a focal attitude and other attitudes in a person's attitude system. The aim of analysis on this level is to assess the pattern of these interrelationships and how this pattern helps a person make sense of social objects.

The third guiding principle is Pratkanis, Breckler and Greenwald's (1989) revitalization of the functional analysis of attitudes, going back to the classical treatment by Katz (1960). An attitude, the argument goes, can only be properly understood when we look at the functions it has for an individual. Does it, for example, serve orientation or value-expressive purposes? If such functions can be assessed, the argument continues, it will also be possible to understand why certain attitudes are easily influenced by particular types of arguments, whilst others are utterly resistant to persuasive attempts. Hence, functional analysis provides the tools for matched social influence attempts.

3.1.2. Definition of an Attitude

In the end of Chapter 1, we presented a working definition for the purposes of the review. This was Eagly and Chaiken's definition of an attitude as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly & Chaiken, 1993, p. 1). Somewhat typical for textbook definitions, it is the lowest common denominator shared by different approaches that have been advanced in a hundred years of attitude research. For the sake of theory construction, a more precise definition will be required. In the following, we shall understand attitudes in the same sense as modern social cognition approaches do (cf. Kunda, 1999; Fiske & Taylor, 1991).

In particular, we will follow Fazio's concept of attitudes as object-evaluation associations: "An attitude is essentially an association between a given object and a given evaluation. This evaluation may range in nature between a very hot affect (associated with a strong emotional response) to a cold, cognitively based judgment of the favorability of the attitude object" (Fazio, 1986, p. 204). This definition has the specific advantage that an attitude is understood as a memory structure. Hence, intra- and inter-attitudinal structures can be expressed and analyzed in terms of associative network models of cognition (Anderson, 1983).

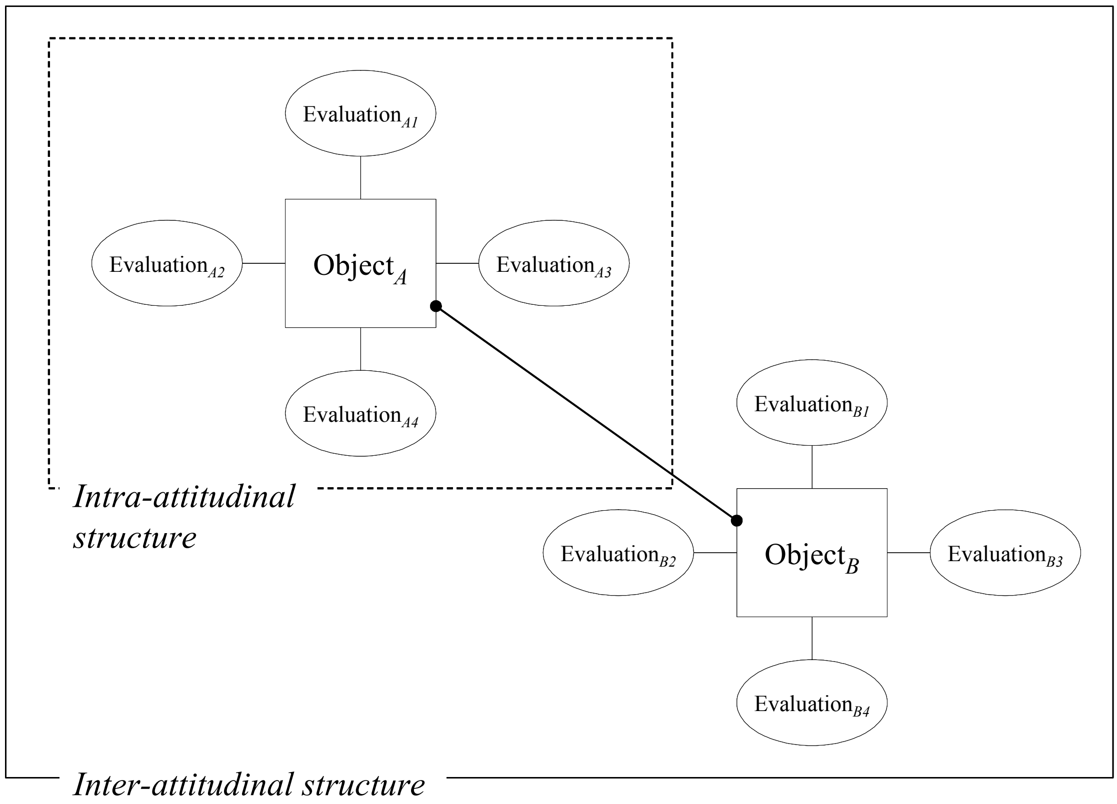

Figure 3.1. Levels of analysis in a systems-of-attitudes perspective.

An attitude object is represented as a node within this network, and so is an evaluation. An attitude towards an object is said to exist when there is an association between an object and an evaluation. The framework allows a number of structural features to be encompassed. One of these is attitude strength: in Fazio's (1986, 1989) perspective, strong attitudes consist of many object-evaluation associations, weak attitudes of few. The partial network formed by a focal object and the evaluations associated with the focal object defines the boundaries of intra-attitudinal structure. Moreover, an object can be associated with other objects. The partial network formed by these object associations and their respective object-evaluation associations defines the boundaries of inter-attitudinal structure. Our framework for the analysis of attitude systems is depicted in Figure 3.1.

We will start our treatment of the structure of attitude systems on the molecular level of beliefs. In terms of Eagly and Chaiken's (1993) distinction between different levels of analysis, we shall refer to this level as intra-attitudinal structure, and interpret different models of intra-attitudinal structure according to Fazio's (1986, 1989) associative network representation. Theories of intra-attitudinal structure aim to define what an attitude *is*. This entails certain assumptions about the atomic components of an attitude, and how these are related to each other.

Historically, quite a number of different theories have been advanced. These can roughly be grouped into three types of models: belief-based models, dimensional models, and functional approaches (Eagly & Chaiken, 1993). Belief-based and dimensional models make unique assumptions about the structure of an attitude, whilst functional approaches are eclectic in the sense that an attitude can have different structures, depending on the function it serves and on the circumstances under which it was formed.

3.2. Belief-based Models of Attitude

Belief-based models of attitude are virtually omnipresent in consumer research. The way products are conceptualized in marketing, for example, is indistinguishable from the way belief-based models assume an attitude to be structured (Peter, Olson & Grunert, 1999). Belief-based models first appeared in social psychology in the mid-1950s (Rosenberg, 1956), at a time where multi-attribute utility models were at the height of fashion in all areas of microeconomics and psychology (for an overview, see Simon, 1959). The rational choice principle inherent in these models was applied to attitudes as well. The prototypical example is Fishbein's (1963) formulation. The model assumes that an attitude object is not evaluated on the object level but in terms of its attributes:

$$A_O = \sum_{q=1}^{Q} b_q e_q , \tag{3.1}$$

where A_O is a person's attitude towards an object, b_q is the belief that the object has attribute q, expressed as a subjective probability, e_q is the evaluation of attribute q, and

Q is the number of salient (or, in more modern terms, accessible; see Ajzen, 2001) attributes on which the object is represented.

3.2.1. Assumptions about Directionality in Intra-attitudinal Structure

The model makes a number of distinctive assumptions (Anderson & Fishbein, 1965; Fishbein, 1963, 1966; Fishbein & Hunter, 1964; Fishbein & Ajzen, 1975). Above all, the model has a bottom-up or compositional structure: attitudes are assumed to emerge from beliefs and evaluations. Second, it has a subjective utility structure, consistent with models of technical rationality (Yi, 1989). Third, it assumes that only salient beliefs contribute to the formation of the attitude: the respective memory structures have to be activated (Kallgren & Wood, 1986). Fourth, the aggregation rule is summation: the more beliefs of the same valence are active, the more extreme the attitude becomes (Anderson, 1971). Finally, the attitude is assumed to evolve automatically if salient beliefs exist (Ajzen, 2001). Certain details of the models have been heatedly discussed. One of these details was Rosenberg's (1956) earlier suggestion to use instrumentalities for the attainment of a particular objective instead of beliefs about the existence of an attribute, another one was Anderson's (1971) suggestion to use an averaging rule instead of a summation rule in the aggregation formula. However, the basic structure remained unchanged.

Important for the present analysis are two assumptions of the model: that evaluations are made on the levels of the attributes of the object (and not on the level of the object itself), and furthermore, that the attitude is assumed to evolve in a bottom-up aggregation process from the evaluations made on the attribute level. Using the graph notation introduced before, the model can be depicted as in Figure 3.2. In terms of Fazio's (1986) conceptualization, it can be seen that the intra-attitudinal structure is already a relatively complex network of associations in itself. Attitude objects are represented as sets of associations between an object and a set of attributes. The strength of the association between an object and a given attribute would be equivalent with Fishbein's (1963) original notion of belief strength. Most importantly, the "objects" to which evaluations are associated in this model are actually the attributes.

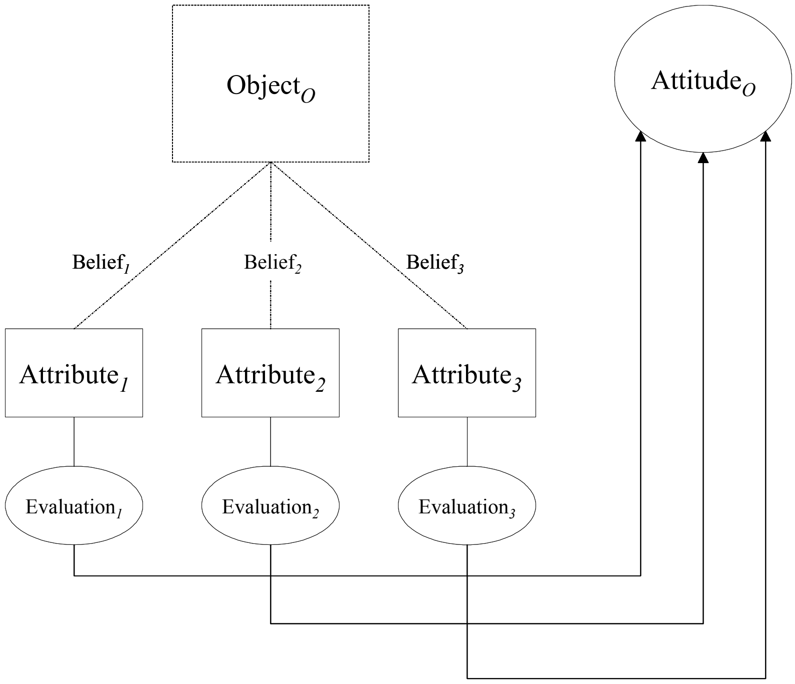

Figure 3.2. Intra-attitudinal structure as assumed by belief-based models of attitudes.

The original attitude object does not enter the process in any other way then through the strength of its associations with the respective attributes. In order to clarify this, we shall refer to the final output of such a process as an *aggregate evaluation*.

3.2.2. Assumptions about the Complexity of Intra-attitudinal Structure

The model does not contain any a-priori assumptions about the origin of beliefs or evaluations (Hackman & Anderson, 1968). Hence, they may originally have evolved from any process ranging from the simplest ones such as associative learning or hedonic experience to the most complex ones such as reasoning, as long as these have gained a cognitive representation at some point in time (Fishbein & Ajzen, 1975). A consequence of this is that the beliefs contributing to an attitude will be highly heterogeneous and independent from another if they are founded on diverse and rich experience with, and inferences about, the attributes of the object. Prompted by Rosenberg and Abelson (1960), a heated debate ensued at the time about the viability of this assumption. Social psychology was dominated by theories of cognitive consistency then (Cartwright, 1956; Heider, 1944, 1946, 1958; Festinger, 1954, 1957; see below), a perspective from which it appeared rather unlikely that individuals would tolerate a set of highly inconsistent evaluations of attributes of the same attitude object within their cognitive representations of that object.

The debate went back and forth for a while (e.g., see Anderson & Fishbein, 1965; Fishbein, 1966; Freedman, 1968; Insko & Schopler, 1967; Rosenberg, 1965, 1968) and even resurfaced from time to time during later years (e.g., Chaiken & Baldwin, 1981; Chaiken, Pomerantz & Giner-Sorolla, 1995; Norman, 1975). The conclusion from this debate can probably be best summarized by "it depends" – the degree of consistency between evaluations of and beliefs about the presence of attributes can vary. It depends mainly on the mode of belief formation. If beliefs are indeed formed from heterogeneous experiences where little cognitive influence was involved, belief sets may indeed be as heterogeneous as the Fishbein camp maintained they could (Hackman & Anderson, 1968).

If, on the other hand, beliefs about attributes were mainly inferred in a deductive manner from pre-existing attitudes, they will be highly consistent with evaluations of these attributes because their common source is a pre-existing attitude. In such a case, however, a belief-based, bottom-up model would not actually be an adequate representation of intra-attitudinal structure in the first place (Chaiken et al., 1989). Hence, belief-based models only apply to attitude objects that do in fact have a complex cognitive representation in terms of different attributes, whilst other models of attitude structure should be applied when that is not the case.

3.3. Dimensional Models of Attitude

Quite the opposite approach as compared to belief-based models is taken by what is commonly referred to as "dimensional" or top-down models of intra-attitudinal structure. The generic terms stand for social judgment theory (Sherif & Hovland, 1961; Sherif & Sherif, 1967), the framework from which the concepts of assimilation and contrast, expectancy disconfirmation, and involvement originated. The central tenet of the theory is that all incoming stimuli of attitudinal relevance are evaluated in terms of a bipolar dimensional schema.

3.3.1. Assumptions about Directionality in Intra- and Inter-attitudinal Structure

In this theory, individuals are never understood as being entirely without preconceptions. Every incoming stimulus of attitudinal relevance is evaluated relative to the preexisting position of the self on the evaluative dimension. This preexisting position is the person's existing attitude at the particular point in time. Around this position, a latitude of acceptance is assumed to exist (Sherif & Sherif, 1967). If the incoming stimulus is a belief statement, and it does not deviate substantially from the person's preexisting attitude, it will fall into the latitude of acceptance and will be assimilated. If the belief statement does substantially deviate from the person's pre-existing attitude, it is assumed to fall into a latitude of rejection. Between these latitudes, a third one is assumed to exist, the latitude of non-commitment. If a belief statement falls into the latitude of non-commitment, indifference will result. The width of these latitudes has been shown to vary inter-individually, depending on a person's involvement (Eagly, 1967; Hovland, Harvey & Sherif, 1957)

The same process is assumed to underlie the formation of an attitude towards a new object. In most instances, people will invoke a dimensional schema that can position a new object relative to *some* other object for which an evaluative position already exists. Fiske and Neuberg (1990) have shown that individuals use category-exemplar relationships for this purpose if evaluations of more directly associated objects are not available: the new attitude object is construed as an exemplar of a more general category of objects. The person's attitude towards the category-level object (or, alternatively, the prototypical object from within the category) will then define valence and extremity of the person's attitude towards the novel object.

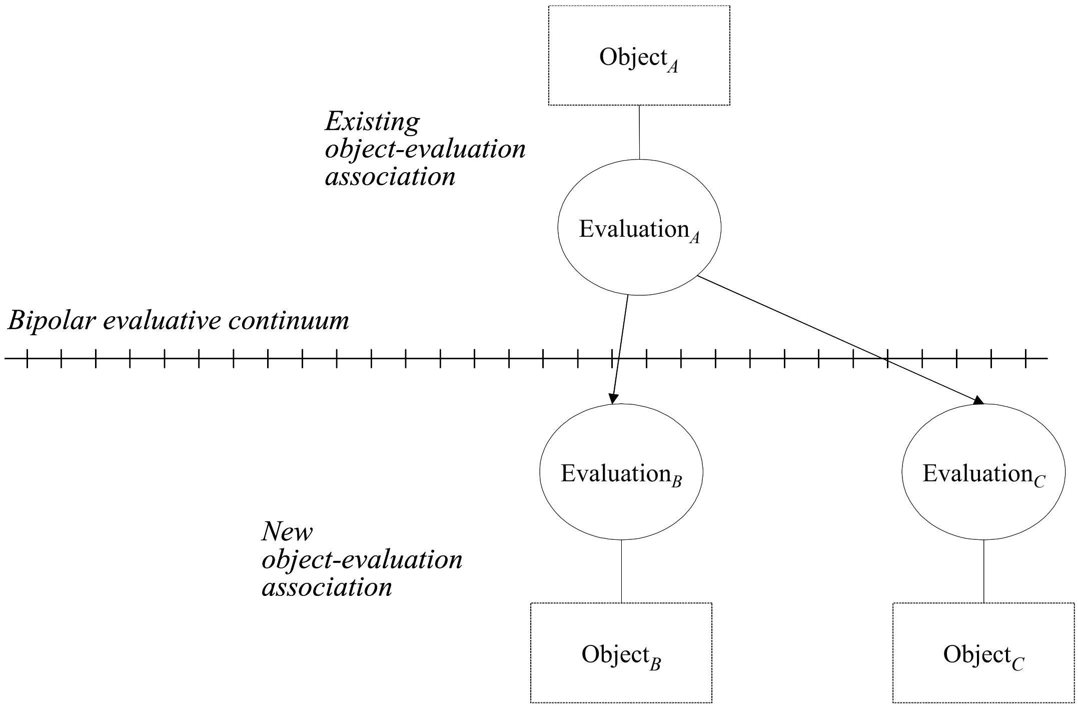

Figure 3.3. Intra- and inter-attitudinal structure as assumed by dimensional models of attitudes.

For the present analysis, there are again two features of the theory that are of importance: that evaluations are made on the level of the attitude object, and that evaluations are always made relative to pre-existing evaluations. Using the graph notation introduced above, the model can be depicted as in Figure 3.3. In this notation, it becomes clear that social judgment theory is essentially a theory of inter-attitudinal structure. Attitudes are never understood as monadic, isolated phenomena. Pre-existing attitudes always serve as judgmental anchors relative to which incoming stimuli are evaluated and new attitudes are formed. Hence, the theory already incorporates many aspects of a systems approach to attitudes as programmatically called for by McGuire (1989, 1990; McGuire & McGuire, 1991).

Furthermore, social judgment theory is essentially dynamic. Attitude formation and change are conceptualized in terms of the same processes, and the emergence of attitude structures follows directly from the way belief statements, or whole attitude objects, are evaluated relative to existing ones. Because of this we shall refer to the structures evolving from such a process as "top-down" models" of intra- and inter-attitudinal structure, in contrast to belief-based models, which we will refer to as "bottom-up" models.

The evaluative schema is assumed to be invoked anew for each set of objects that are evaluated relative to each other. Hence, for any domain-specific attitude structure (and, as said above, this applies to intra- as well as inter-attitudinal structures as they are treated in the same way by the theory), there is a common dimension on which the attitude object and all belief statements about the attitude object are evaluated. Each belief statement is evaluated based on its distance to the attitude object on that dimension. To make this aspect clear and distinguish it from the term "aggregate evaluation" which we had introduced for the output of a belief-based, bottom-up evaluation process, we shall use the term "heuristic evaluation" for the underlying dimension governing a top-down evaluation process.

3.3.2. Assumptions about Complexity in Intra-and Inter-attitudinal Structure

A problem arises from the fact that the terms of the theory are defined on the individual level. As shown by Kerlinger (1984), the individual-level properties of the heuristic evaluation dimension are not invariant when aggregation over individuals takes place. In particular, Kerlinger (1984) has shown that, among people with opposing attitudes towards an issue, belief statements endorsing the opposite view often do not fall into people's latitudes of rejection but into their latitudes of non-commitment. A person with a strong negative preexisting attitude towards gene technology, for example, might find the argument that an application of the technology has certain benefits in quality management not so much offensive but merely besides the point.

A person with a strong positive preexisting attitude towards gene technology, on the other hand, might find the argument that gene technology interferes with the order of nature not so much counter to his or her own attitude but merely irrelevant, for example because he or she does not subscribe to a quasi-religious view of nature. As Kerlinger (1994) has demonstrated for a large number of data sets, the observable empirical result that is obtained when such mixtures of heuristic evaluations are aggregated over individuals is a *two*-dimensional factor structure instead of the one-dimensional structure that would normally be expected based on the theory. Hence, factorial structures with one as well as two dimensions can be regarded as equally indicative of a heuristic, top-down attitude structure.

3.4. The Functional Approach

The functional approach to attitudes (for overviews, see Maio & Olson, 2000; Pratkanis, Breckler & Greenwald, 1989) is not actually a theory of attitude structure in the way that belief-based models and dimensional models are, which make distinctive assumptions about the directionality and dimensionality of intra-attitudinal structures. Rather, the functional approach synthesizes the opposing models under a common framework, specifying the conditions under which one of them is to be found and under which the other. In a way, the philosophy of such a "contingency approach" is not unlike the philosophy behind modern, eclectic models of attitude change, such as the elaboration likelihood model (Petty & Cacioppo, 1986) and the heuristic-systematic model (Chaiken, 1987).

3.4.1. Attitudes with Purposes

The functional approach to the analysis of attitudes was initiated by Katz (1960; Katz & Stotland, 1959). The basic idea of the approach is that attitudes serve distinct purposes for individuals[6]. In the original treatment, Katz (1960) outlined four basic functions attitudes may have: a utilitarian function, an ego-defensive function, a value-expressive function, and a knowledge function. The utilitarian function is defined in terms of instrumentality: utilitarian attitudes help an individual achieve his or her goals and avoid failures. The ego-defensive function is defined in terms of the self: ego-

[6] The whole approach is not unlike means-end chain theory (Reynolds & Gutman, 1984, 1988) in this way but somewhat more inclusive. Quite surprisingly the connection between the two approaches is hardly ever made.

defensive attitudes help an individual maintain the integrity of his or her self-concept in situations where the self is threatened. The value-expressive function is defined in terms of other attitudes: value-expressive attitudes enable an individual to express more general and deeply held attitudes and values by forming attitudes towards a specific object in a way that makes them evaluatively consistent with the more general attitudes and values. Finally, the knowledge function is defined in terms of orientation purposes: attitudes with a knowledge function serve an individual as an orienting schema in the evaluation of objects for which factual knowledge or experience do not as yet exist.

The utilitarian and ego-defensive functions encompass well-researched mechanisms adopted from Festinger's (1954, 1957) theory of cognitive dissonance. Of more interest to the present analysis are the value-expressive and knowledge functions. Both are consistent with social judgment theory's top-down approach to attitude structure, which was outlined above (Fiske & Neuberg, 1990; Sherif & Hovland, 1961; Sherif & Sherif, 1967). In the case of value-expressive as well as knowledge functions, evaluations of a specific novel object are formed based on existing attitudes towards other, more general objects. However, and here the distinction bears crucial relevance for the attitude object investigated in the present research (GM foods), the more general objects to which a novel object is related will differ markedly between the two functions.

3.4.2. Value-expressive Attitudes and their Strength

In the case of value-expressive attitudes, the general objects are highly abstract entities or personal goals with strong relevance to the self. As shown by Sherif and Hovland (1961), such attitudes are highly personally involving, which in turn invokes narrow latitudes of acceptance and narrow latitudes of non-commitment. Therefore, attitudes with relatively high extremity are formed towards a novel object even if the evaluation of that object falls just outside the latitude of acceptance in absolute terms. In the terminology of social judgment theory, the attitude towards the new object is *contrasted away* from the individual's pre-existing attitude towards the more general object.

If such a process were involved in the evaluation of the attitude object "GM foods", it is therefore possible that even small discrepancies to the evaluative position of attitude objects like "environment" or "nature" are amplified through such a process, resulting in a strong opposing attitude. Furthermore, the narrow latitudes of acceptance will make it virtually impossible for an even slightly counterattitudinal statement to be accepted by the individual. Hence, strong resistance to persuasive attempts can be predicted (Eagly & Chaiken, 1995; Maio & Olson, 2000). The same prediction would be made by other consistency models of attitude, such as balance theory (Heider, 1944, 1956, 1958).

Two situations have been suggested by Katz (1960) under which value-expressive attitudes are likely to change. The first of these is when the underlying value systems change so that the attitude is not functional anymore in expressing them. Quite obviously, this is not a road that can realistically be taken by social influence attempts operating with a short time horizon. The second possibility is when people are offered a better means to express their values. This possibility has subsequently been linked to the notion of symbolic politics (Sears, 1993; Herek, 2000). From this perspective, one might interpret biotechnology as the successor of nuclear power in the role of a symbolic representation or embodiment of hazardous technologies in general (Bauer, 1997). The road for social influence attempts would be to somehow "pass the buck", that is, try to shift public attention to another issue that has the potential to engage the same system of fundamental attitudes and values in members of the public.

In either case, it would be quite clear why previous attempts to change consumer attitudes towards GM foods by means of persuasive communication have not succeeded. Deliberately changing a person's value systems requires nothing short of brainwashing (O'Keefe, 2002) and is therefore clearly impossible in terms of ethics as well as practicality. Be that as it may, an assessment of the functional properties of consumer attitudes to GM foods appears necessary. If the assessment indicates that the attitudes are predominantly value-expressive, it will at least be known that there is little point in trying to change them by means of simple benefit communication strategies, and that other, non-communicative means will have to be found.

3.4.3. Attitudes with Knowledge Functions and their Strength

In the case of attitudes with a knowledge function, the general attitude objects to which a novel object is related are likely to be in a category-exemplar relationship with the novel object (Fiske & Neuberg, 1990; Sherif & Sherif, 1967). These can be assumed less involving as they are not necessarily of any relevance to the self; they may even have neutral positions on the bipolar evaluative schema. Hence, the latitudes of acceptance and non-commitment will be relatively broad. Therefore, the attitude toward the novel object will be strongly assimilated towards the preexisting attitude even if the evaluation of the novel object falls on a position far away on the evaluative continuum. In the terminology of social judgment theory, the attitude towards the novel object is *assimilated towards* the preexisting attitude. Furthermore, the wide latitudes of acceptance will make it relatively easy for a counter-attitudinal argument to be accepted by the individual.

In addition to suggesting that attitudes with knowledge functions are relatively weak in the first place and therefore much more open to social influence attempts, Katz (1960) suggested that the introduction of ambiguity might destabilize a knowledge function. Information or events that cannot be fitted in the orienting schema provided by the attitude will indicate that the attitude is not functional any more in serving that purpose, and make attitude change more likely. If this were the case with attitudes to GM foods, one might expect that at least the occasional attitude change experiment should have been successful in changing such a weak attitude. From existing research (see Chapter 2), it appears therefore relatively unlikely that the attitudes only serve knowledge functions. Nevertheless, this will be one of the research questions to be investigated later on.

3.5. A Proposed Structure of the Attitude System

The crucial issue for the present research is whether a bottom-up model or a top-down model of attitude structure is a more appropriate representation of European consumers' attitudes towards genetically modified foods, and whether they serve value-expressive or knowledge purposes. From the review of existing research presented in Chapter 2 (see above), the question about the directionality in consumers' attitude structures cannot be fully answered; too much of the research made a-priori assumptions about the existence of bottom-up or top-down processes instead of testing them. Furthermore, the bottom-up and the top-down structures are not actually mutually exclusive. The framework model used in this chapter, Fazio's (1986, 1989) concept of attitudes as object-evaluation association, allows for a multitude of evaluations to be associated with the same object. Some of these object-evaluation associations may be bottom-up, some of these may be top-down. The particular "mixture" of bottom-up and top-down associations that constitutes an overall attitude at a given time depends on way the attitude was formed, and the pattern of activation that occurs within the system.

3.5.1. Evidence from Existing Research

Certain classes of object-evaluation associations can be assumed to dominate over others, depending on whether it is logically possible that they have actually been formed by consumers. In particular, we assert that it is near impossible for European consumers to have personal experience with genetically modified foods. Hence, the factor that is generally regarded the strongest determinant of accessible bottom-up structures in attitudes (Fazio, 1989; Fazio & Zanna, 1981) can be excluded as a source. In the absence of personal experience with identifiable products or ingredients, we will therefore expect that all beliefs European consumers hold about the risks and benefits of genetically modified foods *must* be derived from more general attitudes, following a top-down evaluation process.

Furthermore, convergence emerged in the review in Chapter 2 concerning the level of generality on which evaluations are made. Qualitative research as well as quantitative research suggested that the object of consumers' attitudes to GM foods is the technology as such, represented as an abstract concept, rather than as a variety of different products and applications to which attributes could be associated. Actual beliefs as defined in this section were rarely found in qualitative data. Consumer evaluations appeared to be made predominantly through references to even more abstract attitude objects such as health, environment, animal welfare or producer power where the particular implication between one and the other was left unspecified. This strongly suggests a top-down evaluation process as assumed by social judgment theory. Consistent with this, factor analyses of sets of beliefs usually found that just two dimensions were sufficient to represent the covariation among the beliefs, suggesting a low level of complexity in the belief sets.

3.5.2. A Hierarchical Model

Fitting the available evidence into the framework provided by theories of attitude structure, a working model of the hierarchical structure of the attitude system can be developed, depicted in Figure 3.4. On the highest level of generality, we assume general socio-political attitudes to operate. Judging from the results of previous research (see above), the objects of these attitudes are likely to be abstract entities such as environment and nature, science and modern technology, and powerful institutions. On an upper-medium level of generality, we assume global evaluations of the technology to operate. On a lower-medium level of generality, we expect concretizations in terms of heuristic benefit and heuristic risk evaluations. On the lowest level, we assume concretizations in terms of beliefs about particular risk and benefit attributes, emerging from an inferential belief formation process (Olson, 1978).

The relative horizontal position of each object indicates its location on the evaluative continuum, and the relative vertical position indicates its level of generality. We assume that the vertical relationships between the objects are represented by consumers in terms of category-exemplar relationships, as shown by Fiske and Neuberg (1990). In cognitive psychology, conceptual hierarchies of this type have been shown to exist for natural categories such as foods, plants and animals, yielding positive evidence for their hierarchical nature (for a review see Murphy & Lassaline, 1997). In consumer research, hierarchical attitude systems have been identified as well that are compatible with our suggestion. Homer and Kahle (1987) identified a values-attitudes-behavior hierarchy, whilst Brunsø, Scholderer and Grunert (2004) and Scholderer, Brunsø and Grunert (2002) could establish values-lifestyle-behavior hierarchies.

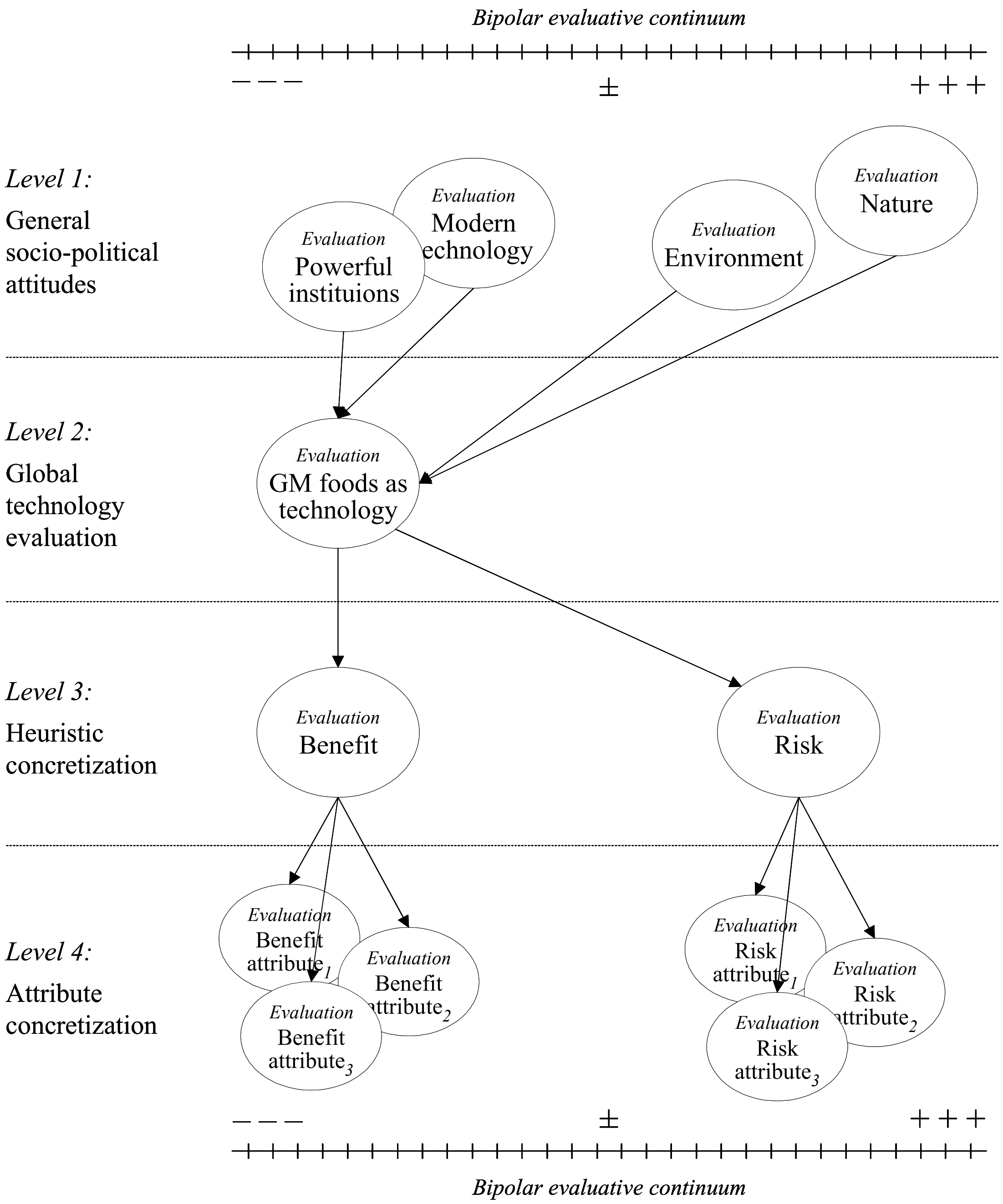

Figure 3.4. Proposed model of the hierarchical structure of consumer attitudes towards genetically modified foods.

3.6. Dynamic Properties and Resistance to Persuasion

The graphic representation in Figure 3.4 can be understood as an associative network representation of inter-attitudinal structure. In line with Fazio's (1986, 1989) conceptualization of attitudes as associative networks, we will assume that an attitude can be automatically activated upon confrontation with the attitude object. Once primed, activation will spread through the network and activate all associated nodes, affecting subsequent evaluation tasks. The effect as such has been demonstrated numerous times by Fazio and colleagues in the laboratory (e.g., Fazio, Sanbonmatsu, Powell & Kardes, 1986; for a review, see Fazio, 1995). Furthermore, Fazio and colleagues have shown that the activation of such network structures increases attitude-consistent behavior (Fazio, Chen, McDoal & Sherman, 1982; Zanna, 1989; Zanna, Olson & Fazio, 1980).

In previous research, we have used this approach to interpret the puzzling finding that benefit communication of any kind appeared to decrease the likelihood that consumers would actually choose a GM product (Scholderer & Frewer, 2003; also see Grunert, Bredahl & Scholderer, 2003; Scholderer, Bredahl & Frewer, 2001). However, we believe that the dynamic properties of network structures will also have relevance for processes that may be responsible for resistance to persuasion. In the following sections, two of these will be outlined.

3.6.1. Attitude Activation and Schematic Processing

In section 3.5 (see above), we have outlined a hierarchical model of the structure we hypothesize for consumer attitudes towards GM foods. If such a structure is completely activated in the way Fazio (1986, 1989) suggests, for example through exposure to communication, it can be interpreted as a *schema* that will exert systematic influence on the processing of information. Tesser (1978) provided such a schema-theoretic treatment of attitudes, with particular emphasis on the structural consistency of a schema and the impact this will have on attitude change. If people have well-organized attitudinal schemata available for the processing of incoming information, he argued, these schemata will help them in the assimilation of pro-attitudinal arguments and in the refutation of counter-attitudinal arguments, resulting in higher production of thoughts that are evaluatively congruent with people's preexisting attitude towards the issue at hand. Because of these highly structured cognitive responses, he predicted, people's attitudes after the processing of information should become even more consistent with their prior attitudes (Tesser & Shaffer, 1990).

If people have less organized schemata, no such help would be provided, resulting in higher production of evaluatively incongruent thoughts. The effect has been demonstrated with regard to a number of different attitude objects (see the review in Tesser, Martin & Mendolia, 1995). Interpreted in terms of functional approaches to attitude (Katz, 1960), value-expressive attitudes would provide exactly such a schema, making the underlying attitudes utterly resistant to change, whilst attitudes with a knowledge function should be relatively open to evaluatively incongruent thoughts and thereby easily become destabilized. This effect has likewise been demonstrated for a number of attitude objects (see Maio & Olson, 2001; O'Keefe, 2002).

3.6.2. Judgmental Distortion

According to Eagly and Chaiken's (1995) classification, Tesser's (1978) schematic processing model can be considered as an active, systematic mechanism that may occur when people feel highly motivated to systematically process incoming information. Another active mechanism but one that can be considered more "peripheral" in terms of Petty and Cacioppo's (1986) elaboration likelihood model, is the check of the evaluative discrepancy between message content and preexisting attitudes, as stipulated in social judgment theory. Once preexisting attitudes are activated in consumers, we expect that these attitudes will operate as fuzzy anchors in the judgment of all attitudinally relevant information (Sherif & Hovland, 1961). If the discrepancy between preexisting attitude and evaluative position of the argument in the message is small, or if latitudes of acceptance and non-commitment are wide (see above), the argument will be assimilated towards the preexisting attitude.

If the discrepancy between preexisting attitude and evaluative position of the argument is high, or if latitudes of acceptance and non-commitment are narrow, the argument will fall into consumers' latitudes of rejection: the message argument itself and all other attitudinally relevant aspects of it will be contrasted away from the preexisting attitude, including evaluations of source credibility (Chaiken *et al.*, 1995; Eagly & Chaiken, 1995; Ostrom & Brock, 1968). If such a process is triggered, counter-attitudinal arguing may backfire on the communicator through distorted judgments of the communicator's motivations made by the receivers of the message (Wood & Eagly, 1981). Again, such an effect can be expected to occur in attitude systems that serve value-expressive purposes, but not in attitude systems that have knowledge functions as they can be expected to be much less involving (Katz, 1960).

In situations where people are less motivated to engage active mechanisms of resistance to persuasion, on the other hand, or if the evaluative schemata discussed above are not fully activated, it may still be the case that passive processes of resistance occur, including selective ignorance of the arguments presented in a message, and unsystematic, peripheral attitude shifts that do not endure and do not affect the underlying evaluative dimensions (Chaiken, 1987; Festinger, 1957; Petty & Cacioppo, 1986). In attitude systems with value-expressive character that are highly involving, we expect passive processes to play a less prominent role. However, the possibility shall not be excluded in the research to be presented later.

3.6.3. Functional Matching

From the above, it can be followed that an assessment of the structural and functional properties of an attitude will allow predicting whether they can be influenced by persuasive attempts or not. If attitudes have value-expressive character, persuasion will be extremely difficult; active refutation of the message content and even re-evaluation of source characteristics may occur. If, on the other hand, attitudes have a knowledge function and serve purely preliminary orientation purposes, this will be relatively easy; attitudes with knowledge functions are assumed preliminary in nature, operating in the manner of a rule-of-thumb heuristic. Judged from the result of the literature review in Chapter 2 (see above), this question cannot be fully decided with regard to European consumers' attitudes towards GM foods. There was clear convergence in the review regarding the general attitude objects to which attitudes towards GM foods are related, and we even considered the evidence for top-down processes to be convincing enough to base our framework model on this assumption.

However, if these attitudes serve value-expressive purposes and are therefore likely to *remain* resistant to persuasive attempts, or if they serve knowledge purposes and are therefore likely to be open to persuasive attempts, will have to be investigated. Once this is known, a functionally matched strategy can be developed to influence the attitudes. If the attitudes have a knowledge function and are therefore preliminary in nature, persuasive communication may still have a chance. If the attitudes are value-expressive, non-communicative means will have to be adopted.

3.7. Building an Alternative Attitude System

The previous sections were concerned with the structure and function of attitudes that are integrated into a hierarchical system, deriving their valence and evaluative extremity from their position relative to other attitudes. In the extreme case of strictly top-down structured, value expressive attitudes, we expected that it would not be possible to change such attitudes through communication. In the following sections, we will develop propositions regarding what else can be done when communication is bound to fail. In short, we suggest building an alternative attitude system.

In practically all current research on consumer attitudes towards genetically modified foods, the fact that the primary object of inquiry had been *food* has virtually been forgotten. This is not very surprising as the debate about the introduction of these foods has always been about the notorious group of breeding and processing technologies that are involved in their production, and not about the particular products themselves. We think that this has created a blind spot in the debate, especially concerning the question of the marketability of these foods. We suggest turning the conceptualization of GM foods back on its feet, understanding them as foods and not just as embodiments of a stigmatized technology.

3.7.1. Experiential Attitude Formation

Consumers evaluate the quality of a food product on quite a number of different dimensions. These can be classified as either extrinsic to the food, such as the brand, packaging, and information about its production process, or as intrinsic to the food, such as its sensory characteristics (Grunert, Hartvig Larsen, Madsen & Baadsgaard, 1996). Abstracting from extrinsic characteristics, the development of basic food likes and dislikes is based on the hedonic gratification gained from its consumption. Hedonic gratification can be understood in this context as the overall affective response evoked by the sensory characteristics of the product (Rozin, 1989; Rozin, Levin & Fallon, 1986).

Liking of particular combinations of sensory attributes is thought to develop through associative learning, where the regular co-occurrence of particular flavors, odors and textures first forms, and then strengthens and maintains a mental representation of the hedonic quality of a product (Mela, 2000; Rozin & Vollmecke, 1986; Rozin, 1990). In the terminology introduced above, an associative network evolves, where each sensory attribute of the product may be associated with a particular hedonic evaluation that is based on direct experiences with the product. Repeated activation of single attribute-evaluation associations strengthens these associations, and repeated activation of the whole network strengthens its coherence or structural consistency (Anderson, 1983; Fazio, 1989, 1995).

3.7.2. Strength of Experiential Attitudes

This way, a true bottom-up structure evolves from sensory attributes and hedonic gratifications. The structure incorporates the mental representation of the product as well as the evaluation of that product, i.e. the attitude towards it. Importantly, the different associations are based on direct experience, the very factor known to make attitudes easily accessible, resistant to change, and predictive of behavior (Fazio & Zanna, 1978a, 1978b, 1981). In marketing contexts, this particular property of experience-based attitudes is utilized in the promotion technique of inviting potential customers to try the product. Comparisons between the effectiveness of product trials and advertising have yielded strong evidence in favor of product trials, indicating substantially increased repeat purchase rates relative to the purely communicative technique of advertising (Kempf & Smith, 1998; Marks & Kamins, 1988; Smith & Swinyard, 1978).

If possible, prospective marketers of GM foods should therefore follow this route. In the US market, the conditions exist for such a strategy; products containing genetically modified ingredients do not have to be labeled as such. In the EU, on the other hand, the quasi moratorium may have been lifted in May 2004, but GM ingredients will have to be labeled. Hence, even if it will theoretically be possible from now on to simply launch products and offer them for trial to consumers, there may still be a number of complications that could distort experiential attitude formation.

3.7.3. Anchoring Effects

In the real world, the idealized model of experiential attitude formation does not apply. Consumers have attitudes towards genetically modified foods, and, as explained above, these attitudes can be expected to serve as anchors relative to which new information is evaluated, even if the information is sensory (Cardello, 1994, 1995, 2003; Tuorila, Meiselman, Bell, Cardello & Hohnson, 1994). Social judgment theory may have gone somewhat out of fashion in academic social psychology, but in sensory science, it is alive and well (Schifferstein, 2001). Sensory scientists apply social judgment theory in the sense Hovland and Sherif understood it when they first conceived it (Sherif, 1935): as a theory of perceptual distortions caused by a person's own or other persons' expectations.

In our above description of the central concepts of the theory, we limited the discussion to preexisting attitudes that serve a person as judgmental anchors relative to which novel stimuli with attitudinal relevance are evaluated. The notion of judgmental anchoring in social judgment theory is actually far broader (Sherif & Sherif, 1961). It refers to all types of tasks ranging from psychophysical size or flavor judgments to the adoption or rejection of whole ideological systems. In the sensory evaluation of foods, the typical research paradigm is the expectancy-disconfirmation experiment (Olson & Dover, 1976). Certain expectations about the flavor, texture, or overall quality of a food are induced in a participant, and these are then systematically confirmed or disconfirmed to different degrees. The concepts of latitudes of acceptance, non-commitment and rejection apply in the same way as outlined above, resulting in assimilation or contrast effects.

3.7.4. Deconstructing an Evaluative Schema

In the expectancy-disconfirmation paradigm, expectations are always created prior to the experience, either by exposing participants to information or by exposing them to other experiential stimuli. In later modifications of the theory, schema-theoretic models were adopted in a similar way as by Tesser (1978; see above) in a communication context. Meyers-Levy and Tybout (1989) developed such a schema theory for cognitive processes during product trials. They could show that, in a series of trials, their participants maintained a product evaluation schema from preceding trials although the nature of the product attributes had changed between trials. Their explanation for the effect was that a switch to a different schema requires considerable cognitive effort, which their participants were unwilling to expend.

If the hypothesis is applied to the case of GM foods, assuming one could get a person to actually try a GM food product, two very different outcomes would be predicted, depending on which schema was activated first. If the value-expressive attitude system hypothesized above were activated as a schema prior to the product trial (e.g., by informing the person that they were to taste a GM food), the schema would remain active even at the point where the tried product sample would be evaluated. Hence, we would predict that the product would be evaluated in terms of a schema that derives all its evaluative anchors from higher-order attitude objects such as environment and technology. The product would not actually contrast with the schema; it would simply not fit into it. Hence, non-commitment would be expected, and no weakening of the evaluative schema.

If, on the other hand, a product-evaluation schema were activated first (e.g., by simply asking a person to try a product sample), and the genetic modification only revealed after the hedonic evaluation of the product, the product would still be evaluated in terms of the product schema even though the genetic modification had been revealed. The concept of genetic modification of foods, on the other hand, would be evaluated in terms of the product schema, which should weaken the degree to which it is determined by technology and value associations, and strengthen the degree to which it is determined by product associations. Whether this effect can actually be observed in the real world, shall be the final research question to be investigated.

4. Research Questions

As stated in Chapter 1, the research presented here will try to solve a problem that has puzzled decision-makers in the food-industry, regulatory institutions, and in the natural and social sciences alike for the best part of two decades: how to convince European consumers that genetically modified foods are acceptable products. To this end, we reviewed the existing research on consumer attitudes towards GM foods in Europe (Chapter 2), and came to a number of preliminary conclusions and unresolved questions. To recapitulate, the preliminary conclusions were the following:

- Attitudes towards GM foods are strongly related to general socio-political attitudes.
- The object of attitudes towards GM foods appears to be the technology as such, not particular products.
- Beliefs about the consequences of the technology are of low complexity and relatively ill defined.
- Attitudes towards GM foods are very resistant to persuasion.

The unresolved questions were reconstructed in theoretical terms in Chapter 3. We developed a framework for the analysis of structure, function and dynamics of attitudes towards GM foods, built on elements of social judgment theory (Sherif & Sherif, 1961) and the functional analysis of attitudes (Katz, 1960). From this, five research questions can be derived that will be empirically investigated:

- *Intra-attitudinal structure:* are attitudes towards GM foods aggregated from independent sets of beliefs (bottom-up) or are beliefs derived from heuristic evaluations (top-down)?

- *Inter-attitudinal structure:* are attitudes towards GM foods purely derivative of general socio-political attitudes, or are they based on a quasi-rational risk-benefit trade-off?
- *Function:* do attitudes towards GM foods serve value-expressive purposes for consumers, or do they provide preliminary orientation in a situation where factual knowledge is lacking?
- *Resistance to persuasion:* do attitudes towards GM foods provide a schema for the refutation of arguments, and will they distort perceptions of the credibility of an information source?
- *Deconstruction through product experience:* can an alternative attitude system be built through direct experience that weakens the value-expressive character of consumers' existing attitudes to GM foods?

In the following chapter, we will develop a methodology for investigating structural properties of attitudes. In Chapter 6, we will present the first empirical study. Based on this cross-national survey, we will try to answer the questions about intra- and inter-attitudinal structure as well as the function of consumer attitudes towards GM foods. In Chapter 7, we will present the second empirical study, an attitude change experiment in which communication failed to persuade consumers of the benefits of GM foods. Based on this experiment, we will try to answer the questions about resistance to persuasion. In Chapter 8, we will present the third empirical study, another attitude change experiment. Based on this experiment, we will try to answer the question about deconstruction through direct product experience. Finally, in Chapter 9, we will present our overall conclusions and outline their implications, trying to answer the question stated at the beginning: how can we convince European consumers that genetically modified foods are acceptable products?

5. Methodological Framework

5.1. Overview

In the social sciences, structural equation modeling (Jöreskog, 1971) has emerged as *the* state-of-the-art method for the modeling of non-experimental data. Synthesizing a multitude of models under a common statistical framework, including true-and-error score theory (Spearman, 1904; Lord, 1959; Lord & Novick, 1968) and factor analysis (Thurstone, 1934; Lawley, 1958) originally developed in psychometrics, path analysis (Wright, 1918) originally developed in genetics, and simultaneous equation modeling (Wold & Jureen, 1953) originally developed in econometrics, it is one of the most flexible statistical techniques for estimating and testing hypothesized model structures against competing ones.

A number of comprehensive texts on structural equation modeling have been published in the last two decades, including introductory textbooks (e.g., Bollen, 1989), updates on methodological developments (e.g., Anderson & Gerbing, 1988; Bagozzi & Yi, 1988; Browne & Cudeck, 1993; Little, 1997; Yuan & Bentler, 1997) and benchmark assessments of the way the method is being used and abused by researchers in the field (e.g., Baumgartner & Homburg, 1996).

The empirical research presented later will rely heavily on this method. Therefore, the method will be introduced in relative depth in the beginning of this chapter. Building on this framework, we will develop algebraic representations for the different types of attitude structures discussed in Chapter 3, and outline how they can be estimated as special cases of the general statistical model described before. Finally, we will outline the conditions that are necessary to ensure that data collected in different consumer populations are comparable.

5.2. Multi-Sample Structural Equation Modeling with Structured Means

5.2.1. The General Model

In its most general form (Jöreskog, 1970, 1971; Sörbom, 1974) a multi-sample structural equation model with structured means is defined by three simultaneous equations. The first one specifies a factor-analytic measurement model for the endogenous variables, representing the observed responses to *P* items ($p = 1,... P$) as a linear function of *M* latent factors ($m = 1, ... M, M \leq P$) and *P* random errors.

$$\mathbf{y}^{(g)} = \boldsymbol{\tau}_y^{(g)} + \boldsymbol{\Lambda}_y^{(g)}\boldsymbol{\eta}^{(g)} + \boldsymbol{\varepsilon}^{(g)} , \tag{5.1}$$

where $\mathbf{y}^{(g)}$ is the $P\times1$ vector of observed endogenous variables in group *g*, $\boldsymbol{\tau}_\mathbf{y}^{(g)}$ is the $P\times1$ vector of intercept terms, $\boldsymbol{\eta}^{(g)}$ is the $M\times1$ vector of latent endogenous factors, $\boldsymbol{\Lambda}_y^{(g)}$ is the $P\times M$ matrix of factor loadings, and $\boldsymbol{\varepsilon}^{(g)}$ is the $P\times1$ vector of random errors, assumed to be uncorrelated with the latent factors and to have zero expectation. The second equation defines another factor-analytical measurement model, this time for the exogenous variables:

$$\mathbf{x}^{(g)} = \boldsymbol{\tau}_x^{(g)} + \boldsymbol{\Lambda}_x^{(g)}\boldsymbol{\xi}^{(g)} + \boldsymbol{\delta}^{(g)} , \tag{5.2}$$

where $\mathbf{x}^{(g)}$ is the $Q\times1$ vector of observed exogenous variables in group *g*, $\boldsymbol{\tau}_\mathbf{x}^{(g)}$ is the $P\times1$ vector of intercept terms, $\boldsymbol{\xi}^{(g)}$ is the $N\times1$ vector of latent exogenous factors, $\boldsymbol{\Lambda}_x^{(g)}$ is the $Q\times N$ matrix of factor loadings, and $\boldsymbol{\delta}^{(g)}$ is a $Q\times1$ vector of random errors, again assumed to be uncorrelated with the latent factors and to have zero expectation. The third equation defines the structural model:

$$\boldsymbol{\eta}^{(g)} = \boldsymbol{\alpha}^{(g)} + \mathbf{B}^{(g)}\boldsymbol{\eta}^{(g)} + \boldsymbol{\Gamma}^{(g)}\boldsymbol{\xi}^{(g)} + \boldsymbol{\zeta}^{(g)} , \tag{5.3}$$

where $\boldsymbol{\alpha}^{(g)}$ is an $M\times1$ vector of intercept terms, $\mathbf{B}^{(g)}$ is the $M\times M$ weight matrix of the regression among the endogenous factors in group *g*, $\boldsymbol{\Gamma}^{(g)}$ is the $M\times N$ weight matrix of the regression of the endogenous on the exogenous factors, and $\boldsymbol{\zeta}^{(g)}$ is an $M\times1$ vector of equation errors. Expectations of $\mathbf{y}$ and $\mathbf{x}$ are

$$\boldsymbol{\mu}_y^{(g)} = \boldsymbol{\tau}_y^{(g)} + \boldsymbol{\Lambda}_y^{(g)}(\mathbf{I} - \mathbf{B}^{(g)})^{-1}(\boldsymbol{\alpha}^{(g)} + \boldsymbol{\Gamma}^{(g)}\boldsymbol{\kappa}^{(g)}) \ , \tag{5.4}$$

$$\boldsymbol{\mu}_x^{(g)} = \boldsymbol{\tau}_x^{(g)} + \boldsymbol{\Lambda}_x^{(g)}\boldsymbol{\kappa}^{(g)} \ , \tag{5.5}$$

with $\boldsymbol{\kappa}^{(g)}$ the $N\times 1$ vector of latent exogenous factor means and $(\mathbf{I} - \mathbf{B}^{(g)})^{-1}(\boldsymbol{\alpha}^{(g)} + \boldsymbol{\Gamma}^{(g)}\boldsymbol{\kappa}^{(g)})$ the $M\times 1$ vector of latent endogenous factor means. Finally, the $(P+Q)\times(P+Q)$ model-implied covariance matrix $\boldsymbol{\Sigma}^{(g)}$ in the gth group is composed by its four sub-matrices

$$\boldsymbol{\Sigma}_{yy}^{(g)} = \boldsymbol{\Lambda}_y^{(g)}(\mathbf{I} - \mathbf{B}^{(g)})^{-1}(\boldsymbol{\Gamma}^{(g)}\boldsymbol{\Phi}^{(g)}\boldsymbol{\Gamma}'^{(g)} + \boldsymbol{\Psi}^{(g)})\ [(\mathbf{I} - \mathbf{B}^{(g)})^{-1}]'\boldsymbol{\Lambda}'^{(g)}_y + \boldsymbol{\Theta}_\varepsilon^{(g)} \ , \tag{5.6}$$

$$\boldsymbol{\Sigma}_{yx}^{(g)} = \boldsymbol{\Lambda}_y^{(g)}(\mathbf{I} - \mathbf{B}^{(g)})^{-1}\boldsymbol{\Gamma}^{(g)}\boldsymbol{\Phi}^{(g)}\boldsymbol{\Lambda}'^{(g)}_x \ , \tag{5.7}$$

$$\boldsymbol{\Sigma}_{xy}^{(g)} = \boldsymbol{\Lambda}_x^{(g)}\boldsymbol{\Phi}^{(g)}\boldsymbol{\Gamma}'^{(g)}[(\mathbf{I} - \mathbf{B}^{(g)})^{-1}]'\boldsymbol{\Lambda}'^{(g)}_y \ , \tag{5.8}$$

$$\boldsymbol{\Sigma}_{xx}^{(g)} = \boldsymbol{\Lambda}_x^{(g)}\boldsymbol{\Phi}^{(g)}\boldsymbol{\Lambda}'^{(g)}_x + \boldsymbol{\Theta}_\delta^{(g)} \ , \tag{5.9}$$

with $\boldsymbol{\Psi}^{(g)}$ being the $M\times M$ covariance matrix of equation errors in group g, $\boldsymbol{\Phi}^{(g)}$ the $N\times N$ covariance matrix of the exogenous factors, $\boldsymbol{\Theta}_\varepsilon^{(g)}$ the $P\times P$ covariance matrix of random measurement errors in $\mathbf{y}^{(g)}$, and $\boldsymbol{\Theta}_\delta^{(g)}$ the $Q\times Q$ covariance matrix of random measurement errors in $\mathbf{x}^{(g)}$.

The model contains all linear statistical models as special cases. Equation 5.2, for example, defining the measurement model for the exogenous variables, can be simplified to the model of single-sample confirmatory factor analysis with structured means by omitting the group indices g. The model for simple confirmatory factor analysis, i.e. where all observed variables are centered around their means, is obtained by omitting the intercept terms $\boldsymbol{\tau}_\mathbf{x}$ from the model (it follows that right-hand as well as left-hand sides of Equation 5.5., defining the mean model of the exogenous variables, become zero too). The model of traditional exploratory factor analysis is obtained by a defining $\boldsymbol{\Phi}$, the covariance matrix of the exogenous factors, as an identity matrix.

The models of classical path analysis and simultaneous equation modeling are obtained by replacing the latent variables η and ξ in the structural model defined by Equation 5.3 with manifest variables. Doing the same and, in addition, omitting the term for the regression $\mathbf{B}\boldsymbol{\eta}$ among the endogenous variables from the structural model, results in the general linear model. If the covariance matrix $\mathbf{\Psi}$ of the equation errors is further defined as diagonal, we obtain multivariate regression. If finally, vector-valued endogenous variables are replaced with scalar-valued ones, the model becomes that of multiple linear regression, and if, in addition, vector-valued exogenous variables are replaced with scalar-valued ones, the model simplifies to simple linear regression.

5.2.2. Estimation and Goodness-of-Fit

The general model can be estimated by a variety of methods such as maximum likelihood or generalized least squares (for an overview, see Bollen, 1989; Yuan & Bentler, 1997). Let $\mathbf{m}^{(g)}$ be the observed $(P+Q)\times 1$ mean vector in group g, $\mathbf{S}^{(g)}$ the observed $(P+Q)\times(P+Q)$ covariance matrix in group g, $\theta = (\beta'_1, \ldots \beta_G')$ the unknown vector of parameter values generating the model-implied means $\boldsymbol{\mu}^{(g)}$ and covariances $\boldsymbol{\Sigma}^{(g)}$ in group g, and N the total sample size obtained by adding up the group sample sizes N_g. The maximum likelihood discrepancy function is given by

$$F(\theta) = \frac{1}{N} \sum_{g=1}^{G} N_g F_g(\beta_g) \qquad (5.10)$$

with
$$F_g(\beta_g) = [\mathbf{m}^{(g)} - \boldsymbol{\mu}^{(g)}(\beta_g)]' \, \boldsymbol{\Sigma}^{(g)-1}(\beta_g)[\mathbf{m}^{(g)} - \boldsymbol{\mu}^{(g)}(\beta_g)] + \mathrm{tr}[\mathbf{S}^{(g)}\boldsymbol{\Sigma}^{(g)-1}(\beta_g)] - \log|\mathbf{S}^{(g)}\boldsymbol{\Sigma}^{(g)-1}(\beta_g)| - (P_g + Q_g)\,.$$

Estimation of θ involves minimization of Equation (5.10) under a set of appropriately chosen constraints that incorporate the hypotheses to be tested. Under multivariate normality of $\mathbf{x}^{(g)}$ and $\mathbf{y}^{(g)}$, the discrepancy

$$T_{\mathrm{ML}} = NF(\theta)\,, \qquad (5.11)$$

commonly referred to as the "overall goodness-of-fit χ^2" of the model, is asymptotically χ^2 distributed with degrees of freedom equaling $df = \frac{1}{N}\, G(P_g+Q_g)(P_g+Q_g+2) - R$, where R is the number of unknown parameters in θ. A significant result of this test implies that the model-implied sample moments (i.e., the model-implied mean vectors and covariance matrices) deviate from the observed sample moments (i.e., the observed mean vectors and covariance matrices).

5.2.3. Descriptive Goodness-of-Fit Measures

The three studies reported later will involve samples of considerable size. In such situations, the overall χ^2 goodness-of-fit test is of limited use as a stand-alone measure. Being a function of sample size (see Equation 5.11), it tends to gain excessive power in large samples (Bentler, 1990; Bollen, 1990; Tanaka, 1987). The problem is aggravated by the fact that, within a structural equation model, the measurement models (as defined Equations 5.1 and 5.2) tend to impose substantially more restrictions on the model-implied mean vectors and covariance matrices than does the structural model (as defined in Equation 5.3). As a result, the overall χ^2 goodness-of-fit test tends to weigh discrepancies arising from weaknesses of the measurement models even in situations where the hypotheses to be tested are concerned with restrictions on the structural model.

In order to compensate for this, descriptive goodness-of-fit measures will be used in addition in order to evaluate model-wise goodness of fit where measurement models are concerned (Browne & Cudeck, 1993). Current versions of structural equation modeling software produce a sizeable amount of different fit indices. The output of Lisrel 8.54 (Jöreskog & Sörbom, 1996; Jöreskog, Sörbom, du Toit & du Toit, 1999; the program that will be used for the analyses reported in Chapters 6, 7 and 8), for example, lists around thirty different fit indices in the output from a standard analysis. Most of these measures are relatively simple transformations of the overall goodness-of-fit chi-square and can easily be transformed into each other. In order not to cause more confusion than clarity, one particular measure will consistently be used throughout the analyses reported later, the root mean squared error of approximation (RMSEA; Steiger, 1990, 1998).

The RMSEA is a relative non-centrality measure, estimating how well the fitted model approximates the population covariance matrix per degree of freedom. It is defined as

$$\text{RMSEA} = \sqrt{G\,\frac{\text{Max}[\frac{T}{df}-1\ ;\ 0]}{N}}\ , \tag{5.12}$$

where G is the number of groups in the analysis, T is the maximum-likelihood discrepancy (i.e., the goodness-of-fit χ^2) defined in Equation (5.11), and N is the total sample size. The RMSEA has the advantage that relatively much is known about its sampling distribution, and that so much experience exists about its behavior that the scientific community has developed conventions about acceptance limits, in analogy to the conventional levels of significance in a statistical test. Browne and Cudeck (1993) suggest taking RMSEA values below .080 as an indicator of acceptable fit, and values below .050 as an indicator of close fit.

5.2.4. Hierarchical and Nonhierarchical Model Comparisons

Testing hypotheses about the structure underlying a whole system of variables often requires that the many restrictions on different model parameters that incorporate a structural hypothesis, are evaluated jointly. Steiger, Shapiro and Browne (1985) have shown that the difference

$$\Delta T = T_1 - T_0 \tag{5.13}$$

obtained from comparing the fit of a more restricted target model M_1 to the fit of a less restricted baseline model M_0 is asymptotically χ^2 distributed with $\Delta df = df_1 - df_0$ degrees of freedom. In the literature, this test is commonly referred to as the χ^2-difference test (or, equivalently, the likelihood ratio test) for incremental model fit. In the empirical studies presented later, the quantity ΔT will simply be referred to as $\Delta\chi^2$.

Since $\Delta\chi^2$ values are differences between pairs of χ^2 values, they share the property of the χ^2 values from which they are computed, i.e. that they are a function of sample size. In large samples, the statistical power of a $\Delta\chi^2$-test can therefore become excessive: miniscule deviations of predicted from observed moment matrices are detected by the test even though the size of the deviation may be so small that it is theoretically meaningless. In order to alleviate this problem, we will use a descriptive measure of improvement in addition to the actual $\Delta\chi^2$-test in our analyses, the normed fit index (NFI; Bentler & Bonnett, 1980). The NFI is defined as

$$\text{NFI} = 1 - \frac{T_1}{T_0} , \tag{5.14}$$

where T_1 and T_0 are maximum-likelihood discrepancies (defined in Equation 5.11) of a less constrained target model and a more constrained baseline model which are hierarchically nested. The numerical value of the NFI varies between 0 and 1 and can conveniently be interpreted as the relative amount of the way towards perfect fit (i.e., a discrepancy of zero) that is accomplished by relaxing the constraints distinguish the target from the baseline model.

However, the $\Delta\chi^2$-test is only applicable in situations where the models that are compared are nested, that is, the more restricted model can be expressed as a special case of the more general model, involving one or more constraints on parameters that are free in the more general model. In situations where the models that are to be compared are not nested, the test is not valid. For such situations, Akaike (1974, 1987) developed an alternative model comparison approach, based on information theory.

The Akaike information criterion (AIC) which he originally suggested had some problems though (Bozdogan, 1987). When applied to series of competing models, it showed a bias in favor of more complex models. Bozdogan (1987) suggested a number of modifications of the original AIC, involving different ways of penalizing for model complexity in order to include the criterion of parsimoniousness in the evaluation of competing models.

The consistent Akaike information criterion (CAIC) is one of these modifications. Compared to the original AIC, the CAIC puts a moderate penalty on model complexity – more severe than the AIC, though not as severe as other measures such as the Bayes Information Criterion (BIC; Bozdogan, 1987), which were explicitly developed for situations where parsimoniousness is the primary criterion in a model comparison strategy. The CAIC is defined as

$$\text{CAIC} = T + q(1 + \ln N), \tag{5.15}$$

where T is the maximum-likelihood discrepancy (i.e., the goodness-of-fit χ^2) as defined in Equation (5.11), q is the number of free parameters in the model, and N is the total sample size. In situations where several competing models are specified a priori, the one yielding the lowest CAIC is to be selected. Unfortunately, the sampling distributions of the CAIC itself as well as of differences between pairs of CAICs are unknown, hence explicit model comparison tests do not exist.

5.2.5. Corrections for Non-Normality

Maximum likelihood estimation of the parameters of a structural equation model assumes multivariate normality of observed and latent variables (Jöreskog, 1970). To account for serious violations of distributional assumptions, the Satorra-Bentler scaled χ^2 statistic will be used for evaluating model fit (Satorra & Bentler, 1988; see Hu, Bentler & Kano, 1992, for a robustness analysis). The statistic is obtained by dividing the maximum likelihood discrepancy T_{ML} defined in Equation (5.11) by a scaling correction c to better approximate the expected value of the χ^2 distribution under non-normality. The scaling correction c is defined as

$$c = \mathrm{tr}[\mathbf{UV}^*]/df, \tag{5.16}$$

where df is the expected value of the χ^2 distribution, $\mathbf{U} = \mathbf{V}^{-1} - \mathbf{V}^{-1}\mathbf{D}\Delta\mathbf{D}'\mathbf{V}^{-1}$, and $\mathbf{V} = 2\mathbf{K}'(\mathbf{\Sigma}\otimes\mathbf{\Sigma})\mathbf{K}$ is the asymptotic covariance matrix of non-redundant sample moments as assumed by maximum likelihood. The weight matrix $\mathbf{K}$ consists of elements $k(ij, kl) = \{1/2$ if $i \neq j$ except when $(i = k, j = l)$ or $(i = l, j = k)$; 1 if $i = j = k = l$; 0 else$\}$. $\mathbf{V}^*$, finally, is a fourth-order multivariate product-moment matrix consisting of elements $v(ij, kl) = \sigma_{ijkl} - \sigma_{ij}\sigma_{kl}$ where σ_{ijkl} is the expected fourth-order moment.

In order to account for the fact that the difference between two scaled χ^2 values obtained from hierarchical models does *not* follow a χ^2-distribution, Satorra (2000) and Satorra and Bentler (1999) have extended their approach to χ^2-difference testing and devised another correction formula. Let $\Delta T_{\mathrm{ML}} = T_1 - T_0$ be the difference obtained from comparing the maximum-likelihood discrepancy of a more restricted target model M_1 to the discrepancy of a less restricted baseline model M_0, let $\Delta df = df_1 - df_0$ be the associated degrees of freedom, and c_1 and c_0 the model-wise scaling corrections computed according to Satorra and Bentler (1994; see Equation 14, above). Satorra and Bentler (1999) have shown that the scaled difference statistic

$$\Delta T_{\mathrm{SB}} = \Delta T_{\mathrm{ML}}/c_{\Delta} \tag{5.17}$$

with $$c_{\Delta} = (df_1 c_1 - df_0 c_0)/\Delta df$$

is asymptotically χ^2 distributed with Δdf degrees of freedom. As yet, the scaled difference statistic has only occasionally been used in empirical applications (examples can be found in Scholderer & Frewer, 2003; Scholderer & Grunert, 2001). Hence, little experience exists with its behavior under conditions of extreme irregularities in the data (e.g., floor or ceiling effects resulting in J-shaped or U-shaped distributions, many large outliers). In order to compensate for this, results of statistical tests based on the statistic will always be interpreted in conjunction with descriptive measures (see above).

5.3. Comparing Directional Influence Structures in Attitude Systems

The first set of research questions outlined in Chapter 4 was concerned with the directionality of the attitude system formed by general socio-political attitudes, attitudes towards GM foods as a technology, and beliefs about particular properties, attributes and consequences of the technology and its products. We used the generic terms "bottom-up" and "top-down" to indicate different possible directionalities in such structures, both on the molecular level of intra-attitudinal structures as well as on the molar level of inter-attitudinal structures. If such models are to be compared to each other based on their fit to empirical data, explicit algebraic structures are needed for the formulation of statistical models. In the following sections, we will outline the formalizations on which the empirical analyses reported later will be based.

5.3.1. Algebraic Structure of Bottom-up Models of Intra-attitudinal Structure

In bottom-up models of intra-attitudinal structure, attitudes emerge from an aggregation process, that is, the beliefs a consumer holds about the presence or absence of valenced properties, attributes, or consequences of the object, form the basis from which aggregate evaluations of the object are then generated. Although earlier formulations exist (e.g., Rosenberg, 1956), the prototypical formulation, used almost synonymously with the generic expression "bottom-up models", is Fishbein's (1963) multi-attribute attitude model. From the beginning, Fishbein has formulated an explicit algebraic structure for his concept of an attitude that has remained unchanged throughout the years in which it has been applied by researchers (Anderson & Fishbein, 1965; Day, 1972; Dillon & Kumar, 1985; Fishbein, 1966; Fishbein & Ajzen, 1975; Yi, 1989):

$$A_O = \sum_{q=1}^{Q} b_q e_q , \tag{5.18}$$

where A_O is a person's attitude towards an object, b_q is the belief that the object has attribute q, expressed as a subjective probability, e_q is the evaluation of attribute q, and Q is the number of salient (or, expressed in a modern way, accessible) attributes of the object. As such, the formula is just a measurement rule: it specifies that an overall attitude towards an object is measured by summing up over attributes the products of the respective beliefs and evaluations. The measurement rule as such is therefore not a true model in the sense that it would impose falsifiable restrictions on the data. Usually, the aggregate evaluation A_O can only be validated by correlating it with an independently collected measure of the overall evaluation of the object (Fishbein & Ajzen, 1975).

There has been much discussion in the literature whether such a validation really entails conceptually equivalent operationalizations of the underlying idea of what an attitude is (e.g., Fiske & Neuberg, 1990; McGuire, 1985; Rosenberg, 1968). We propose an alternative formulation here that avoids this problem altogether by using a *latent* variable to model the aggregate evaluation A_O. For this, we will utilize another special case of the general structural equation model outlined above: a MIMIC-type, formative measurement model.

The MIMIC model ("multiple indicators, multiple causes") was first introduced by Hauser and Goldberger (1971), but received wider attention only after the publication of Jöreskog and Goldberger's (1975) treatment. The model is defined by three simultaneous equations. The first equation defines the formative measurement model, representing M latent composite factors $\boldsymbol{\eta}_a$ ($m = 1, 2, \ldots M$) as linear functions of Q observed exogenous variables ($q = 1, 2, \ldots Q$) and M equation errors:

$$\boldsymbol{\eta}_a = \boldsymbol{\Gamma}\mathbf{x} + \boldsymbol{\zeta}_a \ , \tag{5.19}$$

where $\mathbf{x}$ is the $Q\times1$ vector of observed exogenous variables with an unconstrained $Q\times Q$ covariance matrix $\boldsymbol{\Phi}$, $\boldsymbol{\Gamma}$ is the $M\times Q$ matrix of regression weights of the regression of $\boldsymbol{\eta}_a$ on $\mathbf{x}$, and $\boldsymbol{\zeta}_a$ is an $M\times1$ vector of equation errors. The second equation defines the measurement model of a set of additional endogenous variables. These are required for identification purposes; were they not included in the model, the weight matrix $\boldsymbol{\Gamma}$ in Equation (5.19) would not be estimable. The measurement model for the additional endogenous variables is factor analytic, defining the observed responses to P items ($p = 1, 2, \ldots P$) as a linear function of M latent factors ($m = 1, \ldots M$, $M \leq P$) and P random measurement errors:

$$\mathbf{y} = \boldsymbol{\Lambda}_y\boldsymbol{\eta}_b + \boldsymbol{\varepsilon} \ , \tag{5.20}$$

where $\mathbf{y}$ is the $P\times1$ vector of observed endogenous variables, $\boldsymbol{\eta}_b$ is the $M\times1$ vector of latent endogenous factors, $\boldsymbol{\Lambda}_y$ is the $P\times M$ matrix of factor loadings, and $\boldsymbol{\varepsilon}$ is the $P\times1$ vector of random errors, assumed to be uncorrelated with the latent factors and to have zero expectation. The third equation defines the link between the two measurement models. In order to be identified, each of the latent composite factors $\boldsymbol{\eta}_a$ has to emit at least two paths pointing to the additional endogenous variables $\boldsymbol{\eta}_b$:

$$\boldsymbol{\eta}_b = \mathbf{B}\boldsymbol{\eta}_a + \boldsymbol{\zeta}_b \ , \tag{5.21}$$

where is the $M\times Q$ weight matrix of the regression of $\boldsymbol{\eta}_b$ on $\boldsymbol{\eta}_a$, and $\boldsymbol{\zeta}_b$ is an $M\times1$ vector of equation errors. To keep the equations simple, we have omitted mean structures and group indices here, but these can be added easily in line with the general model outlined in Chapter 5.2.1.

The noteworthy feature of the measurement model described by Equation (5.19) becomes apparent when we assume that the exogenous variables **x** in the model are responses collected from consumers to a set of belief items b_1, b_2, $\ldots b_q$ about the Q "modal" (Fishbein & Ajzen, 1975) attributes of an object *O* that are salient in the consumer population. Then, the latent composite factors η_a can be interpreted as attitudes towards the object that emerge from the set of beliefs about the object's attributes, and the regression weights Γ can be interpreted as population-level evaluations e_1, e_2, $\ldots e_q$ of the Q modal attributes. Unreliability on the composite factor level is modeled by the equation errors ζ_a, and the model even allows for potential multidimensionality by assuming a vector-valued attitude instead of a scalar-valued one.

The model is a true model in the sense that it does impose certain restrictions on the data: all effects of the belief items on the additional endogenous variables are assumed to be completely mediated by the latent composite attitudes. Hence, the model can be estimated as a structural equation model and subjected to all model evaluation procedures outlined in Chapter 5.2.

5.3.2. Algebraic Structure of Top-down Models of Intra-attitudinal Structure

In top-down models of intra-attitudinal structure, heuristic evaluations of an attitude object form the basis from which evaluation-congruent beliefs about the properties, attributes or consequences of the object are then generated as mere instantiations of the object-level evaluation. Unlike for bottom-up models, no formalized structure has been proposed for such models in the literature. The different operationalizations reviewed in Chaiken, Pomerantz and Giner-Sorella (1995), for example, are all based on ad-hoc rules that have certain plausibility. Most of these are variations of Rosenberg's (1968) method for measuring evaluative-cognitive consistency, which is based on the rank correlations between responses to a set of belief items and a set of evaluation items concerning the same attributes. The size of the rank correlation is interpreted as a measure of evaluative-cognitive consistency, which in turn is then interpreted as an indicator of evaluation-congruent (top-down) belief formation.

Instead of this cumbersome procedure, we propose a very straightforward way of formalizing top-down structures in belief formation. Again, we will utilize a latent variable approach that can be treated as a special case of the general structural equation model outlined above. Let us assume that each belief b_1, b_2, $\dots b_q$ in a set of Q different beliefs about an object O is instantiated from the same heuristic evaluation of the object, E_O. The beliefs will express the underlying heuristic evaluations with different degrees of congruity strength, which we will denote c_q here, and with a certain degree of randomness, hence we will add a random error d_q to the representation. A simple model of evaluation-congruent belief formation would then be

$$b_q = c_q E_O + d_q \quad . \tag{5.22}$$

Since only the Q belief items are actually measured, E_O as well as d_q are latent variables. If we represent all Q beliefs together in a population-level model, we obtain a simple factor-analytic measurement model, equivalent to the one defined in Equation (5.2) where intercept terms and multi-sample indexing are omitted. Hence, we propose to represent evaluation-congruent belief formation or, more generically speaking, top-down intra-attitudinal structures, by factor-analytic measurement models of the form

$$\mathbf{x} = \Lambda_x \xi + \delta \,, \tag{5.23}$$

where $\mathbf{x}$ is a $Q\times1$ vector of measured belief items, ξ is a $P\times1$ vector of latent evaluation dimensions, the $Q\times P$ loading matrix Λ_x is understood as a matrix of congruity strength weights, and δ is a $Q\times1$ vector of random errors, assumed to be uncorrelated with the latent evaluation dimensions and having zero expectation. If we further assume that Θ_δ, the $Q\times Q$ covariance matrix of random measurement errors in $\mathbf{x}$, is diagonal, the model becomes a true model in the sense that it imposes severe restrictions on the data: all covariation between the observed belief items is due to the common, underlying evaluation dimensions (cf. Alwin, 1976). Once these are statistically controlled, the residual covariation between each pair of beliefs should be zero (local independence).

For the sake of simplicity, we have omitted mean structures and group indices in this formalization. These can be added easily in line with the general model outlined in Chapter 5.2.1. Like the model for bottom-up structures, the model for top-down structures can be estimated as a structural equation model and subjected to all model evaluation procedures described above. And again, the model has the virtues that it allows for multi-dimensionality in the heuristic evaluations (Kerlinger, 1984; see Chapter 3.2.3), and that it accounts for unreliability in the belief formation process.

5.3.3. Problems with Population-level Representation of Intra-attitudinal Structures

A necessary precondition for achieving valid representations of intra-attitudinal structures is, of course, that the set of beliefs for which different structural models are tested, is content-valid. Several methods have been proposed for eliciting content-valid beliefs, some of them using individual representations, some of them using population-level representations (for reviews, Fishbein & Ajzen, 1975; Jaccard, Radecki, Wilson & Dittus, 1995). In the design of Study 1 (see Chapter 6.2, below), a three-step procedure was chosen that closely followed Fishbein and Ajzen's (1975) modal set approach.

In a first step, individual-level belief sets were elicited from a representative sample of individuals from the target populations in individual face-to-face interviews, using Reynolds and Gutman's (1984, 1988) laddering method. In a second step, a content analysis was conducted on the data, mapping the individual belief sets onto a common set of categories. In a third step, category frequencies were computed across individuals, and beliefs were selected as "modal" when their frequencies exceeded a certain cut-off value.

From an economics-of-data-collection perspective, the modal-set approach has the advantage of yielding a limited set of beliefs that are easily transformed into questionnaire items. From a validity-of-representation perspective, it retains the key advantage of free elicitation methods, that is, that the resulting belief set contains only beliefs that were actually generated by members of the target population, and not constructed ad-hoc by researchers. However, the procedure selects only such beliefs that have a high frequency after aggregation over individuals. In a strict sense, this eliminates the possibility of investigating whether purely idiosyncratic belief sets are associated with a given attitude (for detailed discussions, see Grunert & Grunert, 1995; Jaccard *et al.*, 1995; Van der Pligt & Vries, 1998).

Two points can be made to qualify this restriction. Firstly, complete non-overlap of individual belief sets would result in a flat across-individuals distribution. In other words, there would be no modal beliefs to identify in the first place. Secondly, early social cognition research has shown that idiosyncratic belief systems typically evolve when individuals receive highly heterogeneous information at the time they form an attitude (Edwards & Ostrom, 1971). As argued before, such heterogeneity is implausible in the case of the information European consumers received about GM foods.

5.3.4. Algebraic Structure of Models of Inter-attitudinal Structure

Directionality in inter-attitudinal structures can be specified in a very straightforward manner within the structural equation-modeling framework used here. In line with the theoretical model outlined in Chapter 3.5, general socio-political attitudes can be assumed to pre-exist in an individual, be highly stable, and therefore exogenous to the relationships between attitudes on lower levels of generality. Using the structural model defined in Equation 5.3, we can therefore specify the general algebraic structure as

$$\boldsymbol{\eta} = \mathbf{B}\boldsymbol{\eta} + \boldsymbol{\Gamma}\boldsymbol{\xi} + \boldsymbol{\zeta}, \tag{5.24}$$

where the latent endogenous factors $\boldsymbol{\eta}$ stand for the lower-level attitudes, the latent exogenous factors $\boldsymbol{\xi}$ stand for the more general, higher-level attitudes, and $\mathbf{B}$ and $\boldsymbol{\Gamma}$ are matrices of regression coefficients measuring the structural consistency between them. If two levels of endogenous variables are distinguished, the model becomes a completely mediated model of the form[7]

[7] For the sake of simplicity, we have omitted the mean structure and multi-sample indexing from the model. These can be easily added again using the specification in Equation 5.3 (see above).

$$\boldsymbol{\eta}_a = \boldsymbol{\Gamma\xi} + \boldsymbol{\zeta}_a \text{ and } \boldsymbol{\eta}_b = \mathbf{B}\boldsymbol{\eta}_a + \boldsymbol{\zeta}_b, \tag{5.25}$$

If it is possible to decide a-priori which attitudes are mediators $\boldsymbol{\eta}_a$ and which attitudes are "truly" dependent factors $\boldsymbol{\eta}_b$, standard tests of mediation can be applied (e.g., Judd & Kenny, 1981) because the models that are to be compared can be hierarchically nested.

If, however, two different sequences of exogenous factors, mediators and dependent factors are to be compared and the variables exchange their position, that I,s the dependent factors in the first model become the mediators in the second model, and the mediators in the first model become the dependent factors in the second model, this is not possible any more because the models are not hierarchically nested (MacCallum, Wegener, Uchino & Fabrigar, 1993; Williams, Bozdogan & Aiman-Smith, 1996). In these situations, methods for non-hierarchical model comparisons have to be used, as discussed in Chapter 5.2.4 (Bozdogan, 1987; example applications can be found in Brunsø, Scholderer & Grunert, 2004; Scholderer, Brunsø & Grunert, 2002).

5.4. Generalizing over Different Populations

The three studies reported later will use cross-cultural designs, involving samples drawn from different consumer populations within the European Union. Although the focus of the present analysis is not on cross-cultural differences in consumer attitudes towards GM foods (which might well become a research area in its own right), designs involving multiple populations pose methodological difficulties.

5.4.1. Potential Biases in Measurement across Populations

The basic problem is the following: suppose we have collected measurements of an observed variable x in two consumer populations A and B and are interested in differences between the expected values of x. A direct test of the hypothesis $\mu_x^A - \mu_x^B = 0$ would rest on the assumption that, in both populations, x measures an underlying quantity ξ on a common interval scale f: $x = \tau + \lambda\xi$ with invariant location and scale parameters τ and λ such that differences in ξ can be meaningfully inferred from differences in x (Krantz, Luce, Suppes & Tversky, 1971). When populations A and B are different cultures, and the observed variable x is a questionnaire item, it becomes unreasonable to simply assume a common interval scale for responses on x. Different languages may imply differences in the semantics of item wording or response category labels, so that the existence of systematically biased location parameters τ^A and τ^B (additive bias) and scale parameters λ^A and λ^B (multiplicative bias) has to be considered.

Explicit treatment of such biases requires the use of an appropriate psychometric model. Two major frameworks have been used in this context: analysis of differential item functioning in item response theory (Lord & Novick, 1968; Muthén & Lehman, 1985), and multi-sample models in confirmatory factor analysis (see Chapter 5.2, above; Jöreskog, 1971; Sörbom, 1974). Common to both frameworks is that they specify a latent trait structure, which allows the researcher to utilize responses to other items as additional information on the underlying quantity that is to be measured, and based on that, in turn, to draw conclusions about the unique characteristics of a particular item. As structural equation modeling is used throughout the present work as a statistical model, we shall use its framework here too.

5.4.2. A Hierarchical Approach to Invariance Testing

Multi-sample confirmatory factor analysis with structured means is a sub-model of the general framework presented above. The model is defined in Equation (5.2) as the measurement model of the exogenous variables in a structural equation model. Across groups, the measurement model can be invariant with respect to each of its parameter matrices $\boldsymbol{\tau}^g$, $\boldsymbol{\Lambda}^g$, $\boldsymbol{\Phi}^g$, $\boldsymbol{\Theta}^g$, and $\boldsymbol{\kappa}^g$. Steenkamp and Baumgartner (1998) have proposed a hierarchical model comparison procedure for such situations, distinguishing between six consecutive levels of measurement invariance:

- *Configural invariance*. The pattern of zero and non-zero factor loadings is assumed to be invariant across groups $g = 1, 2, \ldots G$. Configural invariance implies that the same underlying constructs are measured in all groups.

- *Metric invariance*. The factor loadings are assumed to be invariant across groups *g*, implying the additional constraint $\Lambda^1 = \Lambda^2 = ... = \Lambda^G$. Metric invariance implies that the observed variables are measured according to the same scale units.
- *Scalar invariance*. Factor loadings and intercept terms are assumed to be invariant across groups *g*, implying the additional constraint $\tau^1 = \tau^2 = ... = \tau^G$. Scalar invariance implies that the observed variables are measured according to the same scale units and scale locations (i.e., on common interval scales).
- *Factor covariance invariance*. Factor loadings, intercept terms and factor covariances are assumed to be invariant across groups *g*, implying the additional constraint $\phi_{mn}{}^1 = \phi_{mn}{}^2 = ... = \phi_{mn}{}^G$ for all factors *m*, *n* ($m \neq n$). Factor covariance invariance implies that interrelationships among the underlying constructs are the same across samples.
- *Factor variance invariance*. Factor loadings, intercept terms, factor covariances and factor variances are assumed to be invariant across groups *g*, implying the additional constraint $\phi_{mm}{}^1 = \phi_{mm}{}^2 = ... = \phi_{mm}{}^G$ for all factors *m*. Factor variance invariance implies that variability of the underlying constructs is the same across samples.
- *Error variance invariance*. Factor loadings, intercept terms, factor covariances, factor variances and error variances are assumed to be invariant across groups *g*, implying the additional constraint $\theta_{pp}{}^1 = \theta_{pp}{}^2 = ... = \theta_{pp}{}^G$ for all items *p*. Error variance invariance implies that the item reliabilities are the same across samples.

Of particular interest is a measurement model where factor loadings and intercept terms are invariant across groups *g*, satisfying the constraints

$$\tau^1 = \tau^2 = ... = \tau^G , \tag{5.26}$$

$$\Lambda^1 = \Lambda^2 = ... = \Lambda^G . \tag{5.27}$$

Imposed on Equation (1), the constraints define a congeneric measurement model (Lord & Novick, 1968) with group-invariant location (Eq. 5.26) and scale (Eq. 5.27) parameters. If the constraints hold, the observed variables $\mathbf{x}^g$ are measured on common interval scales and can be meaningfully compared across groups (Meredith, 1995; Rock, Werts & Flaugher, 1978). Hence, data should only be pooled if the constraints hold. Experience shows that this is hardly ever the case in cross-cultural sets of consumer attitude data (e.g., Scholderer, Brunsø, Bredahl & Grunert, 2004). Hence, we shall be very careful here and use multi-sample models with as few across-group constraints as possible, especially when the model structure is not entirely known yet.

In full structural equation models, a number of additional parameter matrices can be invariant as well. In analogy to the measurement invariance approach suggested by Steenkamp and Baumgartner (1998), three additional invariance levels can be formulated on the level of the structural model (cf. Scholderer & Grunert, 2001)

- *Regression invariance*. In addition to invariance of all measurement model parameters, the regression coefficients $\mathbf{\Gamma}$ and $\mathbf{B}$ are assumed to be invariant across groups *g*, implying the additional constraints $\mathbf{\Gamma}^1 = \mathbf{\Gamma}^2 = ... = \mathbf{\Gamma}^G$ and $\mathbf{B}^1 = \mathbf{B}^2 = ... = \mathbf{B}^G$. Regression invariance implies that the structural relationships between the exogenous and endogenous factor as well as among the endogenous factors are invariant across populations.
- *Covariance structure invariance*. In addition to invariance of all measurement model parameters and regression coefficients, the covariance matrix of equation errors $\mathbf{\Psi}$ is assumed to be invariant across groups *g*, implying the additional constraint $\mathbf{\Psi}^1 = \mathbf{\Psi}^2 = ... = \mathbf{\Psi}^G$. Covariance structure invariance implies that predictive validity of the model is invariant across groups.
- *Identity*. In addition to invariance of all measurement model parameters, regression coefficients, and covariances of equation errors, the vectors $\boldsymbol{\kappa}$ of exogenous latent factor means and $\boldsymbol{\alpha}$ of structural equation intercepts is assumed to be invariant across groups *g*, implying the additional constraints $\boldsymbol{\kappa}^1 = \boldsymbol{\kappa}^2 = ... = \boldsymbol{\kappa}^G$ and $\boldsymbol{\alpha}^1 = \boldsymbol{\alpha}^2 = ... = \boldsymbol{\alpha}^G$. Identity implies that there are no model differences between groups.

6. Study 1: Intra- and Inter-attitudinal Structure

The aim of Study 1 was to assess the intra- and inter-attitudinal structure of consumer attitudes towards genetically modified foods. In the following, we will first detail the research questions and hypotheses to be investigated in the study. Then, qualitative pilot research will be reported that was conducted to identify a content-valid set of beliefs held by European consumers about the risks and benefits associated with GM foods. After this, we will explain design and data collection of a large, cross-national attitude survey that was conducted in order to quantitatively assess these beliefs and their interrelationships with global evaluations of genetic modification of foods as well as with more general socio-political attitudes. The data will then be analyzed by means of structural equation modeling, evaluating the hypotheses detailed in the beginning. Finally, results will be discussed and preliminary conclusions will be drawn.

6.1. Research Questions and Hypotheses

In Chapter 2 (see above), existing research on the attitudes of European consumers towards genetically modified foods was reviewed. One of the central conclusions from the review was that, in virtually all previous investigations, ad-hoc assumptions had been made concerning the internal structure of these attitudes as well as the particular way they are embedded into larger attitude systems.

Concerning intra-attitudinal structure, these studies tended to assume that consumers' overall attitudes towards genetically modified foods are based on a risk-benefit trade-off (e.g., Bredahl, 2001; Gaskell, Allum, Wagner, Kronberger, Torgersen, Hampel, & Bardes, 2004; Hampel, 1999; Saba, Rosati & Vassallo, 2000; Saba & Vassallo, 2002; Siegrist, 1999, 2000; Sparks, Shepherd & Frewer, 1995), consistent with models of rational decision-making (Keeney & Raiffa, 1976) as well as belief-based models of intra-attitudinal structure (Fishbein, 1963). As shown in the theoretical reconstruction in Chapter 3, such models imply directionality in the internal structure of an attitude. The implied directionality in risk-benefit trade-off models is compositional or *bottom-up*, that is, an aggregate evaluation of the technology is formed from a set of distinct beliefs about risks and benefits associated with particular applications of the technology.

Concerning inter-attitudinal structure, many other studies (and sometimes even the same) assumed that consumer attitudes towards genetically modified foods are influenced by general socio-political attitudes of a higher order of generality, including attitudes towards modern technology, attitudes towards environment and nature, and trust in the institutions that regulate emerging technologies and manage their risks (Bredahl, 2001; Frewer, Howard, Hedderley & Shepherd, 1997; Frewer, Howard & Shepherd, 1997; Frewer, Shepherd & Sparks, 1996; Hamstra, 1991, 1995; Siegrist, 1998, 1999, 2000; Sparks, Shepherd & Frewer, 1994). As argued in Chapter 3, such assumptions about the embeddedness of an attitude into a larger system of higher-order socio-political attitudes imply directionality as well. The directionality implied in systems models of attitudes is reflective or *top-down*, that is, a global evaluation of the technology emerges as a specific instantiation of other, even more general attitudes, in a new context.

The bottom-up and the top-down structures are not mutually exclusive – social psychological research has long ago demonstrated that it is perfectly possible for an individual to have a multitude of evaluations associated with the same attitude object (Fazio, 1986, 1989). Some of these object-evaluation associations may be bottom-up, some of these may be top-down. The particular "mixture" of bottom-up and top-down associations that constitutes an overall attitude at a given time depends on the pattern of activation that occurs within the system of cognitively represented object-evaluation associations in a given situation. As discussed in Chapter 3, however, certain classes of object-evaluation associations can be assumed to dominate over others.

In particular, it is nearly impossible for European consumers to have personal experience with genetically modified foods. In the EU, only two foods have ever been marketed (and only for brief periods in the mid-1990s; see Chapter 1) that were labeled at the time as containing genetically modified ingredients. Since GM foods are not at all labeled in those markets where they are generally available (such as the US), it is not possible for European consumers to have acquired discriminative experience with these products while being abroad either. Hence, personal experience with the attitude object – generally regarded as the strongest determinant of bottom-up attitude formation processes (Fazio, 1989; Fazio & Zanna, 1981) – can be excluded as a source of accessible bottom-up associations between the attitude object and a set of evaluations.

In the absence of personal or vicarious experience with actual products containing genetically modified ingredients, we therefore expect that all beliefs European consumers hold about the risks and benefits of genetically modified foods *must* be derived from more general attitudes, following a top-down evaluation process. In order to make this general prediction testable based on attitude-survey data, we will utilize the structural equation-modeling framework outlined in Chapter 5. Four specific research questions will be focused on in this analysis: the directionality of intra-attitudinal structures, the dimensional complexity of intra-attitudinal structures, the directionality of inter-attitudinal structures, and the strength of the whole attitude system.

6.1.1. Directionality of Intra-attitudinal Structures

The first research question to be investigated in Study 1 is concerned with the directionality of intra-attitudinal structures: we will test whether the interrelationships among a set of beliefs consumers hold about the risks and benefits of genetically foods can be better represented by top-down or bottom-up models of intra-attitudinal structure. Top-down intra-attitudinal structures will be specified as reflective, factor-analytic measurement models, where each belief within a set of heterogeneous beliefs is defined as a function of one or more common, underlying factors (Figure 6.1, left panel). These factors will be understood as *heuristic evaluations*.

The hypothesized top-down model of intra-attitudinal structure will compete against an alternative model of intra-attitudinal structure, incorporating bottom-up structures. Bottom-up intra-attitudinal structures will be specified as formative, MIMIC-type measurement models, where one or more composite factors are defined as

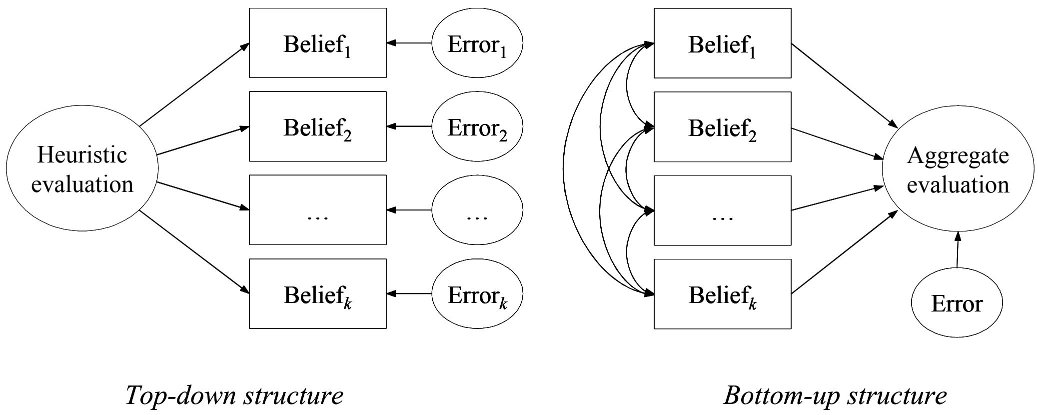

Figure 6.1. Alternative models of directionality in intra-attitudinal structure to be compared in Study 1.

functions of an underlying set of heterogeneous beliefs (Figure 2.1, right panel). These factors will be understood as *aggregate evaluations*.

The two competing structures cannot be formulated as a sequence of hierarchically nested models. Hence, information-theoretic measures (see Chapter 5.2.4) will be used for evaluating the first hypothesis:

- *Hypothesis 1:* The interrelationships among a set of content-valid measures of consumers' beliefs about the risks and benefits of genetically modified foods can be better represented by a reflective, factor-analytic measurement model (operationalizing a top-down structure based on heuristic evaluations) than by a formative, MIMIC-type measurement model (operationalizing a bottom-up structure resulting in aggregate evaluations).

6.1.2. Dimensional Complexity of Intra-attitudinal Structures

The above research question and corresponding hypothesis concerned the directionality of intra-attitudinal structures (top-down versus bottom-up), but left the number of evaluative dimensions unspecified. Hence, the second research question to be investigated in Study 1 is how many evaluative dimensions are required to represent the intra-attitudinal structure underlying consumer's beliefs about risks and benefits associated with GM foods.

Theoretically, the structure with the lowest possible complexity is a model where only one global evaluative dimension is the underlying heuristic of (in case of a top-down structure) or the aggregate evaluation formed by (in case of a bottom-up structure) all beliefs consumers hold about risks and benefits of genetically modified foods. The structure with the highest possible complexity is one where each belief operates as its own evaluative dimension, i.e. no global evaluation factor intervenes in either of the directions between the set of beliefs and a set of relevant criterion variables. Between the extremes of lowest and highest complexity, a large number of models can be formulated that exhibit medium degrees of complexity.

In addition to the lowest-complexity model (one global evaluative dimension, risk versus benefit) and the highest-complexity model (each belief its own evaluative dimension), we will evaluate two dimensionalities that can be formulated a priori: a model with two global evaluative dimensions (risk, benefit) and a model with four evaluative dimensions (risk arising from genetic modification as a process, risk arising from genetically modified products, benefit arising from genetic modification as a process, benefit arising from genetically modified products).

In line with previous research that utilized explorative modeling techniques (e.g., Bredahl, 2001; Hamstra, 1991; Midden *et al.*, 2002; Saba & Vassallo, 2002) we expect relatively low dimensionality. In particular, it appears from these studies that a two-dimensional model, operationalizing positive valence (benefit) and negative valence (risk), respectively, may be the most appropriate representation. Furthermore, based on the results of Kerlinger's (1984) analysis, such two-dimensionality can be expected in aggregate analyses of belief sets even though the underlying evaluation may be uni-dimensional for each individual (see Chapter 3.2.3). Hence, the following hypothesis can be formulated concerning the dimensionality of intra-attitudinal structures:

- *Hypothesis 2:* The interrelationships among a set of content-valid measures of consumers' beliefs about the risks and benefits of genetically modified foods can be better represented by two-dimensional model, operationalizing separate evaluative dimensions with positive valence (benefit) and negative valence (risk), respectively, than by models of higher or lower complexity.

Directionality and dimensionality cannot be assessed independently. Therefore, Hypothesis 2 can only be tested in conjunction with Hypothesis 1. Top-down as well as bottom-up models will be formulated for each dimensionality and evaluated by means of information-theoretic measures for non-hierarchical model comparisons. The decision for the model that best represents the data will therefore provide a test of Hypothesis 1 as well as Hypothesis 2.

6.1.3. Directionality of Inter-attitudinal Structures

The first two research questions were concerned with intra-attitudinal structure. The third research question to be investigated in Study 1 will focus on inter-attitudinal structure, examining the way consumer attitudes towards genetically modified foods are embedded into a larger system of more general socio-political attitudes. Specifically, we will examine the directionality in this system of attitudes. In previous research, the various authors who have investigated inter-attitudinal structures have without exception assumed that the directionality in the system has the following structure: general socio-political attitudes influence separate global evaluations of the risk and benefit of genetically modified foods, which then are re-aggregated to form an overall evaluation of the technology (Bredahl, 2001; Gaskell *et al.*, 2004; Hampel, 1999; Midden *et al.*, 2002; Siegrist, 2000).

In terms of levels of generality, such a system proceeds from a level of high generality to a level of low generality, but then up again to a level of medium generality (top-down and up-again). In all cases, this structure has been specified on a-priori grounds following the pervasive assumption that a risk-benefit trade-off underlies consumers' overall attitude towards genetically modified foods (see above). No tests have been reported in the literature that would indicate whether this is indeed the true model structure or not.

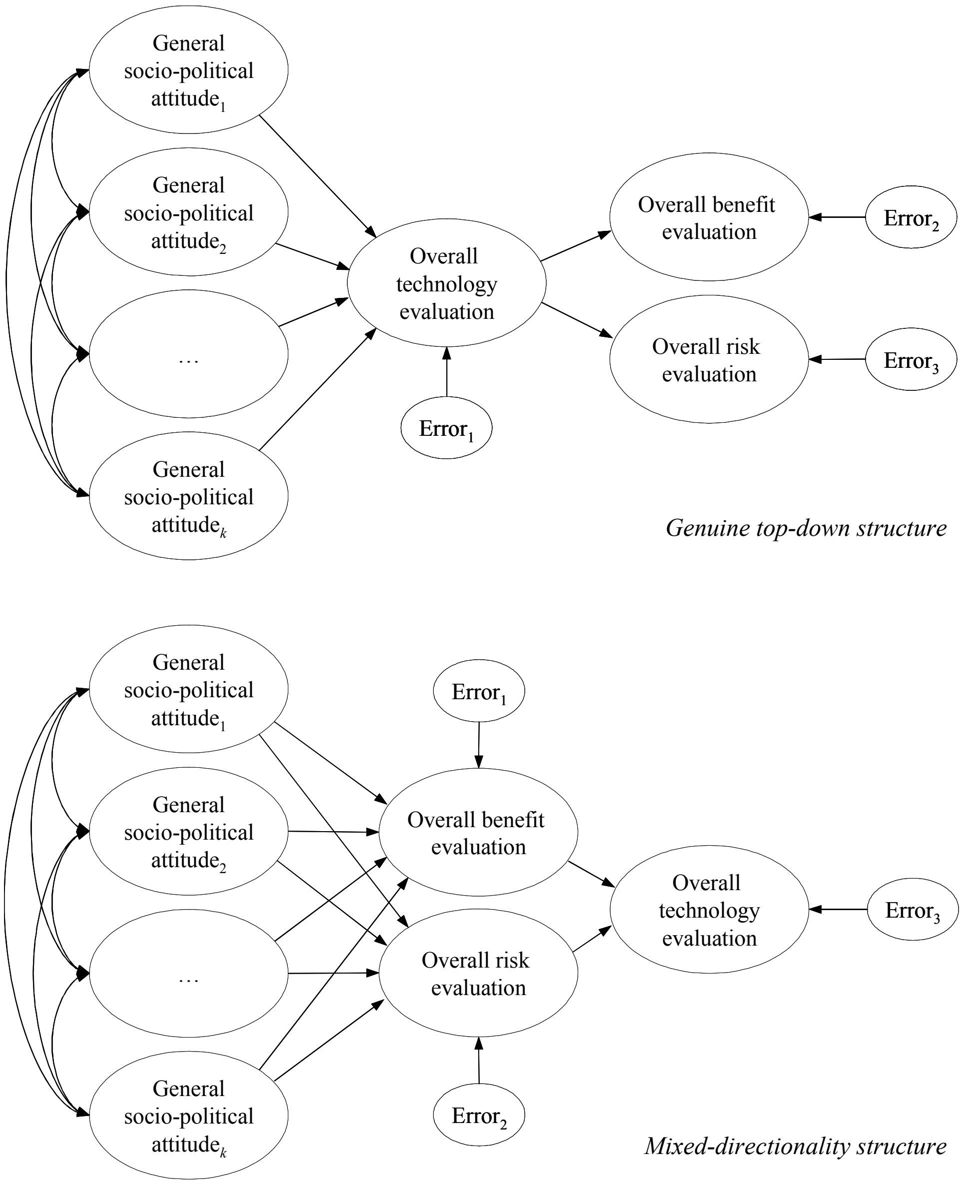

Figure 6.2. Alternative models of directionality in inter-attitudinal structure to be compared in Study 1.

Hence, the third research question to be investigated in this study is whether the mixed-directionality assumption made in previous research is correct (Figure 6.2, lower panel), or whether a genuine, unconditional top-down structure will represent the data better (Figure 6.2, upper panel). In line with previous research (Bredahl, 2001; Frewer *et al.*, 1996; Frewer *et al.*, 1997; Hamstra, 1991, 1995; Siegrist, 1998, 1999, 2000; Sparks *et al.*, 1994), the present analysis will include attitudes toward environment and nature, attitudes towards modern technology, and social trust (i.e. trust in the institutions that regulate emerging technologies and manage their risks) as general socio-political attitudes. These will be defined as exogenous factors in all models of inter-attitudinal structure. Based upon this, two competing structural model will be specified.

The first candidate model will be a genuine top-down model, where, in first layer, paths are specified from consumers' general socio-political attitudes to their global evaluation of GM foods as a technology, and then, in a second layer, from the overall technology evaluation to global risk and benefit evaluations. In this model, all effects of general socio-political attitudes on risk and benefit evaluations are assumed to be completely mediated by consumers' overall technology evaluation. No risk-benefit trade-off is assumed to occur.

The second candidate model will have a mixed-directionality structure, where, in the first layer, paths are specified from consumers' general socio-political attitudes to their global risk and benefit evaluations, and then, in a second layer, from global risk and benefit evaluations to their overall technology evaluation. In this model, all effects of general socio-political attitudes on consumers' overall technology evaluation are assumed to be completely mediated by their risk and benefit evaluations. In other words, consumers' overall evaluation of the technology is assumed to be formed through a risk-benefit trade-off.

Like before, the competing structures cannot be formulated as a sequence of hierarchically nested models. Hence, information-theoretic measures will also be used again for evaluating the third hypothesis:

- *Hypothesis 3:* The interrelationships between consumers' general socio-political attitudes, their global evaluations of GM foods as a technology, and their global evaluations of the risks and benefits of GM foods can be better represented by a genuine top-down model (no risk benefit trade-off) than by a mixed-directionality model (including a risk-benefit trade-off).

6.1.4. Attitude Strength

The final research question to be investigated in Study 1 is concerned with the structural consistency and strength of the attitude system formed by general socio-political attitudes and attitudes towards genetically modified foods. As discussed in Chapter 3.4, the literature is somewhat ambiguous about this issue. One the one hand, research in the risk perception area (Earle & Cvetkovich, 1995; Siegrist & Cvetkovich, 2000) suggests that top-down processes in attitude systems may serve as substitutes for more accurate, information-based judgments of the overall risks and benefits of a technology in situations where an individual does not possess enough information about the technology to be judged.

The hypothesis reflects a more general point made in classical treatments of attitude functions, namely that certain types of attitudes may have a knowledge function (Katz, 1960) that enables an individual to evaluate a novel attitude object by way of categorizing it as a special instance of a broader class of attitude objects for which evaluations already exist (Fiske & Neuberg, 1990; see Chapter 3). If the assumption were correct and applicable to the present case, we would expect that consumers with more factual knowledge about food science in general, and food biotechnology in particular, should rely less on top-down processes to arrive at their overall evaluations of genetically foods than less knowledgeable individuals. In other words, the attitude system formed by the interrelationships between general socio-political attitudes and attitudes to GM foods should be structurally less consistent and therefore weaker when factual knowledge is higher.

On the other hand, theoretical analyses of attitude strength (Abelson & Prentice, 1989; Eagly & Chaiken, 1995) suggest that attitudes which are firmly embedded in a larger system of higher-order attitudes and values gain strength through the very fact of being embedded in such system. Again, this reflects a notion that can be found in classical treatments of attitude functions, namely that attitudes may have a value-expressive function (Katz, 1960; Rokeach, 1968; Sherif, 1980) that allows an individual to maintain a consistent self-concept by aligning attitudes towards novel objects with other attitudes that are strongly endorsed by the individual. If this assumption were correct and applicable to the present case, we would expect that those individuals who rely more on top-down processes to arrive at their overall evaluations of genetically foods, should also have more confidence in their own ability to pass a judgment on the issue of GM foods. Otherwise, inconsistency with higher-order attitudes would become apparent, threatening the integrity of the self-concept (Gross, Holtz & Miller, 1995).

The two assumptions do not yield mutually exclusive predictions. Hence, two independent hypotheses can be formulated about the consequences that each of these assumptions would have on the structural consistency and strength of the attitude system: is the system consistent with the assumptions of a knowledge function, or with the assumptions of a value-expressive function, or both. In operational terms, the hypotheses can be stated as follows:

- *Hypothesis 4*: The degree to which overall evaluations of genetically modified foods are determined by general socio-political attitudes is higher among consumers with lower factual knowledge than among consumers with higher factual knowledge.

- *Hypothesis 5*: The degree to which overall evaluations of genetically modified foods are determined by general socio-political attitudes is higher among consumers with higher confidence in their own ability to make judgments about GM food than among consumers with lower confidence in their own ability to make such judgments.

6.2. Pilot Research

Pilot research[8] was carried out in summer 1998 to identify a content-valid set of modal beliefs (Fishbein & Ajzen, 1975). Altogether, 400 laddering interviews (Reynolds & Gutman, 1988) were conducted with regular beer and yoghurt consumers in Denmark, Germany, Italy, and the United Kingdom, including 50 interviews per product category in each country. In the beer sample, quotas were imposed on consumption

[8] The pilot study has already been published in detail in Bredahl (1998, 1999) and Scholderer, Balderjahn, Bredahl and Grunert (1999). Hence, only those parts of the research will be reported here that have direct relevance for the design of Study 1 (see Chapter 2 for a review of the overall results of the study).

frequency (with extreme consumers excluded), education, and gender. In the yoghurt sample, quotas were imposed on consumption frequency, education, and presence of children in the household. All yoghurt respondents were the main food shoppers in their households.

Four product profiles were developed for each product category. The yoghurt products varied with respect to fat content, production method, presence of additives, and texture:

- Traditional full-fat whole-milk yoghurt without additives, described as having "a nice taste and smooth texture",
- Traditional low-fat skim-milk yoghurt without additives, described as having "a nice taste and thin texture",
- Fat-free yoghurt containing stabilizers and antioxidants, described as having "a nice taste and smooth texture", and
- Fat-free yoghurt produced with genetically modified starter cultures, described as having "a nice taste and smooth texture".

The beer products varied with respect to production method, energy consumption/ environmental friendliness, quality of raw materials, and price:

- Beer produced in a traditional way from high quality raw materials, sold at a medium price,
- Beer produced in a traditional way from standard quality raw materials, sold at a low price,
- 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 friendly, sold at a high price, and
- Beer produced by means of genetically modified yeast, ensuring reductions in time and energy expenditure during the production process, and thus more environmentally friendly, sold at a low price.

The benefits related to the 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 engineering 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 more realistic, the beer products were given brand names ("Classic" for the traditional, medium-price beer, "Economy" for the traditional, low-price beer, "Hi-tech" for the beer produced by unspecified modern process technology, and "Green" for the genetically modified beer). The yoghurts were kept as no-name products. All products were used for visual presentation only.

In the first part of the interview, the participants were asked to rank the products according to preference and give their reasons for this ranking. In the second part, these salient attributes were used as starting points for the laddering procedure. Reverse laddering was used in cases where abstract attributes or consequences were mentioned initially. The interviewers listed the resulting ladders in standardized forms. In addition, all interviews were tape-recorded for subsequent quality checks. Altogether, 2187 ladders were extracted from the yoghurt interviews and 1874 from the beer interviews.

After completion of the fieldwork, the Danish laddering data were categorized into attributes, consequences, and values. By thorough meaning-based interpretation of all individually mentioned concepts, the data were then coded into broader categories. The procedure was carried out separately for the beer and yoghurt data. The resulting categories were translated and applied to the German, British, and Italian data. Additional categories were added when necessary. All codes were finally checked and synchronized across countries, resulting in a 60-category system for the yoghurt data and a 61-category system for the beer data. Modal beliefs about risks and benefits of genetically modified foods were then identified by selecting the fifteen consequences that were most often associated with the attribute “genetically modified”. These included beliefs about product-related benefits, beliefs about benefits arising from genetic modification of foods as a general technology, beliefs about product related risks, as well as beliefs about risks arising from genetic modification of foods as a technology:

- “Genetically modified food products will improve the standard of living of 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”,
- “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 foods”,
- “Applying gene technology in food production is a necessary activity”,
- “Applying gene technology in food production will only benefit the producer”,
- “Genetically modified food products will cause allergy in human beings”,
- “Genetically modified food products are a threat to human health”,
- “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”, and
- “Applying gene technology in food production is unnatural”.

These beliefs were then transformed into questionnaire items that could be used in a standardized consumer survey (see below).

6.3. Method

6.3.1. Participants and Procedure

In November and December 1998, altogether *N* = 2031 consumers from Denmark, Germany, Italy, and the United Kingdom participated in an attitude survey. Within each of the four countries, half of the participants were sampled at random from nationally representative panels of beer consumers. The other half of the respondents was sampled at random from nationally representative panels of yoghurt consumers[9]. Demographic characteristics of the participants are shown in Table 6.1.

Danish, German, and Italian respondents were personally interviewed at home. UK respondents were interviewed at central research facilities. Before the actual interviews started, respondents received an information sheet providing a common definition of the term “gene technology” (see Appendix 1), making sure that the same attitude object would be evaluated by all respondents. After respondents had read the definition and indicated they had fully understood its content, they were asked to fill in the first part of the questionnaire. This first part consisted of 15 items measuring specific beliefs about gene technology in food production, 9 items measuring overall evaluations of gene technology in food production, and altogether 21 items measuring other, more general socio-political attitudes (see below). None of the items asked as yet about specific products.

After respondents had completed the first part of the questionnaire, they received an information sheet describing one out of two genetically modified example products. For beer consumers, the example product was a fictitious lager brand produced by means of genetically modified yeast. For yoghurt consumers, the example product was a fictitious fat-free yoghurt brand produced by means of genetically modified starter cultures.

---

[9] Data collection in the four countries was subcontracted to local market research institutes maintaining nationally representative consumer panels for all major product categories.

Table 6.1. Demographic characteristics of Study 1 participants.

	Country				
Variable	Denmark	Germany	Italy	UK	Total
Sample Size					
Total *N*	505	516	511	499	2031
Beer consumers	255	258	255	249	1017
Yoghurt consumers	250	258	256	250	1014
Age					
Total *M (SD)*	44.53 (16.57)	44.04 (16.33)	36.46 (13.84)	38.43 (13.19)	40.91 (15.48)
Beer consumers	43.98 (17.44)	44.92 (15.36)	35.90 (13.28)	37.65 (12.12)	40.68 (15.23)
Yoghurt consumers	45.09 (15.64)	43.17 (17.23)	37.00 (14.38)	39.21 (14.17)	41.14 (15.74)
Sex					
Total *% female (male)*	46.3 (53.7)	43.1 (56.9)	50.4 (49.6)	59.4 (40.6)	49.7 (50.3)
Beer consumers	33.2 (66.7)	28.0 (72.0)	40.0 (60.0)	26.7 (73.3)	32.0 (68.0)
Yoghurt consumers	59.5 (40.4)	58.1 (41.9)	60.9 (39.1)	91.9 (8.1)	67.6 (32.4)
Family status					
Total *% single (cohabit.)*	30.6 (69.4)	35.7 (64.3)	41.2 (48.8)	25.7 (74.3)	33.3 (66.7)
Beer consumers	31.7 (68.3)	31.7 (68.3)	40.2 (59.8)	28.0 (72.0)	32.9 (67.1)
Yoghurt consumers	29.4 (70.6)	39.6 (60.4)	42.3 (57.7)	23.4 (76.6)	33.6 (66.4)
Household size					
Total *Median (Min, Max)*	2 (1, 6)	2 (1, 8)	4 (1, 6)	3 (1, 8)	3 (1, 8)
Beer consumers	2 (1, 6)	2 (1, 8)	4 (1, 6)	3 (1, 7)	3 (1, 8)
Yoghurt consumers	2 (1, 6)	2 (1, 6)	4 (1, 6)	3 (1, 8)	3 (1, 8)

After having read the information materials, participants were asked to fill in the second part of the questionnaire, containing a larger number of items concerned with attitudes towards the product examples. This part of the survey has already been published in detail in Bredahl (2001). Hence, no further analyses will be reported here concerning the product-specific parts of the survey.

6.3.2. Belief Measures

The set of fifteen modal beliefs identified in the pilot study was used to assess consumers' beliefs about specific risks and benefits associated with genetically modified foods. Based on the classification by Bredahl, Grunert and Frewer (1998), such beliefs can be grouped into four sets: (PB) product-related benefit beliefs, (CB) process-related benefit beliefs, (PR) product-related risk beliefs, and (CR) process-related risk beliefs. Each belief was transformed into a questionnaire item, answered on a seven-point scale ranging from "strongly disagree" to "strongly agree".

Product-related benefit beliefs. Participants' beliefs about the benefits of product innovations developed by means of gene technology were measured by four items: (PB1) "Genetically modified food products will improve the standard of living of the future generations", (PB2) "Genetically modified food products will increase my own and my family's standard of living", (PB3) "Genetically modified food products are healthier than other food products", and (PB4) "Genetically modified food products are better quality foodstuffs than other food products".

Process-related benefit beliefs. Participants' beliefs about the benefits of gene technology as a process innovation in food production were measured by five items: (CB1) "Applying gene technology in food production will increase the product choice in supermarkets", (CB2) "Applying gene technology in food production can be used to solve environmental problems", (CB3) "Applying gene technology in food production will reduce the price of food products", (CB4) "Applying gene technology in food production is a necessary activity", and (CB5) "Applying gene technology in food production will only benefit the producer" [-][10].

Product-related risk beliefs. Participants' beliefs about the risks of product innovations developed by means of gene technology were measured by four items: (PR1) "Genetically modified food products will cause allergy in human beings", and (PR2) "Genetically modified food products are a threat to human health".

---

[10] [-] indicates a negatively formulated item.

Table 6.2. Means and standard deviations of specific belief measures.

Variable	Country				
	Denmark *M (SD)*	Germany *M (SD)*	Italy *M (SD)*	UK *M (SD)*	Total *M (SD)*
Product-related benefit beliefs					
PB1	3.12 (1.93)	3.54 (1.80)	3.92 (1.73)	3.73 (1.60)	3.58 (1.79)
PB2	2.73 (1.73)	2.66 (1.73)	3.78 (1.65)	3.43 (1.55)	3.15 (1.73)
PB3	2.23 (1.47)	2.30 (1.48)	3.50 (1.72)	3.12 (1.49)	2.79 (1.63)
PB4	2.53 (1.68)	2.76 (1.72)	3.51 (1.72)	3.19 (1.52)	3.00 (1.70)
Process-related benefit beliefs					
CB1	3.71 (2.05)	4.51 (1.78)	4.50 (1.78)	4.21 (1.60)	4.23 (1.84)
CB2	3.01 (1.86)	3.67 (1.81)	4.11 (1.67)	3.66 (1.61)	3.62 (1.78)
CB3	3.72 (2.05)	3.50 (1.90)	4.29 (1.84)	3.48 (1.60)	3.75 (1.88)
CB4	2.22 (1.67)	2.88 (1.84)	3.72 (1.81)	3.10 (1.64)	2.98 (1.82)
CB5	4.76 (1.97)	5.19 (1.75)	4.59 (1.79)	4.74 (1.67)	4.82 (1.81)
Product-related risk beliefs					
PR1	3.95 (1.77)	4.38 (1.78)	3.96 (1.73)	4.21 (1.49)	4.12 (1.70)
PR2	4.39 (2.04)	4.48 (1.90)	3.99 (1.73)	4.09 (1.64)	4.24 (1.84)
Process-related risk beliefs					
CR1	4.31 (1.98)	4.54 (1.74)	3.92 (1.74)	4.20 (1.60)	4.24 (1.78)
CR2	4.91 (1.86)	4.76 (1.66)	4.36 (1.65)	4.62 (1.60)	4.66 (1.71)
CR3	6.00 (1.60)	6.00 (1.41)	4.81 (1.81)	5.70 (1.42)	5.62 (1.64)
CR4	5.44 (1.99)	5.69 (1.67)	4.61 (1.92)	5.09 (1.76)	5.21 (1.88)

Process-related risk beliefs. Participants' beliefs about the risks of gene technology as a process innovation in food production were measured by five items: (CR1) "Applying gene technology in food production will cause environmental hazards", (CR2) "Genetically modified organisms are likely to interfere with wild species in nature", (CR3) "Nobody knows the long term consequences on the environment and human health of applying gene technology in food production", and (CR4) "Applying gene technology in food production is unnatural". Means and standard deviations are presented in Table 6.1.

6.3.3. Overall Evaluation Measures

In addition to the specific belief measures, three global evaluative constructs were used to assess the structure of respondents' attitudes towards gene technology in food production: (A) overall evaluation of genetically modified foods as a technology, (B) overall benefit evaluation, and (R) overall risk evaluation.

Overall technology evaluation. Respondents' overall evaluation of genetically modified foods as a technology was measured by three items: (A1) "Applying gene technology in food production is ...", to be answered on a seven-point scale ranging from "extremely bad" to "extremely good", (A2) "Applying gene technology in food production is ...", to be answered on a seven-point scale ranging from "extremely foolish" to "extremely wise", and (A3) "I am strongly ... applying gene technology in food production", to be answered on a seven-point scale ranging from "strongly against" to "strongly for".

Overall benefit evaluation. Respondents' overall benefit evaluation was measured by three items, each answered on seven-point scales ranging from "strongly disagree" to "strongly agree": (B1) "Overall, applying gene technology to produce food products will prove beneficial to the environment, myself and other people who are important to me", (B2) "Overall, applying gene technology to produce food products will offer great benefits to the environment, myself and other people who are important to me", and (B3) "Overall, applying gene technology to produce food products will prove advantageous to the environment, myself and other people who are important to me".

Overall risk evaluation. Respondents' overall risk evaluation was measured by another three items, again to be answered on seven-point scales ranging from "strongly disagree" to "strongly agree": (R1) "Overall, applying gene technology to produce food products involves considerable risk to the environment, myself and other people who are important to me", (R2) "Overall, applying gene technology to produce food products will prove harmful to the environment, myself and other people who are important to me", and (R3) "Overall, applying gene technology to produce food products will prove disadvantageous to the environment, myself and other people who are important to me". Means and standard deviations are presented in Table 6.3.

Table 6.3. Means and standard deviations of global evaluation measures.

Variable	Country				Total
	Denmark *M (SD)*	Germany *M (SD)*	Italy *M (SD)*	UK *M (SD)*	*M (SD)*
Overall technology evaluation					
A1	2.70 (1.57)	2.98 (1.64)	3.92 (1.66)	3.51 (1.52)	3.28 (1.67)
A2	2.70 (1.69)	3.08 (1.68)	3.83 (1.57)	3.54 (1.53)	3.33 (1.66)
A3	2.85 (1.74)	2.76 (1.70)	3.94 (1.74)	3.30 (1.57)	3.21 (1.75)
Overall benefit evaluation					
B1	2.82 (1.81)	3.03 (1.68)	3.80 (1.71)	3.57 (1.63)	3.33 (1.74)
B2	2.94 (1.71)	2.98 (1.74)	3.78 (1.59)	3.49 (1.56)	3.27 (1.69)
B3	2.82 (1.80)	3.05 (1.73)	3.86 (1.66)	3.56 (1.58)	3.36 (1.73)
Overall risk evaluation					
R1	2.98 (2.04)	4.79 (1.79)	4.06 (1.69)	4.30 (1.65)	4.44 (1.82)
R2	4.60 (2.01)	4.60 (1.81)	3.92 (1.70)	4.19 (1.64)	4.30 (1.81)
R3	4.50 (1.99)	4.72 (1.75)	4.06 (1.70)	4.44 (1.55)	4.44 (1.77)

6.3.4. General Socio-political Attitude Measures

To assess the degree to which respondents' attitudes towards genetically modified foods were embedded into a system of more general attitudes, a number of established instruments were adopted for the present study, including (AE) attitude towards environment and nature, (AT) attitude towards technology, and (ST) social trust. All items were answered on seven-point scales ranging from "strongly disagree" to "strongly agree".

Attitude towards environment and nature. Respondents' general attitude towards environment and nature was measured by six items from the "new environmental paradigm" scale by Dunlap and Van Liere (1978). Steger, Pierce, Steel and Lovrich (1989) report the abbreviated version to be as reliable as the complete scale. Thus, the items included in the present study were (AE1) "The balance of nature is very delicate and easily upset by human activities", (AE2) "The earth is like a spaceship with only limited room and resources", (AE3) "Plants and animals do not exist primarily to be used by humans", (AE4) "Modifying the environment for human use seldom causes serious problems", (AE5) "There are no limits to growth for nations like [Denmark/Germany/Italy/UK]" [-], and (AE6) "Mankind was created to rule over the rest of nature" [-].

Attitude towards technology. Respondents' general attitude towards modern technologies was measured by five items adapted from Hamstra (1991), including (AT1) "The degree of civilization of a people can be measured from the degree of its technological development", (AT2) "New technological inventions and applications make up the driving force of the progress of society", (AT3) "In [Denmark/Germany/Italy/UK] and in the rest of Europe we are probably better off than ever, thanks to the tremendous progress in technology", (AT4) "Throughout the ages, technological know-how has been the most important weapon in the struggle for life", and (AT5) "Because of the development of technology we will be able to face up to the problems of tomorrow's society".

Social trust. Respondents' general attitude towards the competence of actors and institutions regulating emerging technologies and managing their risks was measured by three items adapted from Frewer, Shepherd and Sparks (1994), including (ST1)

"Science is very knowledgeable about the use of gene technology in food production", (ST2) "The government is very knowledgeable about the use of gene technology in food production", and (ST3) "The industry is very knowledgeable about the use of gene technology in food production".

Table 6.4. Means and standard deviations of general socio-political attitude measures.

Variable	Country				Total
	Denmark *M (SD)*	Germany *M (SD)*	Italy *M (SD)*	UK *M (SD)*	*M (SD)*
Attitude towards environment and nature					
AN1	6.203 (1.257)	5.991 (1.349)	5.452 (1.669)	5.521 (1.397)	5.764 (1.470)
AN2	5.499 (1.691)	5.669 (1.604)	4.675 (1.824)	5.176 (1.597)	5.228 (1.726)
AN3	6.117 (1.505)	5.483 (1.625)	4.245 (1.985)	5.521 (1.505)	5.293 (1.812)
AN4	5.831 (1.540)	4.899 (1.890)	4.967 (1.849)	4.703 (1.719)	5.070 (1.808)
AN5	5.535 (1.613)	4.745 (1.839)	4.558 (1.777)	4.341 (1.643)	4.759 (1.776)
AN6	5.956 (1.670)	5.548 (1.713)	4.683 (1.856)	5.040 (1.788)	5.265 (1.827)
Attitude towards technology					
AT1	3.597 (1.878)	4.736 (1.590)	4.432 (1.791)	3.836 (1.533)	4.162 (1.754)
AT2	4.790 (1.604)	5.143 (1.449)	4.832 (1.544)	4.495 (1.354)	4.807 (1.503)
AT3	4.570 (1.712)	5.208 (1.395)	4.783 (1.502)	4.752 (1.418)	4.830 (1.521)
AT4	4.538 (1.702)	5.043 (1.457)	4.910 (1.399)	4.794 (1.417)	4.829 (1.498)
AT5	3.670 (1.818)	4.803 (1.446)	4.468 (1.689)	4.377 (1.494)	4.349 (1.659)
Social trust					
ST1	4.100 (1.790)	5.179 (1.601)	4.468 (1.728)	4.246 (1.597)	4.498 (1.725)
ST2	2.645 (1.524)	4.237 (1.805)	4.055 (1.748)	3.609 (1.658)	3.670 (1.790)
ST3	3.751 (1.795)	5.136 (1.615)	5.072 (1.610)	3.894 (1.620)	4.483 (1.774)

All items were answered on seven-point scales ranging from "strongly disagree" to "strongly agree". Means and standard deviations are presented in Table 6.4.

6.3.5. Factual Knowledge and Judgmental Confidence Measures

Factual knowledge. Participants' factual knowledge (KN) about food science and food biotechnology issues was measured by eight items: (KN1) "Enzymes are used in all foods" [-], (KN2) "All bacteria found in food are harmful" [-], (KN3) "Some proteins found in foods can be toxic", (KN4) "Natural does not necessarily mean healthy", (KN5) "All processed foods are made using genetically modified products" [-], (KN6) "We eat DNA everyday", (KN7) "To be healthy food should be sterile before it is eaten" [-], and (KN8) "There are no laws or regulations on the use of gene technology in food production" [-]. All items were answered on dichotomous true-false scales. Prior to the analysis, data were recoded so that the means and standard deviations in Table 6.5 refer to incorrect answers (coded as 0) versus correct answers (coded as 1).

Judgmental confidence. Participants' confidence in their own ability to make judgments about gene technology was measured by the item (AC1) "I personally am very knowledgeable about the use of gene technology in food production". The item was answered on a seven-point scale ranging from "strongly disagree" to "strongly agree". Means and standard deviations are presented in Table 6.5.

Table 6.5. Means and standard deviations of objective knowledge and attitude certainty measures.

Variable	Country				Total
	Denmark *M (SD)*	Germany *M (SD)*	Italy *M (SD)*	UK *M (SD)*	*M (SD)*
Objective knowledge					
KN1	0.641 (.480)	0.481 (.500)	0.526 (.515)	0.483 (.535)	0.529 (.513)
KN2	0.905 (.294)	0.792 (.406)	0.362 (.485)	0.842 (.382)	0.712 (.458)
KN3	0.489 (.500)	0.642 (.480)	0.571 (.511)	0.583 (.529)	0.573 (.509)
KN4	0.914 (.280)	0.841 (.366)	0.601 (.498)	0.852 (.378)	0.794 (.412)
KN5	0.956 (.205)	0.928 (.258)	0.779 (.425)	0.814 (.395)	0.863 (.349)
KN6	0.533 (.500)	0.331 (.471)	0.339 (.498)	0.473 (.535)	0.415 (.509)
KN7	0.883 (.322)	0.494 (.501)	0.687 (.468)	0.713 (.483)	0.691 (.471)
KN8	0.682 (.466)	0.609 (.489)	0.699 (.468)	0.629 (.523)	0.655 (.489)
KN sum score	5.889 (1.315)	5.070 (1.446)	4.607 (1.407)	5.493 (1.496)	5.261 (1.495)
Judgmental confidence					
JC1	2.956 (1.647)	3.396 (1.641)	3.006 (1.642)	2.802 (1.515)	3.034 (1.623)

6.4. Analysis and Results

Data analysis and results will be presented in two steps. First, we will concentrate on intra-attitudinal structures, probing their directionality and dimensionality (Hypotheses 1 and 2). Then, we will focus on inter-attitudinal structures, examining their directionality (Hypothesis 3). Finally, we will present results pertaining to the structural consistency and strength of the attitude system (Hypotheses 4 and 5). Within each section, we will first specify the models to be estimated, then report details of the estimation, and finally compare the different models by appropriate techniques to provide answers to the hypotheses, along with estimates of the respective model parameters.

6.4.1. Competing Models of Intra-attitudinal Structure

Model specification. Altogether, seven competing measurement models were specified. Models 1, 2 and 3 were top-down models of intra-attitudinal structure, assuming that the 15 specific belief measures included in the survey are functions of more general, heuristic evaluation dimensions. These were implemented as reflective, factor-analytic measurement models. The crucial assumption that makes these models testable is that of local independence: once the effects of heuristic evaluation dimensions on the belief measures are controlled for, all residuals in the belief measures should be uncorrelated (see Chapter 5.3.1).

The three models differed in the dimensionality they assumed. Model 1 assumed that one heuristic evaluation dimension (risk versus benefit) would be necessary and sufficient to explain the observed covariation between the fifteen specific belief measures. Model 2 assumed that two heuristic evaluation dimensions (risk and benefit) would be necessary and sufficient, and Model 3 assumed that four heuristic evaluation dimensions (product-related risk, process-related risk, product related benefit, and process-related benefit, respectively) would be necessary and sufficient. Conceptual models are depicted in path diagram notation in Figure 6.3.

Models 4, 5 and 6 were bottom-up models of intra-attitudinal structure, assuming that beliefs are the basic components from which aggregate evaluations are formed. These were implemented as formative, MIMIC-type measurement models, where all belief measures operate as manifest exogenous variables, and an aggregate evaluation dimension is then defined as a joint function of the beliefs. Formative measurement models make no assumptions about local independence (see Chapter 5.3.2). Hence, Models 4, 5 and 6 provide a far less constrained measurement structure relative to which Models 1, 2 and 3 can be evaluated.

In analogy to the top-down models, the three bottom-up models differed in the dimensionality they assumed. Model 1 assumed that one aggregate evaluation dimension (risk versus benefit) would be necessary and sufficient, Model 2 assumed that two aggregate evaluation dimensions (risk and benefit) would be necessary and sufficient, and Model 3 assumed that four aggregate evaluation dimensions (product-related risk, process-related risk, product related benefit, and process-related benefit, respectively) would be necessary and sufficient. Conceptual models are depicted in Figure 6.4 .

Finally, Model 7 assumed no general evaluation dimensions at all. In this model, all beliefs were specified as manifest exogenous variables that operate as their own evaluative dimensions. No further assumptions were made. Technically, Model 7 is not a true statistical model that can be falsified in any way. It will be regarded as a saturated model against which the slightly more restricted measurement structures in Models 4, 5, and 6 as well as the far more restricted measurement structures assumed by Models 1, 2 and 3, can be evaluated. A conceptual model is depicted in Figure 6.5.

Since the errors of the latent dimensions in formative, MIMIC-type measurement structures (as assumed by Models 4, 5 and 6) are only identified when each of the latent dimensions emits at least two paths to other variables in the model which are not formative indicators of the same or another latent variable (see Chapter 5.3.2), and since Model 7 only becomes an equation once one or more dependent variables are added, two endogenous factors, global benefit evaluation and global risk evaluation, were added to each model to provide identification. The measurement models for these were factor-analytic, including as indicators the three global benefit-evaluation measures (B1, B2 and B3; see above) and the three global risk-evaluation measures (R1, R2 and R3, see above) that had been collected in the survey in addition to the fifteen specific belief measures.

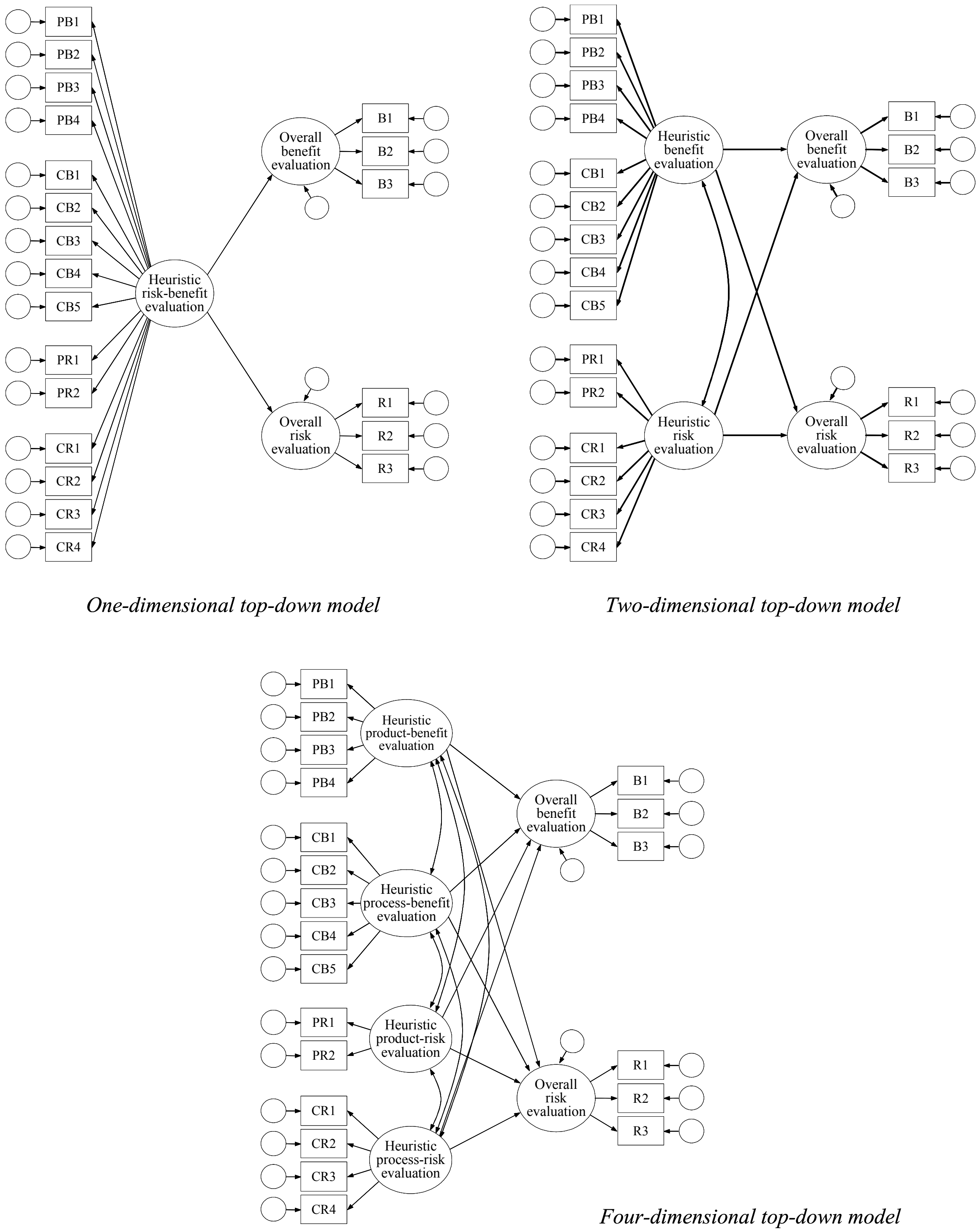

Figure 6.3. Top-down models of intra-attitudinal structure: Model 1 (one-dimensional top-down structure), Model 2 (two-dimensional top-down structure) and Model 3 (four-dimensional top-down structure).

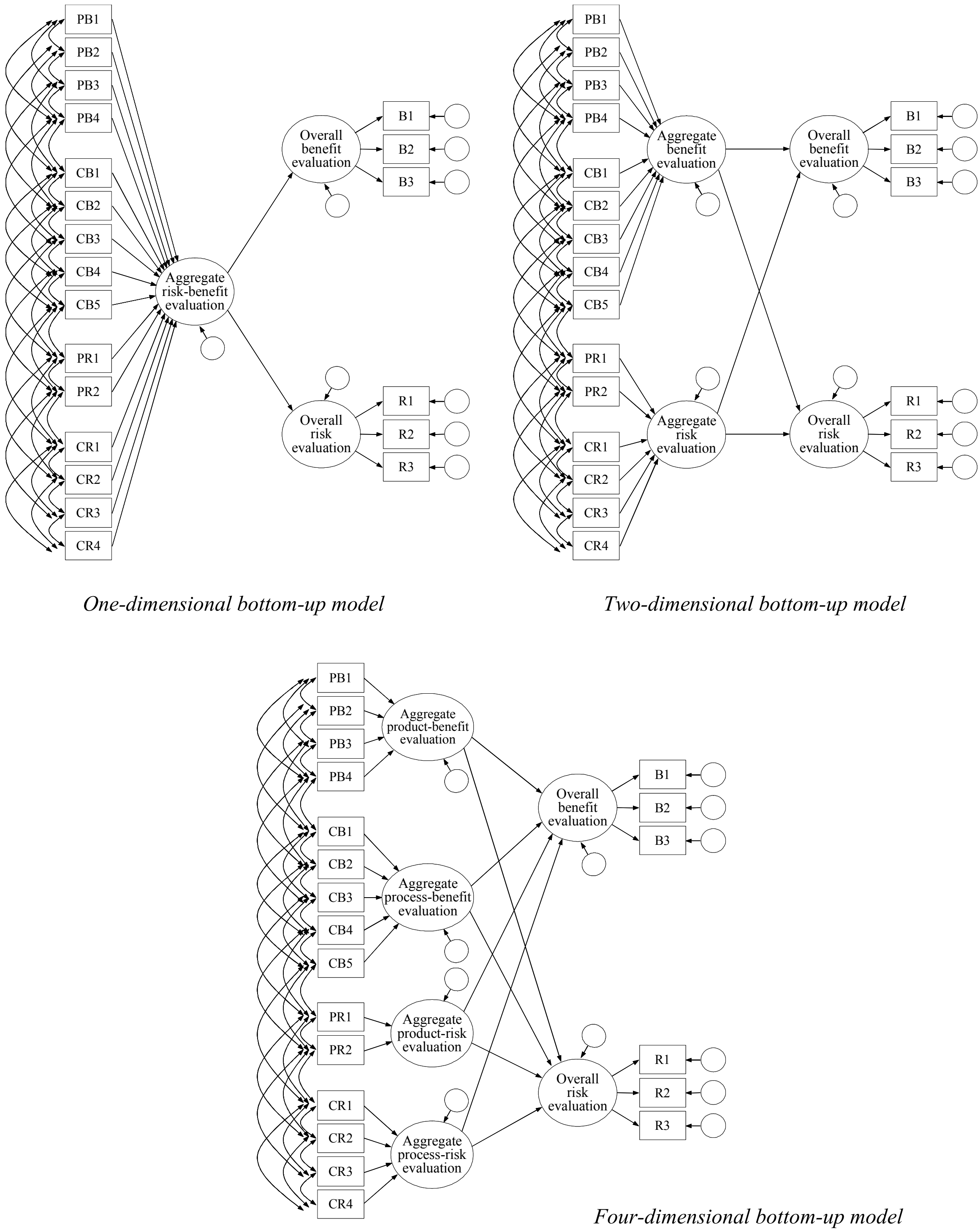

Figure 6.4. Bottom-up models of intra-attitudinal structure: Model 4 (one-dimensional bottom-up structure), Model 5 (two-dimensional bottom-up structure) and Model 6 (four-dimensional bottom-up structure).

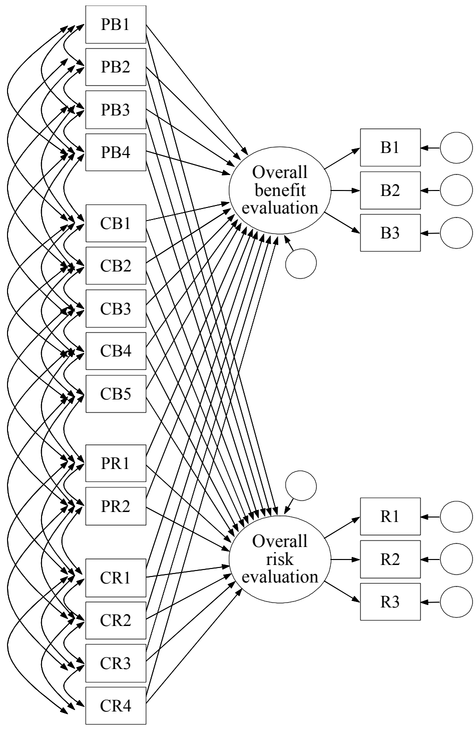

Figure 6.5. Saturated model of intra-attitudinal structure: Model 7 (each belief its own evaluative dimension).

Normality check. To check whether the distributional assumptions of maximum likelihood estimation were met, multivariate skewness and kurtosis statistics were computed for the joint distribution of the 15 specific belief measures and the 6 global evaluation measures within each sample. In the Danish sub-sample, the multivariate skewness was 74.120 ($Z = 43.26$, $p < .001$), and the multivariate kurtosis was 638.25 ($Z = 23.25$, $p < .001$). Taken together, the multivariate distribution departed significantly from normality ($\chi^2 = 2412.67$, $p < .001$). Similar conditions were found in the German sub-sample (skewness = 62.51, $Z = 38.13$, $p < .001$; kurtosis = 630.92, $Z = 23.29$, $p < .001$; $\chi^2 = 1996.80$, $p < .001$), the Italian sub-sample (skewness = 49.31, $Z = 29.78$, $p < .001$; kurtosis = 603.62, $Z = 21.42$, $p < .001$; $\chi^2 = 1346.11$, $p < .001$), and the UK sub-sample (skewness = 82.46, $Z = 50.93$, $p < .001$; kurtosis = 696.37, $Z = 27.50$, $p < .001$; $\chi^2 = 3350.50$, $p < .001$). Hence, corrections for non-normality will be used in the analyses.

Estimation. All models were estimated by means of maximum likelihood using LISREL 8.54 (Jöreskog & Sörbom, 1996; Jöreskog, Sörbom, du Toit & du Toit, 1999, 2003). To account for the non-normality detected in the data, the Satorra-Bentler scaled χ^2 statistic was used in all computations instead of the normal minimum fit-function χ^2 that assumes multivariate normality (Satorra & Bentler, 1988; see Chapter 5.2.5). Estimation was based on within-sample covariance matrices and asymptotic covariance matrices computed from the Danish (N = 505), German (N = 516), Italian (N = 511), and UK (N = 499) sub-samples. All models were estimated simultaneously in the four groups. At this stage, no constraints were imposed across groups.

Table 6.6. Goodness-of-fit and model comparison statistics for competing models of intra-attitudinal structure.

		Goodness-of-fit statistics				Model comparison statistic
No.	Estimated model	Satorra-Bentler χ^2	*df*	$p <$	RMSEA	CAIC
	Top-down models					
1	One heuristic evaluation dimension	3269.21	748	.001	.081	4785.68
2	Two heuristic evaluation dimensions	2134.04	736	.001	.061	3753.90
3	Four heuristic evaluation dimensions	2070.41	700	.001	.062	4000.46
	Bottom-up models					
4	One aggregate evaluation dimension	804.08	328	.001	.053	5939.39
5	Two aggregate evaluation dimensions	549.58	320	.001	.038	5753.82
6	Four aggregate evaluation dimensions	533.98	304	.001	.039	5876.08
	Saturated model					
7	Each belief its own evaluative dimension	509.09	276	.001	.041	6092.44

Goodness of fit. Goodness-of-fit statistics are presented in Table 6.6. Given the large samples on which the present analysis was based, it comes as no surprise that, in all instances, the overall goodness-of-fit χ^2 indicates significant deviations of model-implied from observed covariance matrices, even though Satorra and Bentler's scaled χ^2 was used in the test. As discussed in Chapter 5.2.3, the overall χ^2 test gains excessive power in large samples (Bollen, 1990) and is therefore of limited use here. The RMSEA, as a descriptive goodness-of-fit measure, indicates acceptable fit for all models apart from Model 1, where it is slightly above the conventional acceptance limit of RMSEA < .08 (Cudeck & Browne, 1993). However, the RMSEA does not penalize model complexity and is therefore somewhat sensitive to over-fitting (Haughton, Oud & Jansen, 1997; Hu & Bentler, 1998). Hence, it is no surprise either that the RMSEA steadily decreases when the models become more complex, i.e. have fewer degrees of freedom.

Model comparisons. Since the seven models to be compared in this analysis cannot be expressed as a hierarchically nested sequence, we will use an information-theoretic measure, the CAIC, for a comparative evaluation of their fit (see Chapter 5.2.4). CAIC values for all models are shown in Table 6.6. The decision rule used in connection with the CAIC is that, among a set of competing models that are specified a priori, the one yielding the lowest CAIC value is to be selected. Among the models included in this analysis, Model 2 (the top-down model with two heuristic evaluation dimensions) yielded the lowest CAIC and will therefore be accepted as the best representation of the data.

Hypothesis evaluation. The accepted model supports the predictions made in Hypotheses 1 and 2. Hence, it can be concluded that the interrelationships between consumers' beliefs about specific risks and benefits of genetically modified foods can best be represented by a two-dimensional top-down model of intra-attitudinal structure. In this model, all beliefs about benefits of genetically modified foods are functions of a common, underlying factor (heuristic benefit evaluation), and, in the same manner, all beliefs about risk of genetically modified foods are functions of a second common, underlying factor (heuristic risk evaluation). The model does not support the existence of a risk-benefit trade-off or any other form of compositional attitude formation.

6.4.2. Invariance across Populations

Model specification. The above analysis was conducted simultaneously, but with independent parameterizations in the four sub-samples from Denmark, Germany, Italy and the UK. To examine the degree to which the model was invariant in its parameters across the four populations, the measurement model was re-specified as a multi-sample confirmatory factor analysis model involving a means structure, allowing more extensive checks of differences between populations than a model based on mean-centered variables alone (see Chapter 5.4). The endogenous variables (overall benefit evaluation and overall risk evaluations), which had in the previous analysis only been necessary for identification of formative, MIMIC-type measurement models, will be omitted here as the accepted measurement model is a factor-analytic, reflective one.

Following the procedure suggested by Steenkamp and Baumgartner (1998), six hierarchically nested models were estimated. In each step, a further set of constraints on the means-and-covariance structure was relaxed. Model 1 (identity) constrained factor loadings Λ_x, item intercepts τ_x, factor covariances and variances Φ, error variances Θ_δ, and latent factor means κ to be invariant across populations. Model 2 (error variance invariance) constrained factor loadings, item intercepts, factor covariances and factor variances, and measurement error variances to be invariant. Model 3 (factor variance invariance) constrained factor loadings, item intercepts, factor covariances, and factor variances to be invariant. Model 4 (factor covariance invariance) constrained factor loadings, item intercepts, and factor covariances to be invariant. Model 5 (scalar invariance) constrained factor loadings and item intercepts to be invariant. Model 6 (metric invariance) constrained the complete matrix of factor loadings to be invariant. Model 7 (configural invariance) imposed an identical simple structure on the data, assuming the same pattern of zero and non-zero loadings to hold in all samples.

Estimation. The same estimation method was used as above, but now also based on within-sample mean vectors in addition to within-sample covariance matrices and asymptotic covariance matrices. Goodness-of-fit statistics and model comparison statistics are shown in Table 6.7.

Table 6.7. Measurement invariance of two-dimensional top-down model across populations.

		Goodness-of-fit statistics			
No.	Estimated model	Satorra-Bentler χ^2	*df*	$p <$	RMSEA
1	Identity	3898.53	494	.001	.117
2	Error variance invariance	3644.27	488	.001	.113
3	Factor variance invariance	2161.39	443	.001	.087
4	Factor covariance invariance	2139.60	437	.001	.088
5	Scalar invariance	2124.62	434	.001	.088
6	Metric invariance	1614.72	395	.001	.078
7	Configural invariance	1378.34	356	.001	.075
		Stepwise model comparison statistics			
No.	Invariance constraint relaxed	Satorra-Bentler scaled $\Delta\chi^2$	Δdf	$p <$	NFI
1	None				
2	Factor means	891.27	6	.001	.065
3	Error variances	362.08	45	.001	.407
4	Factor variances	18.53	6	.010	.010
5	Factor covariances	14.88	3	.010	.007
6	Item intercepts	1758.58	39	.001	.240
7	Factor loadings	407.35	39	.001	.146

Goodness of fit. The overall goodness-of-fit χ^2 indicated significant deviations of model-implied from observed covariance matrices for all models. Because of the excessive statistical power the test gained from the large samples involved in the analysis, it shall not be used as a criterion for model evaluation here. The RMSEA, as a descriptive measure of model fit, declined in two major steps. The first major step occurred between Models 2 and 3, when error variances (i.e., the item reliabilities of the belief measures) were allowed to differ between populations. The second major step occurred between Models 5 and 6, when item intercepts (i.e., the item-specific location parameters of the belief measures) were allowed to vary between populations. Between these steps, the RMSEA changed only slightly in its value. Acceptable fit (RMSEA < .08) was indicated for Model 6 (metric invariance) and Model 7 (configural invariance). From this, it can already be concluded that the pattern of zero and non-zero factor loadings as well as the factor loadings themselves did not vary across the four consumer populations in which the data had been collected.

Model comparisons. Stepwise model comparisons, shown in the lower part of Table 7.7, give a more detailed account of the invariance of measurement properties across populations. The explicit model comparison test, using Satorra and Bentler's scaled χ^2-difference statistic (Satorra, 2000; Satorra & Bentler, 1999; see Chapter 5.2.5), indicated significant improvement at every step in which constraints were relaxed. Again, it is somewhat difficult to interpret these test results since differences between chi-squares are, as the chi-squares themselves, still a function of sample size and therefore sensitive to problems of excessive power in large samples. Moreover, it appears from the absolute values of the $\Delta\chi^2$ that the Satorra and Bentler's scaling correction has in several instances blown the difference between two models out of proportion[11]. However, the $\Delta\chi^2$ values and associated *p*s were somewhat lower in the comparisons of Models 3 and 4 (where factor variances were allowed to differ) and Models 4 and 5 (where factor covariances were allowed to differ), indicating that there were relatively small differences between populations in these parameters.

This is reflected in the stepwise NFI values that were computed for each model comparison. The stepwise NFI can be interpreted as the relative amount of the way towards perfect fit that is accomplished by relaxing the particular constraints that distinguish two nested models. The NFI values indicate that only approximately 7% improvement is gained by relaxing constraints on latent factor means, and only 1% further improvement by relaxing constraints on factor variances and covariances, respectively. On the other hand, and reflecting the behavior of the RMSEA (see above), the NFI

[11] Albert Satorra and Peter Bentler, the authors of the scaling correction, were contacted about this problem but could not offer a convincing explanation apart from potential irregularities in the data (Satorra, 2000, personal communication).

indicates that about 41% improvement is gained when constraints on error variances are relaxed, and 24% when constraints on item intercepts are relaxed. Finally, 15% further improvement is gained when constraints on factor loadings are relaxed. Differences between factor loadings can be somewhat discounted because, in the analysis of model-wise fit, the RMSEA indicated acceptable overall fit for Model 6, where all factor loadings had been specified to be invariant across populations.

Final model. Incorporating the above results, a final model was specified where all factor loadings, all factor covariances and all factor variances were invariant across populations, whereas item intercepts, error variances, and latent factor means were allowed to differ. The model was estimated in the same way as the models above and yielded acceptable fit (Satorra-Bentler χ^2 = 1649.95, *df* = 404, *p* < .001 ; RMSEA = .078). Attempts were made to find a representation with partial scalar invariance (Byrne, Shavelson & Muthén, 1989; see Chapter 5.4.3) that would invoke a common scale for the latent factor means. However, no pair of item intercepts could be found for any of the two factors in the model that were invariant across the four populations. Hence, means of belief measures as well as latent factor means remain additively biased and cannot be meaningfully compared across population.

Parameter estimates. Factor loadings, factor covariances and factor variances, on the other hand, can be compared across populations. The invariant subset of parameter estimates for the final model is shown in Figure 6.6 (in path diagram notation; standardized solution). The model appears satisfactory by common standards of construct validity. All factor loadings were above .30, and only two were below .50. Hence, the belief measures show sufficient convergent validity in the degree to which they express their underlying heuristic evaluation dimensions. The belief with the highest factor loading, or, in more substantial terms, the belief that was the strongest expression of the consumers' heuristic benefit evaluation, was PB4 ("Genetically modified food products are better quality foodstuffs than other food products"). The belief that was the strongest expression of consumers' heuristic risk evaluation, on the other hand, was PR2 ("Genetically modified food products are a threat to human health").

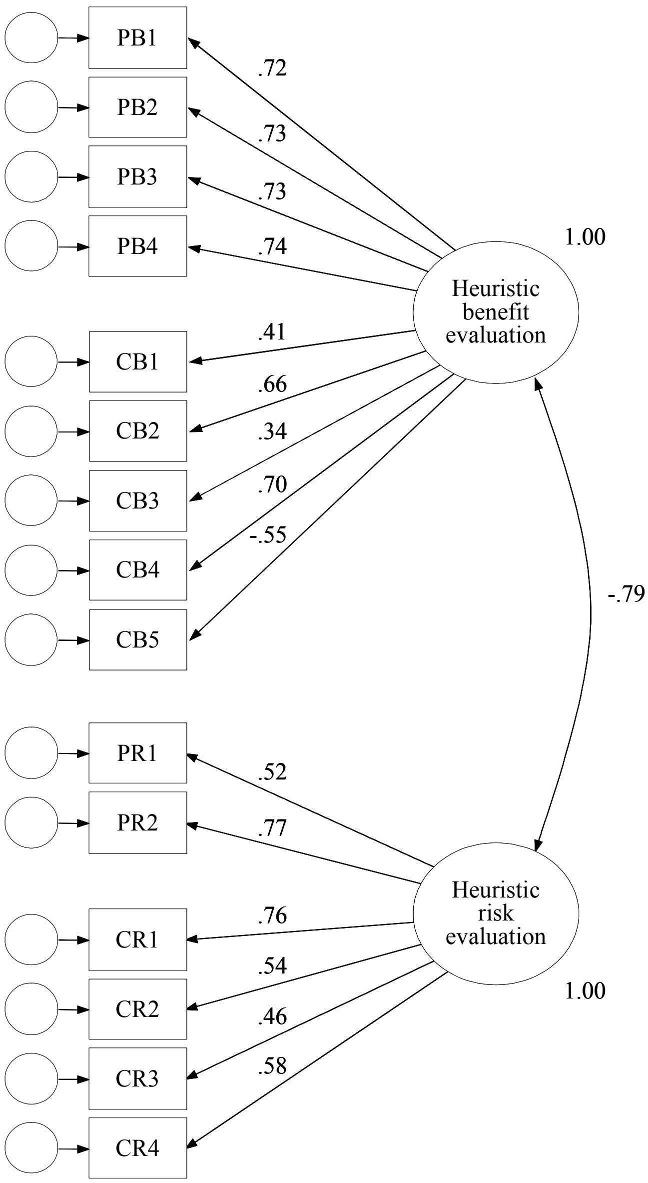

Figure 6.6. Population-invariant parameter estimates for final model of intra-attitudinal structure (standardized solution).

The two underlying dimensions, heuristic benefit evaluation and heuristic risk evaluation, were operationalized by the respective sets of beliefs with sufficient construct reliability (Jöreskog's rho = .85 for heuristic benefit evaluation and .78 for heuristic risk evaluation). The constructs were highly negatively correlated (ϕ = -.79), which could be expected from previous research (see Chapter 2.5). However, the factor intercorrelation was still substantially below and significantly different from 1 to indicate discriminant validity of the two factors.

The analyses in this section were concerned with intra-attitudinal structure, modeling the properties of consumers' attitudes towards genetically modified foods on a molecular level. In the following section, similar properties will be investigated, but on the molar level of inter-attitudinal structure.

6.4.3. Competing Models of Inter-attitudinal Structure

Model specification. Two competing models of inter-attitudinal structure were specified. Model 1 was a genuine top-down model, assuming that consumers' general socio-political attitudes are responsible for the variation in consumers' overall evaluation of genetically modified foods as a technology, and that this overall technology evaluation, in turn, is completely responsible for the variation in consumers' overall risk evaluations as well as in their overall benefit evaluations. The crucial assumption made in this model is a particular type of mediation: all effects of general socio-political attitudes on overall risk and benefit evaluations are assumed to be mediated by consumers' overall evaluation of genetically modified foods as a technology. No risk-benefit trade-off is assumed to occur.

Model 2 was a mixed-directionality model, assuming that consumers' general socio-political attitudes are responsible for the variation in consumers' overall risk evaluations as well as in their overall benefit evaluations, and that these risk and benefit evaluations, in turn, are completely responsible for the variation in consumers' overall evaluation of genetically modified foods as a technology. This model makes a crucial assumption about mediation as well: all effects of general socio-political attitudes on consumers' overall evaluation of genetically modified foods as a technology are assumed to be mediated by their overall risk and benefit evaluations. In other words, the overall technology evaluation is assumed to emerge from a risk-benefit trade-off.

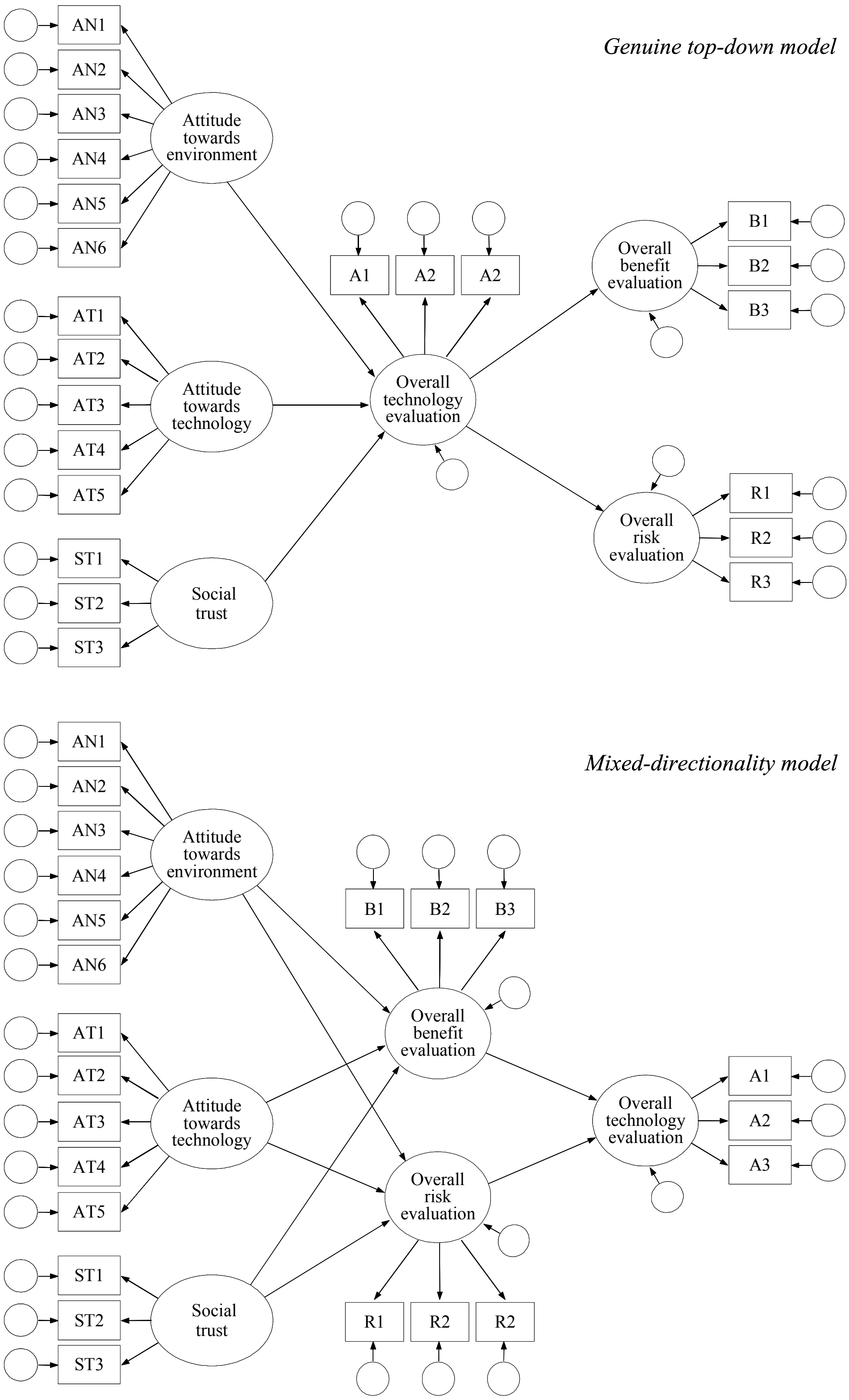

Figure 6.7. Competing models of inter-attitudinal structure: Model 1 (genuine top-down structure) and Model 2 (mixed-directionality structure).

In both models, general socio-political attitudes were specified as latent exogenous factors. The first factor, attitude towards environment and nature, was measured by six indicators (items AN1 to AN6 from the attitude survey). The second factor, attitude towards technology, was measured by five indicators (items AT1 to AT5). The third factor, social trust, was measured by three indicators (items ST1 to ST3). Overall technology evaluation, overall benefit evaluation, and overall risk evaluation were specified as latent endogenous factors, measured by three indicators each (A1 to A3, B1 to B3, and R1 to R3, respectively). Conceptual models are depicted in Figure 6.7.

Normality check. Multivariate skewness and kurtosis statistics were computed for the joint distribution of the 14 socio-political attitude measures and the 9 global evaluation measures. In the Danish sub-sample, the multivariate skewness was 88.57 (Z = 48.83, $p < .001$), and the multivariate kurtosis was 735.48 (Z = 23.74, $p < .001$). The multivariate distribution departed significantly from normality ($\chi^2 = 2948.23$, $p < .001$). The same was found in the German sub-sample (skewness = 70.41, Z = 38.75, $p < .001$; kurtosis = 716.96, Z = 22.60, $p < .001$; $\chi^2 = 2012.34$, $p < .001$), the Italian sub-sample (skewness = 54.99, Z = 27.22, $p < .001$; kurtosis = 676.34, Z = 18.81, $p < .001$; χ^2 = 1094.63, $p < .001$), and the UK sub-sample (skewness = 80.95, Z = 43.81, $p < .001$; kurtosis = 756.50, Z = 25.00, $p < .001$; $\chi^2 = 2543.89$, $p < .001$). Hence, corrections for non-normality will be used in this analysis as well.

Estimation. All models were estimated by means of maximum likelihood using LISREL 8.54. To account for violations of normality, the Satorra-Bentler scaled χ^2 statistic was used in all computations instead of the normal minimum fit-function χ^2. Estimation was based on within-sample covariance matrices and asymptotic covariance matrices computed from the Danish (N = 505), German (N = 516), Italian (N = 511), and UK (N = 499) sub-samples. Like before, all models were estimated simultaneously in the four groups without any constraints imposed across groups.

Goodness of fit. Goodness-of-fit statistics are presented in Table 6.8. For both models, the overall goodness-of-fit χ^2 indicated significant deviations of model-implied from observed covariance matrices. However, this shall be discounted again as statistical power becomes excessive in such large samples. The RMSEA, as a descriptive goodness-of-fit measure, remained within conventional acceptance limits for both models. The genuine top-down model yielded a somewhat lower RMSEA than the mixed-directionality model.

Model comparisons. The two models in this analysis cannot be expressed in a hierarchically nested sequence. Hence, the CAIC will be used again for comparatively evaluating their fit. CAIC values for both models are shown in Table 6.8 as well. Model 1 (the genuine top-down model) yielded the lowest CAIC and will therefore be accepted as the best representation of the data.

Hypothesis evaluation. The accepted model supports the predictions made in Hypotheses 3. From the analysis it can be concluded that the interrelationships between consumers' general socio-political attitudes, their overall evaluations of genetically modified foods as a technology, and their overall evaluations of the risks and benefits of genetically modified foods are indeed best represented by a genuine top-down model, where evaluations are consistently layered from a level of highest generality over a level of medium generality to a level of lowest generality.

The results provide further corroboration to the preliminary conclusions drawn from the previous analysis, where a molecular, intra-attitudinal approach had been taken: no evidence could be found for the existence of a risk-benefit trade-off on an intra-attitudinal level, and, as shown in this analysis, neither could such evidence be found on a molar, inter-attitudinal level.

Table 6.8. Goodness-of-fit and model comparison statistics for competing models of inter-attitudinal structure.

		Goodness-of-fit statistics				Model comparison statistic
No.	Estimated model	Satorra-Bentler χ^2	*df*	*p* <	RMSEA	CAIC
1	Genuine top-down structure	1975.39	888	.001	.049	2285.58
2	Mixed directional structure	2321.38	876	.001	.057	2734.96

6.4.4. Invariance across Populations

Model specification. In the same way as the initial analysis of intra-attitudinal structures (see Chapter 6.4.1), the above analysis of inter-attitudinal structures was initially conducted simultaneously in the four country-specific sub-samples, but with independent parameterizations. To examine the degree to which the model was invariant in its parameters across the four populations, the model was re-specified involving a means structure (see Chapter 5.2.1), enabling a more extensive analysis of differences between populations than a model based on mean-centered variables alone.

Since the model to be checked for its invariance was a full structural equation model, the analysis involves a number of additional steps (Scholderer & Grunert, 2001). Altogether, nine hierarchically nested models were estimated. In each step, a further set of constraints on the means-and-covariance structure was relaxed. Model 1 (identity) constrained all parameter matrices to be invariant, including equation intercepts α, exogenous factor means κ, equation error variances ψ, regression coefficients $\mathbf{B}$ and Γ, measurement error variances Θ_δ and Θ_ε, exogenous factor variances and covariances Φ, item intercepts τ_x and τ_y, and factor loadings Λ_x and Λ_y to be invariant across populations.

Model 2 (covariance structure invariance) dropped the constraints on the means structure of the latent factors (i.e., it allowed the equation intercepts and exogenous factor means to vary), but maintained all other constraints. Model 3 (regression invariance) dropped the constraints on equation errors (i.e., it allowed the predictive validity of the model to vary), but maintained all constraints on regression coefficients and measurement models. Model 4 (error variance invariance) relaxed the constraints on regression coefficients, but maintained all constraints on measurement models. Model 5 (factor variance invariance) dropped the constraints on measurement error variances in the exogenous as well as endogenous measurement models, but maintained the constraints on exogenous factor variances and covariances, factor loadings, and item intercepts.

Model 6 (factor covariance invariance) relaxed the constraints on exogenous factor variances, but maintained the constraints on exogenous factor covariances, factor loadings, and item intercepts. Model 7 (scalar invariance) dropped the constraints on factor covariances, but maintained the constraints on exogenous as well as endogenous factor loadings and item intercepts. Model 8 (metric invariance) dropped the constraints on exogenous and endogenous item intercepts, but maintained the constraints on exogenous and endogenous factor loadings. Finally, Model 9 (configural invariance) dropped the constraint on exact levels of exogenous and endogenous factor loadings but maintained an identical simple structure for the data, assuming the same pattern of zero and non-zero factor loadings to hold across populations.

Estimation. The same estimation method was used as above, but now also based on within-sample mean vectors in addition to within-sample covariance matrices and asymptotic covariance matrices. Goodness-of-fit statistics and model comparison statistics are shown in Table 6.9.

Goodness of fit. The overall goodness-of-fit χ^2 indicated significant deviations of model-implied from observed covariance matrices for all models. Yet as before, the test shall not be used as a criterion for model evaluation here because of the excessive power it gains in large samples. The RMSEA indicated acceptable fit (RMSEA < .08) of Model 4 (error variance invariance), Model 5 (factor variance invariance), Model 6 (factor covariance invariance), Model 7 (scalar invariance), Model 8 (metric invariance) and Model 9 (configural invariance). The fit of Model 3 (regression invariance) was only slightly above the conventional acceptance limit, the fit of Models 1 and 2 was clearly above. Moderately sized changes in the RSMEA occurred between Models 1, 2, 3, 4, and 5. The less constrained models appeared not to differ substantially in their fit.

Model comparisons. Stepwise model comparisons are presented in the lower part of Table 6.9. The Satorra-Bentler scaled χ^2-difference test indicated significant improvement at every step in which constraints were relaxed, providing little guidance for model selection. As already observed once before, it appears from the absolute values that Satorra and Bentler's scaling correction has disproportionally inflated some of the differences, in particular those between Models 1 and 2 and Models 7 and 8. Still, somewhat lower $\Delta\chi^2$ values were obtained in the comparisons of Models 2 and 3 (where equation errors were allowed to differ) and Models 5, 6 and 7 (where factor covariances and variances were allowed to differ, respectively).

Table 6.9. Measurement invariance of genuine top-down model across populations.

		Goodness-of-fit statistics			
No.	Estimated model	Satorra-Bentler χ^2	*df*	*p* <	RMSEA
1	Identity	6437.49	1119	.001	.097
2	Covariance structure invariance	5591.52	1101	.001	.090
3	Regression invariance	4802.44	1092	.001	.082
4	Error variance invariance	4439.96	1077	.001	.078
5	Factor variance invariance	2877.71	1008	.001	.060
6	Factor covariance invariance	2845.38	999	.001	.060
7	Scalar invariance	2811.07	990	.001	.060
8	Metric invariance	2148.18	939	.001	.050
9	Configural invariance	1947.04	888	.001	.048
		Stepwise model comparison statistics			
No.	Invariance constraint relaxed	Satorra-Bentler scaled $\Delta\chi^2$	Δ*df*	*p* <	NFI
1	None				
2	Equation intercepts and factor means	20069.83	18	.001	.131
3	Equation error variances	27.07	9	.010	.141
4	Regression coefficients	178.39	15	.001	.075
5	Measurement error variances	730.34	69	.001	.352
6	Exogenous factor variances	30.92	9	.001	.011
7	Exogenous factor covariances	39.80	9	.001	.012
8	Item intercepts	10537.32	51	.001	.236
9	Factor loadings	444.25	51	.001	.094

The stepwise NFI values are somewhat easier to interpret. The NFI indicates that relatively large improvements in the fit of the structural model were gained by relaxing the constraints on equation intercepts, factor means, and equation errors, whereas improvements from relaxing the constraints on the regression coefficients were somewhat smaller but still substantial. Relatively large improvements in the fit of the measurement models were gained by relaxing the constraints on measurement errors and item intercepts, medium-sized improvements by relaxing constraints on factor loadings, and relatively insubstantial gains by relaxing the constraints on measurement errors.

Final model. As argued in Chapter 5.2.3, all goodness-of-fit and model-comparison statistics are more sensitive to changes in the measurement models than to changes in the structural model since measurement models impose substantially more restrictions on the model-implied mean vectors and covariance matrices. Hence, it was decided to assign more weight to those test results that suggested differences in parameters of the structural model than to those that suggested differences in the parameters of the measurement models – after all, Model 4 (error variance invariance), where all measurement model parameters had been constrained to be invariant across populations, had still attained a fit that was indicated as acceptable by the RMSEA value. For these reasons, Model 4 was accepted as the most desirable representation. All factor loadings, item intercepts, factor covariances and variances, and all measurement error variances were invariant in this model, whereas all parameters of the structural model varied between the four consumer populations from which participants had been sampled.

Parameter estimates. Factor loadings and regression coefficients for the final model are presented in path diagram notation in Figure 6.8 (standardized solution). Latent factor means are shown in Figure 6.9 (unstandardized solution). The measurement models were highly satisfactory in terms of convergent validity. None of the standardized factor loadings was below .30, and only one was below .40. The measurement model of the exogenous factors (the general socio-political attitudes) proved highly satisfactory in terms of discriminant validity as well. All factor intercorrelations had absolute values below .40 and were significantly different from 1.

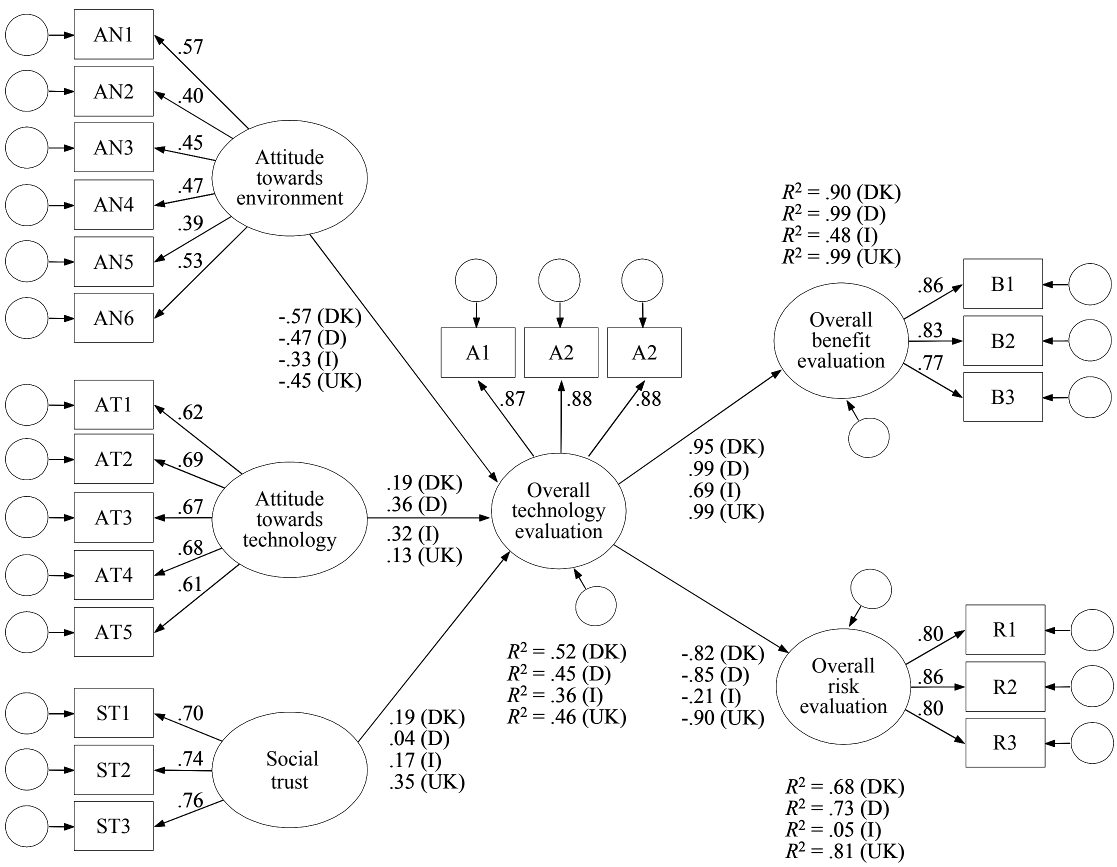

Figure 6.8. Parameter estimates for final model of inter-attitudinal structure (standardized solution).

The very close relationship between the endogenous factors, on the other hand, is not surprising. In substantial terms, this was part of the hypothesis of a consistent top-down model of inter-attitudinal structure, rather than a modeling problem (see below). Furthermore, the observed measures operationalized their underlying constructs with sufficient reliability (Jöreskog's rho = .63 for attitude towards environment and nature, .79 for attitude towards technology, .78 for social trust, .91 for overall technology evaluation, .86 for overall benefit evaluation, and .86 for overall risk evaluation).

The results concerning the structural model were fully in line with the expectations. In all four consumer populations, general socio-political attitudes explained around 50% of the reliable variation in consumers' overall evaluations of the technology (although this was somewhat less in Italy). Among the general socio-political attitudes, attitudes towards environment and nature had the largest effect, followed by attitudes towards modern technology, and social trust. Interestingly, social trust had a substantially higher effect on the overall technology evaluations made by UK consumers than on those made by consumers from the other three populations.

Overall evaluations of GM foods as a technology, in turn, explained almost 100% of the reliable variation in the overall benefit evaluations made by German and UK consumers, still around 90% of the benefit evaluations made by Danish consumers, and around 50% of the benefit evaluations made by Italian consumers. At the same time, global technology evaluation could also explain approximately 70% to 80% of the reliable variation in the global risk evaluations made by Danish, German and UK consumers.

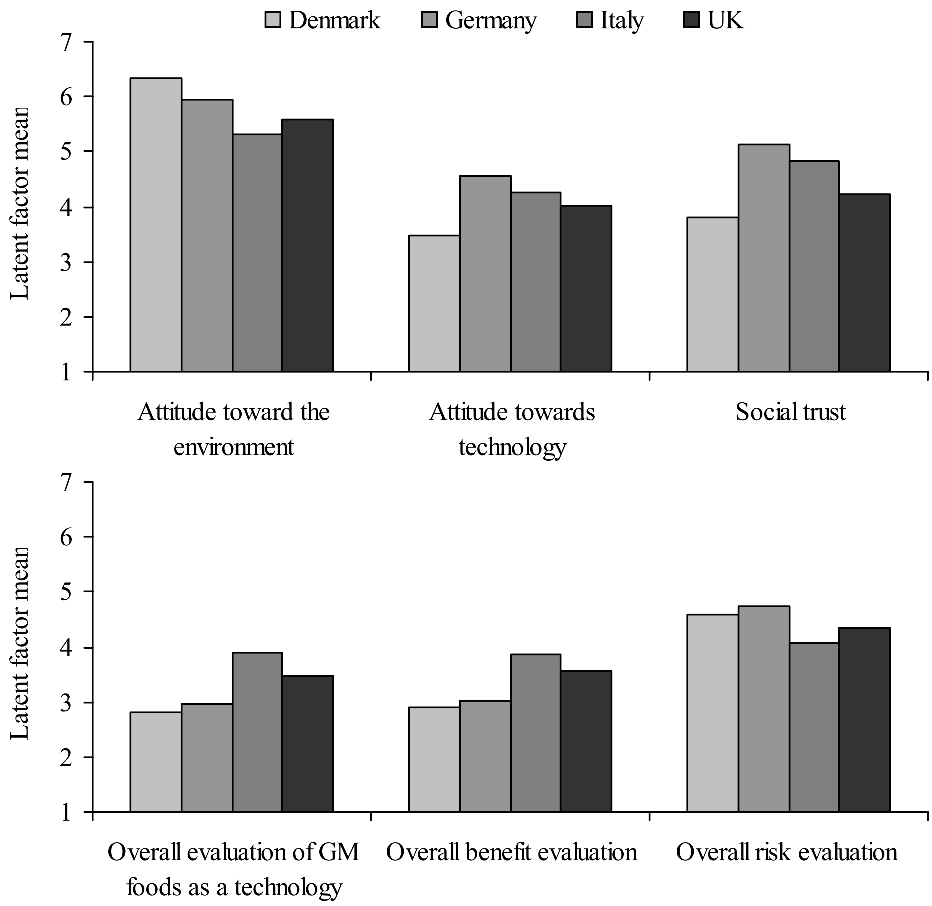

Figure 6.9. Latent factor means of general socio-political attitudes (upper panel) and attitudes towards genetically modified foods (lower panel) in the four consumer populations.

However, only 5% of the variance in global risk evaluations could be accounted for in Italy. Italian consumers' risk evaluations appear to be an exception from the general top-down model of inter-attitudinal structure proposed here.

Figure 6.9 shows differences between the four consumer populations in the average level of the six attitude factors included in the model. Since the invariance constraints on the measurement models satisfied the conditions for the existence of common interval scales across populations (see Chapter 5.4.3), the values can be directly compared. The pattern in the latent factor means appears to be consistent with the assumption that the general socio-political attitudes and attitudes towards GM foods considered here form a stable system.

Compared to the three other consumer populations, Danish consumers had the most positive attitudes towards the environment, the least positive attitudes towards modern technology, and reported the lowest level of social trust (i.e., trust in the institutions that regulate emerging technologies and manage their risks; Siegrist, 2000). Mirroring the pattern in the general socio-political attitudes, Danish consumers reported the least positive evaluation of genetically modified foods as a technology, the lowest overall benefit evaluation, and (together with German consumers) the highest overall risk evaluation.

The opposite pattern was found among Italian consumers. Compared to the three other populations, Italians had the least positive attitudes towards the environment, the second-most positive attitude towards modern technology, and reported the second-highest level of trust in the institutions concerned with regulation and risk management. Mirroring the pattern in their general socio-political attitudes, Italian consumers reported the most positive evaluation of genetically modified foods as a technology, the highest overall benefit evaluation, and the lowest overall risk evaluation. The other two consumer populations investigated in this study, German and UK consumers, showed patterns in between these extremes.

6.4.5. Structural Consistency and Attitude Strength: The Knowledge Function

Model specification. Hypothesis 4 concerned the question whether general socio-political attitudes have a “knowledge function” (Katz, 1960) for consumers, that is, whether they serve as substitutes for more accurate judgments in a situation where consumers do not possess enough factual knowledge to make such judgments, which should make the attitude system investigated here more structurally consistent among consumers with low factual knowledge.

In order to test the hypothesis, a reduced version of the model investigated in the previous analysis was used as a framework, still including the same three general socio-political attitudes as exogenous factors, but only overall evaluation of GM foods as a technology (the central mediator of the system) as an endogenous factor. The four country-specific sub-samples were then further subdivided into two groups each, consisting of consumers with high factual knowledge, and consumers with low factual knowledge, respectively. The groups were defined by within-country median splits, performed on the sum score computed from the eight factual-knowledge items that had been included in the survey (see Chapter 6.3.5 and Table 6.5, above).

The groups defined by the median split on factual knowledge were then used to construct a moderator analysis by means of a multi-group design. Model 1 (equal structural consistency) constrained all regression coefficients and the equation error (i.e., the unexplained variance in overall technology evaluation) to be equal between high-knowledge and low-knowledge consumers within the respective country. Model 2 (moderated by factual knowledge) relaxed this constraint, allowing the regression coefficients and the equation error to vary between high-knowledge and low-knowledge consumers in the respective country.

Estimation. Like before, the models were estimated by means of maximum likelihood using LISREL 8.54. The Satorra-Bentler scaled χ^2 statistic was used in all computations. Estimation was based on altogether eight within-sample covariance matrices and eight within-sample asymptotic covariance matrices, computed from the Danish groups of low-knowledge (N = 173) and high-knowledge (N = 332) consumers, the German groups of low-knowledge (N = 311) and high-knowledge (N = 205) consumers, the Italian groups of low-knowledge (N = 230) and high-knowledge (N = 283) consumers, and the UK groups of low-knowledge (N = 230) and high-knowledge (N = 269) consumers.

Goodness of fit and model comparisons. Results of the moderator analysis are shown in Table 6.10. The RMSEA in the upper panel indicates that the fit of both models was satisfactory. Results in the lower panel indicate, however, that the fit of the models did not significantly differ. The Satorra-Bentler scaled χ^2-difference test yielded an insignificant result. The failure of the test is particularly noteworthy because, as noted several times before, the large sample sizes involved in the present analysis generate extremely high statistical power. The NFI, as a descriptive model-comparison measure, corroborates the test result: the improvement in model fit gained by introducing moderated structural consistencies is below 1% and therefore negligible.

Table 6.10. Factual knowledge as a moderator of structural consistency: goodness-of-fit and model comparison statistics.

		Goodness-of-fit statistics			
No.	Estimated model	Satorra-Bentler χ^2	*df*	$p <$	RMSEA
1	Equal structural consistency	1694.54	1053	.001	.049
2	Moderated by factual knowledge	1678.67	1037	.001	.049
		Stepwise model comparison statistics			
No.	Invariance constraint relaxed	Satorra-Bentler scaled $\Delta\chi^2$	Δdf	$p <$	NFI
1	None				
2	Regression coefficients and equation errors allowed to vary	11.03	16	*n.s.*	.009

Hypothesis evaluation. On the basis of the results of the moderator analysis, Hypothesis 4 has to be rejected. There was no evidence in the data to suggest that consumers with low factual knowledge are more likely than consumers with high factual knowledge to use general socio-political attitudes as a substitute for informed judgments to arrive at an overall evaluation of genetically modified foods. Hence, the assumption of a "knowledge function" of general socio-political attitudes in the context of judgments about GM foods cannot be maintained.

6.4.6. Structural Consistency and Attitude Strength: The Value Expressive Function

Model specification. Hypothesis 5 concerned the question whether general socio-political attitudes have a "value-expressive" function (Katz, 1960) for consumers, that is, whether aligning evaluations of GM foods with other strongly held attitudes strengthens the whole system, which, in turn, would invoke higher judgmental confidence whenever evaluations of GM foods are to be made. In order to test the hypothesis, the moderator analysis from the previous section was repeated, but with a different splitting variable[12]. The groups were defined by within-country median splits performed on the response to item JC1, measuring respondents' confidence in their own ability to make judgments about GM foods (see Chapter 6.3.5 and Table 6.5, above).

Again, the four country-specific sub-samples were subdivided into two groups each, consisting of consumers with high judgmental confidence, and consumers with low judgmental confidence, respectively. Two models were specified. Model 1 (equal structural consistency) constrained all regression coefficients and the equation error (i.e., the unexplained variance in overall technology evaluation) to be equal between high-confidence and low-confidence consumers within the respective country. Model 2

---

[12] Strictly speaking, the setup of this test turns the original hypothesis upside down: theoretically, we expect that higher structural consistency will lead to higher judgmental confidence, whilst operationally, we test whether consumers with higher judgmental confidence have structurally more consistent attitude systems. Yet since no further conditions are tied to the hypothesis, the logical implication is bidirectional. Therefore, the moderator analysis used below can indeed be regarded as a valid test of the original hypothesis.

(moderated by judgmental confidence) relaxed this constraint, allowing the regression coefficients and the equation error to vary between high-confidence and low-confidence consumers in the respective country.

Estimation. The same estimation method was used as before, based on eight within-sample covariance matrices and asymptotic covariance matrices computed from the Danish groups of low-confidence (N = 242) and high-confidence (N = 263) consumers, the German groups of low-confidence (N = 267) and high-confidence (N = 249) consumers, the Italian groups of low-confidence (N = 233) and high-confidence (N = 278) consumers, and the UK groups of low-confidence (N = 256) and high-confidence (N = 243) consumers, respectively.

Goodness of fit and model comparisons. Results are shown in Table 6.11. The RMSEA in the upper panel indicates that the fit of both models was satisfactory. The model comparison statistics in the lower panel indicate that this time, the inclusion of moderated effects yielded a significant improvement in model fit.

Table 6.11. Judgmental confidence as a moderator of structural consistency: goodness-of-fit and model comparison statistics.

		Goodness-of-fit statistics			
No.	Estimated model	Satorra-Bentler χ^2	*df*	$p <$	RMSEA
1	Equal structural consistency	1774.70	1053	.001	.052
2	Moderated by judgmental confidence	1726.19	1037	.001	.051
		Stepwise model comparison statistics			
No.	Invariance constraint relaxed	Satorra-Bentler scaled $\Delta\chi^2$	Δdf	$p <$	NFI
1	None				
2	Regression coefficients and equation errors	79.54	16	.001	.027

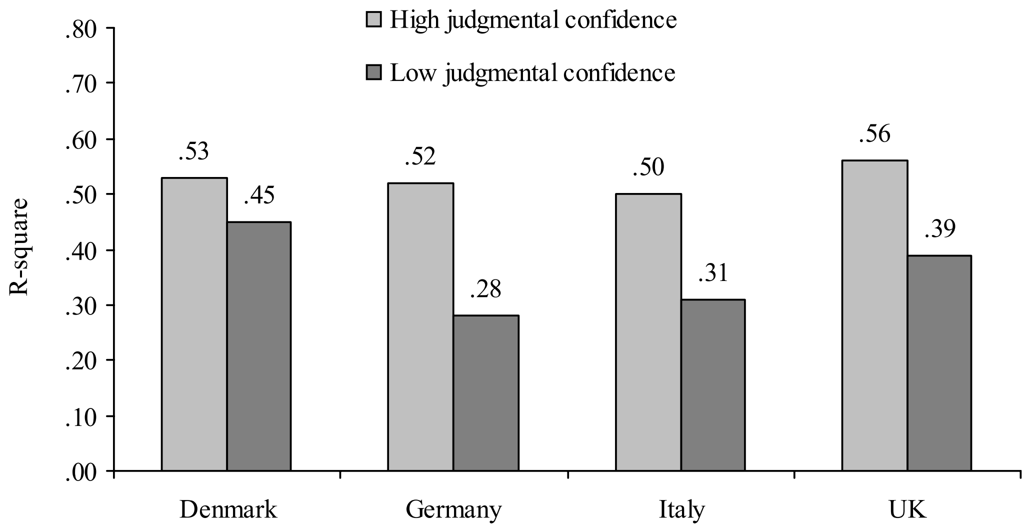

Figure 6.10. Structural consistency and judgmental confidence: degree to which global evaluations of GM foods are determined by general socio-political attitudes in groups defined by high and low judgmental confidence (values are squared multiple correlations).

The Satorra-Bentler scaled χ^2-difference was highly significant, and the NFI measured roughly 3% improvement in overall model fit. The figure may appear some-what low, but considering that a mere 16 out of 1053 degrees of freedom were lost, the result can be considered substantial.

Hypothesis evaluation. Structural consistency estimates, expressed in terms of squared multiple correlations (coefficients of determination) in the prediction of global evaluations of GM foods by means of the three general socio-political attitudes, are shown in Figure 6.10. The results indicate that higher structural consistency in the attitude system systematically co-occurred with higher judgmental confidence. Hence, Hypothesis 5 can be accepted: stating a positive or negative evaluation of GM foods seems to have a value-expressive function for consumers. The more these evaluations are linked into a system of general socio-political attitudes of higher generality, the stronger and more coherent the whole system becomes, and the more confidence it provides the individual with in situations where judgments of GM-foods issues are required.

Most importantly, the confidence effect operates independently from factual knowledge: in all four consumer populations where research had been conducted, the confidence measure was virtually uncorrelated with the factual knowledge score used in the previous analysis (the correlations between the two measures were $r = .12$ in Denmark, -.03 in Germany, -.05 in Italy, and -.03 in the UK). The confidence-bolstering effect of structural consistency appears to be genuine.

6.5. Discussion

The aim of the first study was to provide a comprehensive assessment of the structural characteristics of consumer attitudes towards genetically modified foods. This was done on a molecular level, by identifying the internal structure of these attitudes, as well as on a molar level, by assessing the structure and strength of the wider system of socio-political attitudes in which attitudes towards genetically modified foods are embedded. The theoretical framework developed in Chapter 3 was used to derive five hypotheses. These were concerned with the directionality of intra-attitudinal structures, their complexity, the directionality of inter-attitudinal structures, and their structural consistency and strength.

The empirical basis for the assessment was a large, cross-national consumer survey that had been conducted in parallel in four EU member states in the summer of 1998, just before the time the five-year moratorium on further approvals of genetically modified foods was announced. Arguably, very little has changed for consumers in the EU during the years of the moratorium. No GM products have been traded since 1998, and the heated debate that raged in the media in late 1998 and early 1999 (see Gaskell, Thompson & Allum, 2002; Bauer & Bonfadelli, 2002) – first sparked by the Pusztai affair and, shortly afterwards, the Monarch butterfly affair – has calmed down in the years since. Public opinion research reviewed in Chapter 2, notably the latest Eurobarometer results (Gaskell, Allum & Stares, 2003), appears to indicate that, at the time of writing, consumer attitudes and issue salience have returned back to the level of 1996.

Hence, we are convinced that the results presented here are as relevant now as they would have been at the end of the 1990s, had the moratorium not been announced. Possibly even more so, as the results suggest that a number of assumptions that have been made on a-priori grounds in the existing literature may have been wrong or at least questionable. This includes assumptions made in previous analyses (Bredahl, 2001; see Chapter 2.5) of the very data that were used in this study, in particular assumptions about the complexity of attitude formation processes and their direction.

6.5.1. Intra-attitudinal Structure: Bottom-up or Top-down?

Our first hypothesis challenged the ubiquitous assumption in the literature that consumer attitudes to genetically modified foods are formed from beliefs about particular risks and benefits of these foods. In the absence of personal or vicarious experience with the actual products, we argued, all beliefs European consumers hold about specific risks and benefits of genetically modified foods *must* be derived from more general evaluations, following a top-down process. In order to test the hypothesis, we fitted two types of models to the belief data from the survey.

One type of model had an algebraic structure representing bottom-up processes (a MIMIC-like model), where beliefs are aggregated into a compositional attitude. The other type of model had an algebraic structure that represented top-down processes (a factor-analytic model), where beliefs are mere instantiations of an underlying heuristic evaluation. The top-down model fitted the data substantially better than the bottom-up model, consistent with our hypothesis.

6.5.2. Intra-attitudinal Structure: How Complex?

The second hypothesis concerned the number of dimensions on which consumers make such heuristic evaluations. We tested models with one, two, and four heuristic evaluation dimensions and found that two such dimensions, heuristic benefit and heuristic risk evaluation, represented the data best. This was expected from the literature – previous research that used explorative techniques for modeling similar belief data had generally found two dimensions (e.g., Hamstra, 1995; Midden *et al*., 2002; Saba *et al.*, 2000; Saba & Vassallo, 2002).

Notably, all of these authors interpreted the results of their principal component analyses in terms of belief-based models of attitude structure, i.e. as evidence for a bottom-up process. As discussed above, this may be highly misleading. There may be two separate dimensions in belief data, but they seem to really *underlie* the beliefs and not emerge from them. An alternative interpretation of the two-dimensional structure of belief data, which could not be tested in the present study though, would be one in terms of method factors. Beliefs are commonly defined as expectations, or subjective probabilities, that an attitude object has a certain property (Eagly & Chaiken, 1993). In survey questionnaires, beliefs are usually operationalized as statements that the attitude object has that very property, to which the respondent is asked to give his or her degree of agreement.

The nature of such response scales is unipolar, that is, they do not range into the negative. In the original belief-based attitude model developed by Fishbein (1963), and in the recommendations for formulating attitude measures by Fishbein & Ajzen (1975), the valence of the property that is being asked about is operationalized separately through the evaluation dimension. In recent years, it has become somewhat unfashionable among attitude researchers to actually use the full operationalization. We tend to measure only beliefs, or only evaluations, mainly for the reason that the original product-sum specification of the Fishbein (1963) model is cumbersome to handle and yields very unreliable estimates (Evans, 1991; Schmidt, 1973).

If only belief data with unipolar response scales are collected in a survey and then entered into a factor analysis or principal component analysis, it might therefore be the case that two of the emerging factors or components merely reflect the respective positive and negative valences of the object properties that the belief items ask about. If that were the case, *any* set of beliefs that includes questions about positively valenced properties (benefits) as well as negatively valenced properties (risks) of the same attitude object should have a two-dimensional structure in exactly those cases where the attitude object is evaluated heuristically, i.e. not decomposed into its attributes before evaluations are made. A definite answer to this can only be made through future research. However, the results concerning the third research question already provide some hints about this.

6.5.3. Inter-attitudinal Structure: Bottom-up or Top-down?

Our third hypothesis challenged another pervasive assumption in the literature, namely that overall evaluations of GM foods emerge from a risk-benefit trade-off. We framed the question in terms of inter-attitudinal structures: do general socio-political attitudes *differentially* affect global evaluations of the risks of GM foods on the one hand, and global evaluations of their benefits on the other hand, which are then traded off against each other by consumers and aggregated into an overall evaluation? Without exception, all published research that included separate measures for the three evaluation constructs has made this mixed-directionality assumption a priori (Bredahl, 2001; Gaskell *et al.*, 2004; Hampel, 1999; Midden *et al.*, 2002; Siegrist, 2000).

We confronted such a model with our own prediction, namely that the attitude system is consistently layered from most general to most specific, in a genuine top-down manner: general socio-political attitudes affect overall evaluations of GM foods, and these overall evaluations, in turn, are then merely re-expressed in terms of positive valences (overall benefit evaluation) and negative valences (overall risk evaluation). In these models, we did not use belief measures but global evaluation measures. And indeed, the genuine top-down structure hypothesized by us fitted the data better than the mixed-directionality structure commonly assumed in the literature.

6.5.4. Strength of the Attitude System: Which Functions Does it Serve?

The fourth and fifth research questions were related to the inter-attitudinal structure identified above. If such a top-down system exists, which functions does it serve for an individual, and does this very function make the system weak or strong? To this end, we formulated two hypotheses about the different consequences that a “knowledge function” and a “value-expressive function” (Katz, 1960) would have on the structural consistency of the system. According to Katz’s classical treatment, attitudes that have a knowledge function serve an individual as substitutes for more informed judgments in situations where the individual does not have enough factual information available. They are preliminary in nature, and therefore generally regarded as weak and easy to influence (O'Keefe, 2002).

Value-expressive attitudes, on the other hand, serve an individual as a means to maintain a consistent self-concept. An attitude towards a given object is aligned with other, more general attitudes whose objects are associated with the specific object in question. Through this process, attitude objects may become "symbolic" objects in analogy to the notion of symbolic politics (Herek, 2000). Because such attitudes derive their valence and evaluative strength from attitudes of higher order, they are generally regarded as very strong and nearly impossible to change by simple persuasion techniques (Eagly & Chaiken, 1995).

The two hypotheses were tested by means of moderator analyses. The results were consistent with the assumption of a value-expressive function, but not of a knowledge function. Hence, the attitude system formed by the complex of general socio-political attitudes and attitudes towards GM foods has to be regarded as fairly strong, with obvious consequences for the possibilities of changing them (see below). From a functional perspective, attitudes to GM foods can be interpreted as a vehicle through which consumers express their general attitudes towards environment and nature, technology, and the institutions that they perceive to control and regulate the way modern food production works.

7. Study 2: Resistance to Persuasion

In Chapter 2.6, we reviewed all previous research that investigated whether consumer attitudes towards genetically modified foods can be changed through persuasive communication. However, not a single study had managed to actually produce an attitude change effect. Hence, the aim of Study 2 was to identify the processes that make consumer attitudes towards genetically modified foods so *resistant* to persuasion. In the following, we will first detail the research questions and hypotheses to be investigated. Then qualitative pilot research will be reported that was conducted to identify an ecologically valid set of communication strategies that major stakeholders in the GM-foods debate were planning to enact in the years to follow. After this, we will explain design and data collection of a large, cross-nationally conducted attitude change experiment. The data will then be analyzed by means of structural equation modeling, evaluating the hypotheses detailed in the beginning. Finally, results will be discussed and preliminary conclusions will be drawn.

7.1. Research Questions and Hypotheses

The central conclusion from Study 1 was that the attitudes European consumers hold towards genetically modified foods are firmly embedded in a system of general socio-political attitudes. On the inter-attitudinal level, we have shown that the system is consistently structured in a top-down manner, where general socio-political attitudes provide an "evaluative template" from which, in a first step, consumers derive their overall evaluations of GM foods as a technology. In a second step, these overall technology evaluations are further concretized into evaluations of the risks and benefits of the technology. On an intra-attitudinal level, we could also show that specific beliefs are derived in the same top-down manner from general, heuristic evaluations. On neither of the system levels, any evidence for bottom-up processes could be found that would be consistent with the assumptions of belief-based, compositional attitude formation or the existence of the risk-benefit trade-off that is ubiquitously assumed in the literature (e.g., Bredahl, 2001; Gaskell, Allum, Wagner, Kronberger, Torgersen, Hampel, & Bardes, 2004; Hampel, 1999; Saba, Rosati & Vassallo, 2000; Saba & Vassallo, 2002; Siegrist, 1999, 2000; Sparks, Shepherd & Frewer, 1995).

We concluded that these attitudes serve a value-expressive function for consumers, allowing them to maintain a consistent self-concept by aligning these attitudes with more deeply felt, general convictions about the integrity of nature, the course of technological progress, and the balance of power in society. Because such attitudes derive their valence and evaluative strength from attitudes of higher order, they are generally regarded as very strong and nearly impossible to change through simple persuasion techniques (Chaiken & Baldwin, 1981; Chaiken, Pomerantz & Giner-Sorolla, 1995; Eagly & Chaiken, 1995; Rosenberg, 1968). Arguing against such a system may seem a hopeless task, which would indeed be consistent with the results of all previous studies that have attempted to change consumer attitudes towards genetically modified foods by means of persuasive communication (Frewer, Howard, Hedderley & Shepherd, 1999; Frewer, Howard & Shepherd, 1998; Miles & Frewer, 2002; Peters, 1998, 1999a, 1999b; Scholderer & Frewer, 2003).

In this chapter, we will analyze data from one of the studies which failed to find evidence for attitude change effects (Scholderer & Frewer, 2003, see review in Chapter 2.6). Since the results are published and generally accessible, we shall not repeat the analyses of attitude change effects here. Instead, we will try to map the processes underlying *resistance* to persuasion, based on a number of additional variables and experimental manipulations that had not been reported in the Scholderer and Frewer (2003) analysis. In particular, we will probe two research questions: what changes will occur in the structural consistency of the attitude system in response to persuasive attempts, and whether consumers will change their evaluations of the information sources instead of their attitudes when the messages from the source fail to convince them of the merit of the arguments, resulting in “boomerang” effects.

7.1.1. Persuasive Attempts and Structural Consistency of the Attitude System

The first research question concerns possible changes in the structural consistency of the attitude system that can occur when consumers process the arguments purported by a persuasive message. Theoretically, the issue goes back to Tesser's (1978) schema-theoretic treatment of structural consistency and attitude change (see Chapter 3.6). If people have well-organized schemata available for the processing of incoming information, these schemata should help them in the assimilation of pro-attitudinal arguments and the refutation of counter-attitudinal arguments, resulting in higher production of evaluatively congruent thoughts. Because of these highly structured cognitive responses, we predicted, people's attitudes after the processing of information should become even more consistent with their prior attitudes than those of people who have not processed persuasive information. If people have less organized schemata, no such help would be provided, resulting in higher production of evaluatively incongruent thoughts. Hence, the following hypothesis can be formulated:

- *Hypothesis 1.* Exposure to communication materials with counter-attitudinal messages will activate the attitude system against which the messages argue. This will prompt monitoring by consumers of the compatibility between message content and attitude system, resulting in closer interrelationships within the attitude system and, following from that, smaller amounts of prediction errors in the underlying evaluation dimensions.

Tesser's assumption relies on the fact that the schemata are in fact highly organized (which the results of Study 1 suggest), and that consumers process a message systematically (Petty & Cacioppo, 1986). In situations where people are less motivated to engage active mechanism of resistance to persuasion, on the other hand, it is more likely that passive, heuristic processes of resistance occur, including selective ignorance of the arguments presented in a message, and unsystematic, peripheral attitude shifts that do not endure and do not affect the underlying evaluative dimensions (Chaiken, 1987; Festinger, 1957; Petty & Cacioppo, 1986). Should this be the case, the following hypothesis can be formulated:

- *Hypothesis 2.* Exposure to communication materials will merely add noise to consumers' attitude *statements* but not actually affect the structural consistency of the underlying system of evaluative dimensions.

The two hypotheses make different but not mutually exclusive predictions about changes in response to persuasive attempts in the consistency of consumers' attitude systems. In multiple regression models, which have been utilized in previous research to test such assumptions, the two effects would be confounded because error on a structural level cannot be separated from error on a measurement level in the dependent variables without the use of factor-analytic measurement models. The two effects predicted by Hypothesis 1 and 2 would even counteract each other and, depending on their relative size, possibly cancel each other out, making them unidentifiable in a normal regression model (see Judd & Krosnick, 1982, 1989, for more extensive discussions of this topic). In structural equation models, on the other hand, the two effects can be separated.

7.1.2. Persuasive Attempts and Re-evaluation of Source Characteristics

From the review in Chapter 2, we had concluded that attitudes towards genetically modified foods appear utterly resistant to persuasion. None of the studies that were reported in the literature had been able to change consumer attitudes by means of communication. The surface consequences of failure to persuade were partially identified in these studies, including increased production of negative cognitive responses (Peters, 1998) and decreased probabilities that an actual GM product will be purchased (Scholderer & Frewer, 2003). How the failure of persuasive attempts affects the structure and dynamics of the underlying attitude system, however, remained unknown.

Hence, the second research question concerns the effects which failure to persuade has on other variables in consumers' attitude systems than their attitude towards GM foods itself. In Chapter 3, we argued that consumers' preexisting attitudes operate as fuzzy anchors in their judgment of all incoming information of attitudinal relevance. Social judgment theory (Sherif & Hovland, 1961) predicts that if the discrepancy between the preexisting attitude and the evaluative position of the argument in the message is small, or if latitudes of acceptance and non-commitment are wide, the argument will be assimilated towards the preexisting attitude.

If the discrepancy between preexisting attitude and evaluative position of the argument is high, or if latitudes of acceptance and non-commitment are narrow, the argument will fall into consumers' latitudes of rejection: the message argument itself and all other attitudinally relevant aspects of it will be contrasted away from the preexisting attitude, including evaluations of source characteristics like the credibility of the source. If such a process occurs, counter-attitudinal arguing might backfire on the communicator through distorted judgments of the communicator's motivations. In operational terms, the third hypothesis can therefore be formulated as:

- *Hypothesis 3.* There will be a linear relationship between a person's pre-existing attitude and their evaluations of the credibility of the source of a communication, even when the effect of the source itself is experimentally controlled.

7.2. Pilot Research

A qualitative pilot study was conducted in autumn 1997[13] in order to provide ecologically valid input to the development of the information materials to be used in Study 2. The aim of the pilot study was to identify those communication strategies that the major actors in the GM-foods debate would enact in the years to follow. Altogether, 48 leading European food biotechnology experts were invited to workshops in Aarhus, Potsdam, Reading, and Milan. Participants were balanced between eleven stakeholder groups: academic research, regulating authorities, agribusiness and life sciences companies, food processing companies, public relations agencies, food industry associations, agricultural lobby organizations, retailers, the media, consumer organizations, and environmental organizations.

The Aarhus and Reading workshops were conducted at research facility meeting rooms, the Potsdam and Milan workshops at hotel conference rooms. Upon arrival, participants were given the opportunity to seat freely and accommodate themselves with the location and the workshop schedule. The group discussions were led by a trained moderator, following a standard focus group protocol:

- *Introduction*. The moderator gave a brief outline of the objectives of the workshop and assured confidential treatment of the participants' identities. The participants were then asked to introduce themselves and shortly characterize their organization (approx. 30 minutes).
- *Warm-up*. The participants were asked to construct scenarios for the future development of genetically modified foods (approx. 30 minutes).
- *Elicitation of risks and benefits*. Participants were asked to generate an exhaustive list of risks and benefits associated with the introduction of genetically modified foods to Europe. The moderator prompted the coverage of eleven content domains:

---

[13] Results of the pilot study have already been published in detail in Scholderer and Balderjahn (1999), Scholderer, Balderjahn, Bredahl and Grunert (1999) and Scholderer, Balderjahn and Will (1998). Hence, only key results will be presented here that were essential for the development of the information materials used in Study 2.

safety, health, environment, moral values, price, quality, societal usefulness, distribution of benefits, information, freedom of choice, and decision power over foodstuffs. At the end of this part, each participant was asked to indicate those three topics he or she expected the public debate to focus on in the future (approx. 3 hours).

- *Elicitation of communication strategies*. Participants were asked to outline the communication strategies their organizations were planning or already implementing, generate possible alternatives, and indicate why they expected these strategies to be effective in consumer markets (approx. 3 hours).
- *Summary and conclusion*. The moderator summarized the main results of the discussion and acknowledged participants' contribution. Once again, full confidentiality was assured. Finally, all participants were promised to receive feedback about the results of subsequent analyses (approx. 15 minutes).

A content analysis procedure similar to Knodel (1993) was chosen. In a first step, the videotaped discussions were transcribed, translated, and divided into meaningful segments. Altogether, the resulting verbal material consisted of 787 relevant segments, of which 138 (17.5 per cent) were extracted from the Danish, 288 (36.5 per cent) from the German, 99 (12.6 per cent) from the Italian, and 262 (33.3 per cent) from the British focus group data. In a second step, the segments were classified according to a previously defined category system including 11 risk-and-benefit categories (adapted from Smink & Hamstra, 1994) and 12 communication-strategy categories (adapted from Rohrmann, 1992). In a third step, the segments were paraphrased and grouped according to equivalent content.

An in-depth qualitative analysis was conducted for each category (for details, see Scholderer, Balderjahn & Will, 1998). Based on this, six prototypical communication strategies were identified: (a) a scientific information approach, (b) a balanced/general information approach, (c) a product information approach, (d) conventional product advertising, (e) conventional public relations, and (f) campaigning. A synopsis of the strategies is provided in Tables 7.1 and 7.2.

A majority of the experts who participated in the workshops favored knowledge-oriented approaches, either scientific information, balanced/general information, or product-specific information. Although the three strategies differed in terms of amount of information, time perspective, and information specificity, the assumptions about the nature of attitude formation and change processes were basically the same. Advocates of these strategies maintained that negative consumer attitudes resulted from a lack of information. Lack of information was thought to cause uncertainty about the risks and benefits of genetically modified foods and, subsequently, lead to a *preliminarily* negative evaluation of the entire technology on terms of the precautionary principle.

Table 7.1. Prototypical communication strategies in the GM foods debate: knowledge-oriented approaches (adapted from Scholderer, Balderjahn & Will, 1998).

	Communication strategy		
	Scientific information	Balanced/ general information	Product-specific information
Amount of information communicated	High	Medium	Low
Focus and specificity	Technology	Technology, consumer policy	Product
Main proponents	Academic scientists, regulators, R&D managers in companies	Industry associations	Consumer organizations, retailers
Preferred channels	Education system, textbook, brochure	Brochure	Product label, information sheets at point of sale
Time perspective	Long	Short	Short
Primary target variables	Factual knowledge about technology	Factual knowledge about technology, trust	Factual knowledge about product
Evaluations of products, technologies and actors communicated	No	Partially	No
Underlying persuasion route	central	central, peripheral	central

Table 7.2. Prototypical communication strategies in the GM foods debate: evaluation- and trust-oriented approaches (adapted from Scholderer, Balderjahn & Will, 1998).

	Communication strategy		
	Conventional product advertising	Conventional public relations	Campaigning
Amount of information communicated	Low	Low	Low
Focus and specificity	Product	Communicator, consumer policy	Communicator, consumer policy
Main proponents	Communication managers in life sciences companies and food processing companies	Communication managers in life sciences companies, industry associations, PR agencies	Environmental groups
Preferred channels	Print advertisements, TV commercials in the media	Stakeholder involvement projects, publicity in the media	News reporting in the media
Time perspective	Short	Long	Medium
Primary target variables	Product evaluation	Trust	Trust
Evaluations of products, technologies and actors communicated	Yes	Yes	Yes
Underlying persuasion route	peripheral	peripheral	peripheral

Quite consistently, the proponents of knowledge-oriented approaches expected that increasing consumers' knowledge would reduce the very uncertainty that was made responsible for negative consumer attitudes. Once the technology and its products could offer substantial consumer benefits, and risks could be excluded, communication should aim to establish accurate and factual knowledge in the public about the existence of the benefits and absence of the risks. The more educated consumer was then expected to rationally weigh risks against benefits, proceed to a positive attitude, and act upon this through an informed purchase decision.

A smaller number of experts preferred trust-oriented strategies, either in combination with a knowledge-oriented approach (adding up to the balanced/general information strategy), or as a stand-alone approach (conventional public relations and campaigning). Whilst the advocates of knowledge-oriented approaches were quite specific about the attitude formation and change processes they assumed, the advocates of trust-oriented approaches could not clearly specify the exact mechanics according to which they expected trust to function. They did seem to agree that trust was a facilitating condition for consumer's active attention and information search processes. Finally, a conventional product advertising approach was outlined, aiming to establish salient product evaluations through a message-learning approach.

Furthermore, the in-depth analysis of the results of the expert workshops provided useful information concerning the types of benefit the different stakeholders would focus on in their R&D activities as well as in their communications (for details, see Scholderer *et al.*, 1998; Scholderer *et al.*, 1999). Virtually all experts interpreted the general path of development of genetically modified foods as a generation pattern. Most products that had already reached the marketing stage were perceived to be a first generation whose quality attributes pertained to improved cultivation, processing, and distribution characteristics. Many producers expected that the second generation of GM foods would, in a medium time perspective, dominate the market for functional foods, improving the nutritional value of foods and providing healthiness as a quality attribute.

However, most experts conceded that the second generation was still at an early stage of product development. Hence, the consumer benefits of currently existing GM foods amounted mainly to potential price advantages. It was assumed that decreases in the price of raw materials would carry over to subsequent stages of the production chain and finally enhance the price-performance ratio of consumer goods. Finally, a third key benefit was seen in the potential for more sustainable production. Reduced herbicide expenditure in agriculture, or reduced energy expenditure during manufacturing, were seen as powerful arguments to convince ecologically oriented consumers.

7.3. Method

7.3.1. Participants

In June and July 1999, *N* = 1405 consumers from Denmark, Germany, Italy, and the United Kingdom participated in attitude change experiments. All participants were recruited in major malls during shopping hours. Passing shoppers were addressed at random. Upon agreement to participate, participants were screened according to five inclusion criteria:

- *Responsibility for shopping.* The interviews were only continued when the participant was the main or joint household shopper.
- *Recency of category purchase.* The interviews were only continued when the participant had purchased bottled beer or yoghurt for home consumption during the previous four weeks,
- *Consumption frequency.* The interviews were only continued when the participant consumed bottled beer at home at least once a week (for inclusion in the beer sub-sample) or consumed yoghurt at least once a week (for inclusion in the yoghurt sub-sample),
- *Familiarity with key concept.* The interviews were only continued when the participant had heard of genetic modification or an equivalent term (e.g., genetic engineering or biotechnology), and
- *Prior attitude.* The interviews were only continued when the participant did not hold extreme prior attitudes towards gene technology in food production. Prior attitudes were assessed using the three items (A1, A2 and A3) that had already been used for measuring overall evaluations of GM foods as gene technology in food production used in Study 1. Respondents who marked the lowest possible evaluation on all three items were excluded from the interviews.

As in Study 1, half of the participants were regular beer consumers, the other half were regular yoghurt consumers. Demographic characteristics of the final sample are provided in Table 7.3.

Table 7.3. Demographic characteristics of Study 3 participants.

	Country				
Variable	Denmark	Germany	Italy	UK	Total
Sample Size					
Total *N*	352	350	350	353	1405
Beer consumers	176	175	175	170	696
Yoghurt consumers	176	175	175	183	709
Age					
Total *M (SD)*	33.03 (14.49)	32.65 (15.86)	34.14 (11.56)	28.96 (09.40)	32.27 (13.53)
Beer consumers	31.57 (13.24)	32.87 (15.91)	34.17 (11.25)	24.67 (05.33)	31.07 (12.99)
Yoghurt consumers	34.50 (15.53)	32.44 (15.84)	34.09 (11.90)	32.95 (10.55)	22.46 (13.95)
Sex					
Total *% female (male)*	45.8 (54.2)	39.4 (60.6)	53.9 (46.1)	41.6 (58.4)	44.7 (55.3)
Beer consumers	35.4 (64.6)	18.5 (81.5)	51.7 (48.3)	1.2 (98.8)	26.6 (73.4)
Yoghurt consumers	56.2 (43.8)	60.3 (39.7)	56.1 (43.9)	79.2 (20.8)	62.5 (37.5)
Family status					
Total *% single (cohabit.)*	64.4 (35.6)	57.8 (42.2)	66.2 (33.8)	59.2 (40.8)	61.7 (38.3)
Beer consumers	64.6 (35.4)	60.2 (39.8)	65.9 (34.1)	72.9 (27.1)	65.3 (34.7)
Yoghurt consumers	64.2 (35.8)	55.4 (44.6)	66.5 (33.5)	46.4 (53.6)	58.1 (41.9)
Household size					
Total *Median (Min, Max)*	2 (1, 6)	3 (1, 9)	4 (1, 7)	2 (1, 5)	2 (1, 9)
Beer consumers	2 (1, 6)	3 (1, 6)	4 (1, 7)	3 (1, 5)	2 (1, 6)
Yoghurt consumers	2 (1, 6)	3 (1, 9)	3 (1, 7)	2 (1, 5)	2 (1, 9)

7.3.2. Choice Sets

Choice sets were developed for two product categories: beer and yoghurt. Each choice set contained four product alternatives, in both cases only slight modifications of the product alternatives used in the pilot research for Study 1 (see Chapter 5.2). The beer products varied with respect to the attributes (a) production method, (b) energy consumption during production (indicating environmental friendliness), (c) quality of raw materials, and (d) price. 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 the study. In this way, identical products were obtained for all alternatives, except for the label information. To make the product examples still more realistic, the following brand names were assigned:

- *"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.
- *"Brewmaster's Steinfurter"*. Beer produced in a traditional way from high quality raw materials, sold at a medium price
- *"Brewmaster's Muehlberger"*. Beer produced in a traditional way from standard quality raw materials, sold at a low price.
- *"Brewmaster's Alfelder"*. Beer produced by means of modern process technology (specified as not gene technology), ensuring that the production process becomes less time and energy consuming, and thus more environmentally friendly, sold at low price.

Thus, the consumer benefits of applying genetic engineering were environmentally sound production and a lower price. All products were used for visual presentation only. The yoghurt products, on the other hand, varied with respect to the attributes (a) fat content, (b) production method, (c) presence of additives, and (d) texture. Naturalistic yoghurt products were created from new yoghurt cups that were filled with a substance resembling yoghurt in weight and filling, and provided with labels containing the relevant product information. In this way, identical products were obtained for all alternatives, except for the label information. The yoghurts were assigned a joint brand name ("Dairy fresh"):

- *"Dairy Fresh 0.05% fat, genetically modified".* Fat-free yoghurt produced with genetically modified starter culture, characterized as having a nice taste and smooth texture
- *"Dairy Fresh 0.05% fat".* Fat-free yoghurt produced with stabilizers and antioxidants, characterized as having a nice taste and smooth texture
- *"Dairy Fresh 0.1% fat".* Traditional low-fat skim-milk yoghurt without additives, characterized as having a nice taste but somewhat thin texture (owing to the low fat content).
- *"Dairy Fresh 3% fat".* Traditional full-fat whole-milk yoghurt without additives, characterized as having a nice taste and smooth texture.

Here, the consumer benefits of applying genetic engineering were absence of fat and a smooth texture without the use of artificial additives. Again, all products were used for visual presentation only.

7.3.3. Information Materials

Information materials were developed to match those two communication strategies identified in the pilot study (see above; also see Scholderer *et al.*, 1998; Scholderer et al., 1999) that assumed immediate effects on consumer attitudes and, furthermore, could realistically be enacted by different stakeholder groups such as the food industry, consumer organizations, or public bodies[14]. The resulting materials were:

---

[14] As already noted above, the data analyzed here were part of a larger design that included a number of additional types of communication strategies in the Danish and German sub-samples which could not reasonable be attributed to different sources. Attitude change and product choice effects in those groups have already been analyzed and published by Scholderer and Frewer (2003) and will therefore not be repeated here.

- *Balanced/general information*. A four-page glossy brochure presented important facts about food biotechnology, outlined the main arguments of proponents and opponents, and revealed their stake in the issue (see Appendix 2).
- *Product-specific information*. One-page information leaflets described either the genetically modified beer ("Brewmaster's Korbacher") or the genetically modified yoghurt ("Dairy Fresh 0.05% fat, genetically modified"), focusing on physical product attributes and how they relate to genetic modification (see Appendix 3).
- *No information (control)*. Participants assigned to the control condition did not receive any additional information.

Furthermore, the source of the information was experimentally varied in the balanced/general and in the product-specific information conditions. The information materials were either attributed to a fictitious "European Association of Industry" (an industry source), to a fictitious "European Association of Consumers" (a consumer source), or to the European Commission (a government source).

7.3.4. Procedure

When all inclusion criteria were met, participants were assigned to one of the two product choice conditions and received the four product alternatives of the respective choice set for evaluation (either beer or yoghurt). At the same time, participants were assigned at random to one of the three information conditions (either balanced/general information, product-specific information, or no information/control) and received the respective information materials. In the balanced/general and product-specific information conditions, participants were assigned at random to one of the three source attribution conditions. Participants in the control group did not receive any information in addition to the labeled products. Participants were allowed to evaluate the information materials and product alternatives as long as they liked.

After participants had indicated that they did not want to further evaluate the information materials and product alternatives, they were asked to rank the four product alternatives according to personal preference[15]. Having completed the preference task, participants were asked to answer a set of questions about their overall evaluations of the risks and benefits of genetically modified foods (the same measures as in Study 1) and about their trust in the source of information to which the materials had been attributed (adapted from Frewer, Howard, Hedderley & Shepherd, 1996). At the end of the experiment, all respondents were issued with a disclaimer indicating that the information materials had, in fact, not been issued by these organizations and that the European Association of Industry and the European Association of Consumers did not exist.

7.3.5. Experimental Design

Within each of the four countries where research was conducted, the experimental design included three between-subjects factors: (a) communication strategy, (b) attributed source, and (c) the product example given to participants for visual evaluation. Crossing of these factors resulted in a 3 (balanced/general information, product-specific information, control) × 3 (European Association of Industry, European Association of Consumers, European Commission) × 2 (genetically modified beer with environmental and price benefits, yoghurt with a health benefit) design. The design was incomplete with respect to the crossing of strategy and source: a variation of the source of the communication materials was not possible in the control group (no information, no source). Within each country, 50 participants were assigned to each cell of the design.

Unlike in Study 1, the samples involved here were *not* population-representative and differed considerably in their demographic characteristics (see Table 7.3, above). Hence, no attempts will be made to examine the invariance of modeling results across the four countries where the research was conducted.

---

[15] As noted before (see previous footnote), the product choice data have already been analyzed and published by Scholderer and Frewer (2003). We only include the detailed description of the product choice task here in order to give a full account of the materials participants were confronted with. Since evaluations of source expertise and trustworthiness as well as of overall benefits and risks of GM foods were measured after the choice task, the variation in the tasks constitutes part of the experimental intervention and is captured by the factor "product example".

7.3.6. Measures

Participants' attitudes towards GM foods were assessed twice: before and then again after the experimental intervention. Before the intervention, they were assessed on one dimension: overall evaluation of GM foods as a technology. After the intervention, attitudes were assessed on two dimensions: (a) overall benefit evaluation and (b) overall risk evaluation. Different measures were used before and after the experimental intervention to make sure that no "Hawthorne"-like context effects would bias participants' post-experimental attitudes. Evaluations of the sources to which the materials had been attributed were measured after the intervention as well. This was done on two dimensions: (a) evaluation of source expertise, and (b) evaluation of source trustworthiness.

Overall evaluation of genetically modified foods as a technology. Participants' overall evaluations of the technology were measured before to the experimental intervention, using three items already used in Study 1: (A1) "Applying gene technology in food production is ...", to be answered on a seven-point scale ranging from "extremely bad" to "extremely good", (A2) "Applying gene technology in food production is ...", to be answered on a seven-point scale ranging from "extremely foolish" to "extremely wise", and (A3) "I am strongly ... applying gene technology in food production", to be answered on a seven-point scale ranging from "strongly against" to "strongly for".

Overall benefit evaluation. Participants' overall benefit evaluations were measured after the intervention, using three items which had already been used in Study 1 as well. Each was answered on seven-point scales ranging from "strongly disagree" to "strongly agree": (B1) "Overall, applying gene technology to produce food products will prove beneficial to the environment, myself and other people that are important to me", (B2) "Overall, applying gene technology to produce food products will offer great benefits to the environment, myself and other people that are important to me", and (B3) "Overall, applying gene technology to produce food products will prove advantageous to the environment, myself and other people that are important to me".

Overall risk evaluation. Participants' overall risk evaluations were also measured after the experimental intervention, using another three items from Study 1, again to be answered on seven-point scales ranging from "strongly disagree" to "strongly agree":

(R1) “Overall, applying gene technology to produce food products involves considerable risk to the environment, myself and other people that are important to me”, (R2) “Overall, applying gene technology to produce food products will prove harmful to the environment, myself and other people that are important to me”, and (R3) “Overall, applying gene technology to produce food products will prove disadvantageous to the environment, myself and other people that are important to me”.

Evaluation of source expertise. Participant’s evaluations of the expertise of the source to which the information materials had been attributed were measured after the experimental intervention, measured by six items adapted from Frewer; Howard, Hedderley and Shepherd (1996), including (SE1) “Information about food-related hazards from SOURCE is trustworthy”, (SE2) “Information about food-related hazards from SOURCE is accurate”, (SE3) “Information about food-related hazards from SOURCE is factual”, (SE4) “The SOURCE is knowledgeable about food related hazards”, (SE5) “The SOURCE feels a responsibility to provide good food-related information to the public”, and (SE6) “The SOURCE has a good track record of providing information about food-related hazards”. All items were answered on seven-point scales ranging from “strongly disagree” (1) to “strongly agree” (7).

Evaluation of source trustworthiness. Participant’s evaluations of the trustworthiness of the source to which the information materials had been attributed were measured after the experimental intervention as well, measured by another four items adapted from Frewer *et al*. (1996), including (ST1) “The SOURCE is likely to withhold information about food-related issues from the public”, (ST2) “Information about food-related hazards from SOURCE is distorted”, (ST3) “Information about food-related hazards from the SOURCE has been proven wrong in the past”, and (ST4) “The SOURCE provides accurate information about food-related hazards only to protect themselves and their own interests”. All items were answered on seven-point scales ranging from “strongly disagree” (1) to “strongly agree” (7). Means and standard deviations of all items are listed in Table 7.4.

Table 7.4. Means and standard deviations of measures.

Variable	Country				Total
	Denmark *M (SD)*	Germany *M (SD)*	Italy *M (SD)*	UK *M (SD)*	*M (SD)*
Overall technology evaluation					
A1	3.28 (1.46)	3.45 (1.48)	3.57 (1.64)	3.58 (1.15)	3.47 (1.44)
A2	3.59 (1.45)	3.71 (1.51)	3.73 (1.56)	3.58 (1.14)	3.65 (1.42)
A3	3.47 (1.59)	3.43 (1.58)	3.50 (1.68)	3.56 (1.17)	3.49 (1.52)
Overall benefit evaluation					
B1	3.46 (1.61)	3.71 (1.66)	3.61 (1.66)	3.61 (1.44)	3.60 (1.59)
B2	3.48 (1.66)	3.73 (1.65)	3.67 (1.70)	3.65 (1.53)	3.63 (1.64)
B3	3.54 (1.58)	3.64 (1.67)	3.67 (1.62)	3.69 (1.44)	3.63 (1.58)
Overall risk evaluation					
R1	4.30 (1.67)	4.09 (1.80)	4.11 (1.78)	4.04 (1.53)	4.14 (1.70)
R2	4.13 (1.65)	3.69 (1.76)	4.09 (1.78)	4.01 (1.52)	3.98 (1.69)
R3	4.09 (1.59)	3.79 (1.72)	4.07 (1.77)	4.05 (1.45)	4.00 (1.64)
Evaluation of source expertise					
SE1	3.56 (1.31)	3.86 (1.50)	4.32 (1.43)	3.84 (1.24)	3.89 (1.40)
SE2	3.37 (1.27)	4.16 (1.47)	3.93 (1.37)	3.78 (1.08)	3.81 (1.34)
SE3	3.69 (1.22)	4.23 (1.41)	4.09 (1.39)	4.07 (1.12)	4.02 (1.30)
SE4	4.45 (1.40)	4.46 (1.37)	4.67 (1.34)	4.69 (1.14)	4.57 (1.32)
SE5	4.20 (1.48)	4.43 (1.44)	4.56 (1.42)	4.75 (1.27)	4.48 (1.42)
SE6	3.62 (1.14)	3.83 (1.26)	4.33 (1.21)	3.82 (1.00)	3.90 (1.18)
Evaluation of source trustworthiness					
ST1	4.50 (1.44)	4.46 (1.63)	4.03 (1.52)	4.35 (1.39)	4.34 (1.51)
ST2	3.93 (1.35)	3.39 (1.42)	3.60 (1.39)	4.10 (1.22)	3.76 (1.38)
ST2	4.34 (1.04)	3.80 (1.30)	3.97 (1.17)	4.57 (1.13)	4.17 (1.20)
ST4	4.18 (1.34)	3.97 (1.49)	3.65 (1.57)	4.20 (1.29)	4.00 (1.44)

7.4. Analysis and Results

Data analysis and results will be presented in two parts. First, we will concentrate on the effects which our attempts to persuade consumers of the benefits of GM foods had on the structural consistency of their attitude systems (Hypotheses 1 and 2). In the second part, we will focus on the more "active" processes we assumed to underlie resistance to persuasion, in terms of the effects that the content of the attempts had on evaluations of source characteristics. Within each of the two parts, we will start with the models to be estimated, then report details of the estimation, and finally compare the different models by appropriate techniques in order to provide answers to the hypotheses, along with estimates of the model parameters.

7.4.1. Effects of Persuasive Attempts on the Structural Consistency of Attitudes

Model specification. Hypothesis 1 and 2 made different but not mutually exclusive predictions about changes in the consistency of consumers' attitude systems in response to persuasive attempts. Hypothesis 1 was based on our assumption that exposure to communication materials that contains counter-attitudinal messages would activate the very attitude system against which the messages argued, thereby facilitate the identification of pro-attitudinal and the refutation of counter-attitudinal arguments, which then should result in increased structural consistency of the attitude system. Operationally, this would be observable in terms of closer interrelationships within the attitude system and, following from that, smaller amounts of prediction errors in the underlying evaluation dimensions when they are predicted by other evaluative dimensions in the system.

Hypothesis 2, on the other hand, assumed that persuasive attempts would merely add noise to consumers' attitude statements but not actually affect the structural consistency of the underlying system of evaluative dimensions. In multiple regression models, which have in been utilized in previous research to test such assumptions, the two effects would be confounded because error on a structural level (structural consistency, in the terminology we use here) cannot be separated from error on a measurement level in the dependent variables (noise) without the use of factor-analytic measurement models. The two effects predicted by Hypothesis 1 and 2 would counteract each other in a normal regression model and possibly cancel each other out, making them unidentifiable in a normal regression model. In structural equation models, on the other hand, the two effects can be separated.

To test the two hypotheses, a framework model was adapted from Study 1. Overall evaluation of GM foods as a technology, measured before the experiment, was specified as a latent exogenous factor, measured by the same three items as in Study 1 (A1, A2 and A3). Overall evaluation of the benefits of GM foods and overall evaluation of the risks of GM foods, both measured after the experiment, were specified as latent endogenous factors, also measured by the same items as in Study 1 (B1, B2, B3 and R1, R2, R3, respectively). The model is depicted in Figure 7.3.

Based on this framework, a moderator analysis was then constructed by means of a multiple group design. The four country-specific sup-samples from Denmark, Germany, Italy and the UK were further subdivided into two groups each: the first group consisted of all participants who had received information materials, whilst the other group consisted of participants in the control group, who had not received information materials. Model 1 (equal consistency) imposed, within countries, a set of equality constraints, defining all parameters to be equal in information and control groups. Model 2 (moderated structural consistency) relaxed the constraints on the structural consistency parameters, allowing regression coefficients and equation errors to vary between the information and control groups. Model 3 (moderated noise) further relaxed the constraints on measurement errors in the observed endogenous variables, allowing them to vary between the information and control groups. The models are hierarchically nested and can be compared by means of χ^2-difference tests.

Normality check. Multivariate skewness and kurtosis measures were computed for the joint distribution of the observed variables within each of the eight samples. Within the Danish information group, the multivariate skewness was 13.78 (Z = 16.70, p < .001) and the multivariate kurtosis was 149.14 (Z = 13.91, p = .001). Taken together, the multivariate distribution deviated significantly from normality (overall χ^2 = 472.49, p < .001). The same was true for the Danish control group (skewness = 43.42, Z = 8.42, p < .001; kurtosis = 127.42, Z = 4.70, p < .001; overall χ^2 = 93.04, p < .001).

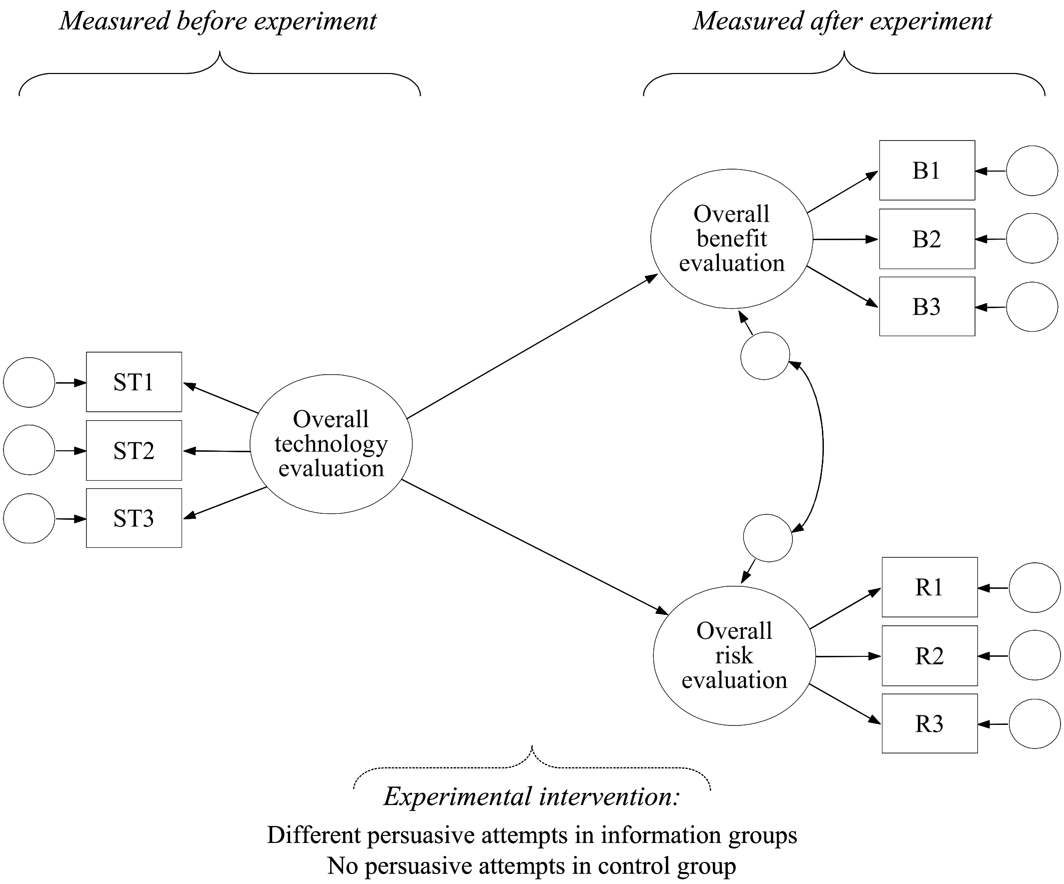

Figure 7.1. Framework model for tests of moderated structural consistency.

Similar conditions were found in the German information group (skewness = 6.98, Z = 7.77 p < .001; kurtosis = 127.47, Z = 10.29, p < .001; overall χ^2 = 166.24, p < .001), the Italian information group (skewness = 36.07, Z = 33.26, p < .001; kurtosis = 192.68, Z = 18.098, p < .001; overall χ^2 = 1433.66, p < .001) (skewness =, Z =, p < .001; kurtosis =, Z =, p < .001; overall χ^2 =, p < .001), and the UK information group (skewness = 13.43, Z = 16.48, p < .001; kurtosis = 151.06, Z = 14.23, p < .001; overall χ^2 = 474.13, p < .001). Hence, corrections for non-normality will be used in all subsequent analyses, in the same manner as we did in Study 1.

Estimation. All models were estimated by means of maximum likelihood using LISREL 8.54 (Jöreskog & Sörbom, 1996; Jöreskog, Sörbom, du Toit & du Toit, 1999, 2003). To account for the non-normality detected in the data, the Satorra-Bentler scaled

χ^2 statistic was used in all computations instead of the normal minimum fit-function χ^2 (Satorra & Bentler, 1988; see Chapter 5.2.5). Estimation was based on within-sample covariance matrices and asymptotic covariance matrices computed from the Danish information (N = 301) and control groups (N = 51), the German information (N = 300) and control groups (N = 50), the Italian information (N = 300) and control groups (N = 50), and the UK information (N = 302) and control groups (N = 51). All models were estimated simultaneously in the four groups. At this stage, no equality constraints were imposed on parameters across countries, and no mean structures were included in the models.

Goodness-of-fit. Model-wise goodness-of-fit statistics are presented in the upper part of Table 7.5. Given that the present analysis involved samples almost as large (total N = 1405) as the ones in Study 1, we had expected that problems of excessive statistical power would occur here as well. However, the overall goodness-of-fit χ^2 only indicated significant deviations of model-implied from observed covariance matrices for Models 1 and 2, but not for Model 3. The RMSEA, as a descriptive measure of model-wise fit, remained within conventional acceptance limits (RMSEA < .080; Browne & Cudeck, 1993) for all models, but was somewhat lower for Model 3 than for Models 1 and 2.

Model comparisons. Stepwise model comparisons are shown in the lower part of Table 7.5. The explicit model comparison test, using Satorra and Bentler's scaled χ^2-difference statistic (Satorra, 2000; Satorra & Bentler, 1999; see Chapter 5.2.5), indicated that no significant improvement of model fit occurred when Model 1 (equal consistency) was compared to Model 2 (moderated structural consistency), where the within-country constraints between information and control groups on the regression coefficients and equation errors had been relaxed. However, the tests did indicate significant improvement of model fit in the comparison of Model 2 (moderated structural consistency) and Model 3 (moderated noise). The stepwise NFI, as a descriptive measure of comparative fit, indicated that the relative improvement in model fit in this step was 19%, whilst it had only been 5% in the first step.

Table 7.5. Tests of moderated structural consistency and moderated measurement errors: goodness-of-fit and model comparison statistics.

		Goodness-of-fit statistics			
No.	Estimated model	Satorra-Bentler χ^2	*df*	*p* <	RMSEA
1	Equal consistency	600.68	329.02	.010	.037
2	Moderate structural consistency	576.90	314.21	.010	.040
3	Moderated noise	473.20	253.76	*n.s.*	.028
		Stepwise model comparison statistics			
No.	Invariance constraint relaxed	Satorra-Bentler scaled $\Delta\chi^2$	Δdf	*p* <	NFI
1	None				
2	Regression coefficients and equation error variances	14.00	20	*n.s.*	.045
3	Endogenous measurement error variances	68.48	20	.001	.192

Parameter estimates. Although highly significant, the absolute differences in the amount of noise in participants' attitude statements were rather small in size. Averaged over the four countries, and cumulated over the six attitude statements by which the endogenous factors had been measured, the unstandardized measurement error variance in the observed endogenous variables was 4.60 in the information groups, and 4.38 in the control groups.

Hypothesis evaluation. Based on the results of the model comparisons, Hypothesis 1 cannot be upheld. Our expectation had been that we would observe increased structural consistency in consumers' attitude systems after the attitude system had been activated by persuasive attempts. However, no evidence for this could be found in the data. Hypothesis 2, on the other hand, can be maintained. Here, our expectation had been that persuasive attempts would add random error to consumers' attitude statements without actually increasing the variation in the underlying evaluative dimension. Hence, we referred to this as a "moderated noise" model. And indeed, the data were in line with the predictions made in the model, even though the effect was small in size. It can be preliminarily concluded that the attempts made in this study to persuade consumers of the benefits of genetically modified foods neither weakened nor strengthened the coherence of the underlying attitude system. The additional variation in consumers' attitude *statements* amounts to mere measurement error, whilst the underlying evaluative dimensions were unaffected in their structural consistency.

7.4.2. Effects of Persuasive Attempts on Evaluations of Source Characteristics

Model specification. Hypothesis 3 predicted that the communication of counter-attitudinal arguments would backfire on the communicator through distorted judgments of the communicator's motivations by the receivers of the message. In operational terms, a linear relationship was expected between consumers' preexisting attitude and their evaluations of the credibility of the source of the communication materials, even when the effect the source itself was statistically controlled.

In order to test the hypothesis, participants' overall evaluation of GM foods as a technology, measured before the experimental intervention, was specified as a latent exogenous factor (measured by the same items as before; A1, A2 and A3). Evaluations of source expertise and source trustworthiness, measured after the experimental intervention, were specified as latent endogenous factors (measured by items SE1, SE2, SE3, SE4, SE5, SE6, and ST1, ST2, ST3, ST4, respectively). The main effects of the two communication strategies, the three information sources to which the materials had been attributed, and the two example products which participants had been confronted with, were encoded by means of dummy variables.

The dummy variables were constructed using the effect coding scheme, with the respective effect category coded as +1, the neutral categories, if present, as 0, and the comparison category as –1. Since *k*–1 dummy variables are required to encode a *k*-level experimental factor, the procedure resulted in one dummy for the experimental factor "communication strategy", two dummies for the experimental factor "attributed information source", and one dummy for the experimental factor "example product". Interaction dummies were then obtained by multiplying the dummies encoding the respective main effects. Each of the altogether eleven dummy variables was then defined as an identity transformation of a separate latent exogenous factor ξ_i, with factor loading fixed to $\lambda_{ii} = 1$ and measurement error variance fixed to $\theta_{ii} = 0$. The full model is outlined in Figure 7.4. Step by step, the constraints were then relaxed in the same way as in a normal analysis of variance.

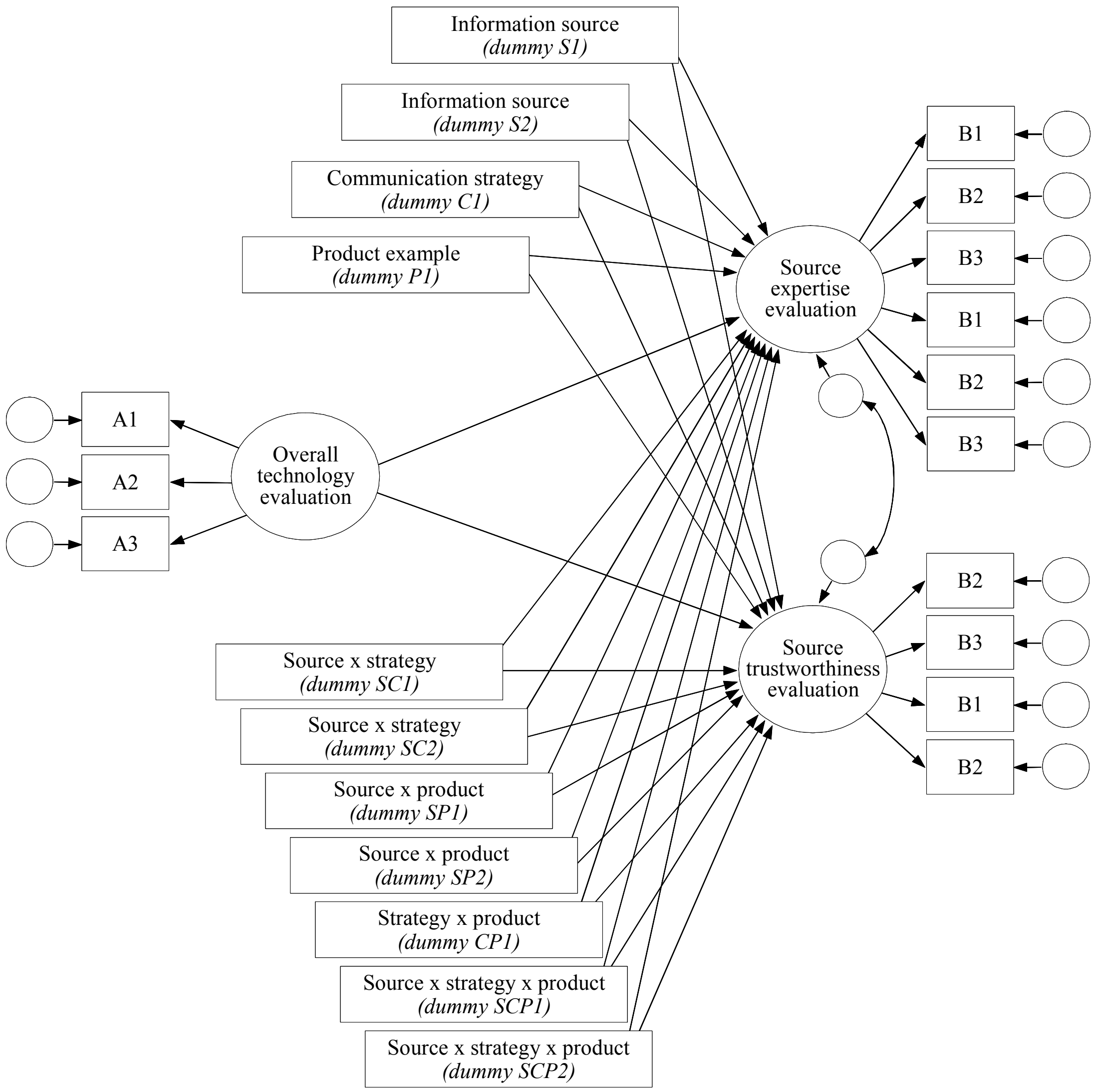

Figure 7.2. Framework model for testing the effects of persuasive attempts on evaluations of source characteristics.

Normality check. Multivariate skewness and kurtosis statistics were computed for the joint distribution of the observed variables within each of the four country-specific sub-samples. The multivariate distribution deviated significantly from normality in the Danish (skewness = 157.31, $Z = 48.46$, $p < .001$; kurtosis = 650.63, $Z = 6.08$, $p < .001$; overall $\chi^2 = 2384.92$, $p < .001$), German (skewness = 154.24, $Z = 47.26$, $p < .001$; kurtosis = 645.31, $Z = 5.20$, $p < .001$; overall $\chi^2 = 2260.12$, $p < .001$), Italian (skewness = 166.09, $Z = 51.14$, $p < .001$; kurtosis = 657.59, $Z = 7.12$, $p < .001$; overall $\chi^2 = 2665.82$, $p < .001$), and UK samples (skewness = 162.47, $Z = 50.67$, $p < .001$; kurtosis = 670.92, $Z = 8.97$, $p < .001$; overall $\chi^2 = 2648.336$, $p < .001$). Hence, corrections for non-normality will be used here as well.

Estimation. Like before, all models were estimated by means of maximum likelihood using LISREL 8.54, and the Satorra-Bentler scaled χ^2 statistic was used in all computations. Estimation was based on within-sample covariance matrices and asymptotic covariance matrices computed from the Danish ($N = 301$), German ($N = 300$), Italian ($N = 300$), and UK ($N = 302$) information groups. Participants in the control groups were excluded from the analysis because they had not received any information materials and could therefore not evaluate any sources. All models were estimated simultaneously in the four groups. At this stage, no equality constraints were imposed on parameters across countries, and no mean structures were included in the models.

Goodness-of fit. Model-wise goodness-of-fit statistics are presented in the upper part of Table 7.6. Apart from the first model that assumed complete independence of endogenous from exogenous variables, all models fitted exceptionally well.

Model comparisons. Model comparison statistics are presented in the lower part of Table 7.6. The explicit model comparison test indicated significant improvements in model fit when prior overall technology evaluation was entered into the model (Model 2), when the experimentally varied source factor was entered into the model (Model 3), and when the interaction between the experimentally varied information strategy and the information source was entered into the model (Model 6). All other model comparisons remained insignificant.

Table 7.6. Effects of persuasive attempts on source evaluations: goodness-of-fit and model comparison statistics.

		Goodness-of-fit statistics			
No.	Effect on source evaluations entered into model	Satorra-Bentler χ^2	*df*	*p* <	RMSEA
1	No effects	1113.11	1032	.050	.016
2	Prior overall technology evaluation	1049.87	1024	*n.s.*	.009
3	Information source	993.77	1008	*n.s.*	.000
4	Information strategy	986.76	1000	*n.s.*	.000
5	Example product	976.41	992	*n.s.*	.000
6	Source x strategy	950.11	976	*n.s.*	.000
7	Source x product	938.05	960	*n.s.*	.000
8	Strategy x product	934.08	952	*n.s.*	.000
9	Source x strategy x product	916.32	936	*n.s.*	.000

		Stepwise model comparison statistics			
No.	Effect on source evaluations entered into model	Satorra-Bentler scaled $\Delta\chi^2$	Δdf	*p* <	NFI
1	None				
2	Prior overall technology evaluation	52.87	8	.001	.057
3	Information source	92.03	16	.001	.053
4	Information strategy	6.86	8	*n.s.*	.007
5	Example product	11.93	8	*n.s.*	.010
6	Source x strategy	33.19	16	.010	.027
7	Source x product	10.92	16	*n.s.*	.013
8	Strategy x product	3.30	8	*n.s.*	.004
9	Source x strategy x product	18.36	16	*n.s.*	.019

The stepwise NFI, as a descriptive measure of comparative fit, indicated that the relative improvement in model fit due to the inclusion of prior overall technology evaluation was 5.7%. The improvement due to inclusion of the experimentally varied source was somewhat smaller at 5.3%, and the improvement due to the interaction between source and strategy was still smaller at 2.7%. Effect sizes in terms of predictive validities, i.e. partial squared multiple correlations with the dependent variables that can be attributed to the respective factor, are shown in Table 7.7.

Hypothesis evaluation. The linear effect of participants' preexisting attitudes, measured in terms of their prior evaluation of the technology, explained 7% of the reliable variance in their evaluations of the expertise and 10% in their evaluations of the trustworthiness of the source to which the information materials had been attributed. Based on the modeling results, Hypothesis 3 can therefore be accepted. Moreover, the effects of preexisting attitudes were almost twice as high as the effects of the source factor itself, suggesting a substantial result.

Table 7.7. Effect sizes (partial squared multiple correlations for each effect; within countries).

	Country				
	Denmark	Germany	Italy	UK	Average R^2
Dependent: Source expertise evaluation					
Prior overall technology evaluation	.08	.08	.03	.05	.07
Attributed information source	.02	.02	.04	.05	.04
Information source x communication strategy	.01	.03	.01	.01	.00
Dependent: Source trustworthiness evaluation					
Prior overall technology evaluation	.08	.03	.05	.07	.10
Attributed information source	.02	.04	.05	.04	.06
Information source x communication strategy	.03	.01	.01	.00	.02

7.5. Discussion

One of the perplexing conclusions from the literature on consumer attitudes to GM foods had been that not a single study ever managed to produce an attitude change effect. In the theoretical reconstruction in Chapter 3, we outlined a number of possible reasons for this. The aim of Study 2 was to identify the processes that make consumer attitudes towards genetically modified foods so resistant to persuasion. To this end, we reanalyzed data from one of the studies that had failed to find evidence for attitude change effects (Scholderer and Frewer, 2003; see review in Chapter 2.6). The analysis was based on a number of additional variables and experimental manipulations that had not been included in the Scholderer and Frewer (2003) analysis. We investigated two research questions: (a) what changes occurred in the structural consistency of consumers' attitude systems in response to failing attempts to persuade, and (b) whether consumers changed their evaluations of the credibility of information sources instead of their attitudes when messages from the source failed to convince them of the merit of the arguments.

7.5.1. Resistance to Persuasion: Active or Passive?

We based our first hypothesis on Tesser's (1978) schema-theoretic conceptualization of structural consistency and attitude change. The value-expressive attitude system identified in Study 1, we expected, would provide consumers with a well-organized attitudinal schema for the processing of incoming information. Once activated, the schema should help consumers in the assimilation of pro-attitudinal arguments and in the refutation of counter-attitudinal arguments, resulting in increased structural consistency of their attitudes (Tesser & Shaffer, 1990). Unfortunately, such an effect could not be found. People in the experimental groups who had been exposed to our benefit communication materials showed no increases in structural consistency as compared to people in the control group, who had not been exposed to such information.

From this, it appears that an "active mode" of resistance to persuasion, using systematic schema-driven processing to withstand the persuasive attempts, is not the main mechanism underlying resistance to persuasion in the present case. However, the consistencies between attitudes before and attitudes after the experiment had been extremely high in all groups in the first place, including the control group. Hence, a ceiling effect may have occurred, rendering the experimental manipulation ineffective. Another explanation might be that the mere measurement of attitudes before the experiment sensitized the participants in the control group as well. If the Fazio, Sanbonmatsu, Powell and Kardes (1986) results about the automatic activation of attitudes are interpreted in a strict way, the mere measurement of attitudes may indeed have primed the whole system to the same degree as the information materials in the experimental groups did.

The second hypothesis concerned “passive modes” of resistance. In situations where people feel unmotivated to engage in active resistance to persuasion, we argued, it would be more likely that they would use passive, heuristic processes of resistance such as selective ignorance of the arguments in a message, or unsystematic, peripheral attitude shifts that are not enduring and do not affect the underlying evaluative dimensions (Chaiken, 1987; Festinger, 1957; Petty & Cacioppo, 1986). Here, the data were in line with the hypothesis. Among participants in the experimental groups, we could identify higher measurement error in the attitude statements as compared to participants in the control group, whilst the variation in the underlying evaluative dimensions remained unaffected. Hence, it seems that passive modes of resistance are indeed a factor to be reckoned with in consumers.

7.5.2. Re-evaluation of Source Characteristics: Boomerang Effects?

Our third hypothesis concerned boomerang effects. If communications from a source fail to convince consumers of a benefit argument, we argued, the sheer fact that the source endorsed a benefit argument might already have been enough to prompt a judgmental contrast phenomenon in consumers. And indeed, the data were consistent with the hypothesis. Even when the effect of the source was experimentally controlled, participants’ evaluations of the expertise as well as of the trustworthiness of the source were significantly dependent on participants’ preexisting attitudes towards the object. This effect was almost twice as large as the effect that the source itself had. Given that we used experimentally manipulated source attributions as different as a consumer organization, an industry organization, and the European Commission, which are known to differ markedly in the average credibility consumers are prepared to grant them (e.g., Gaskell, Allum & Stares, 2003; see Chapter 2.2.5), the size of the effects is quite unsettling.

It appears from the present data that it matters much more for the credibility of a source that it communicates the same view on the GM issue that the average consumer has, than who the source actually is. In other words, the boomerang effect is so enormously high that sources with high credibility would risk losing their credibility altogether if they endorsed, on a broad public scale, arguments that run counter to preexisting attitudes in the general public. Hence, participation in benefit communication campaigns is a strategy that we cannot with a clear conscience recommend to high-credibility sources such as consumer organizations. It is likely that their participation in such campaigns would not just leave consumers' attitudes towards GM food unaffected (as our review of previous research suggested), it might even rob a consumer organization of its main asset, which is its credibility in the eye of the consumer.

8. Study 3: Bypassing the Attitude System and Establishing Alternative Structures

Recapitulating the evidence gathered until now, the research presented here has gone through three stages. The first stage consisted of more or less theoretical tasks: we weighed the results of existing research in Chapter 2 and identified points of convergence as well as unresolved questions, which we then cast in more theoretical terms in Chapter 3. The second stage of our investigation was Study 1. Here, we provided a comprehensive assessment of the structure, function and strength of consumer attitudes towards GM foods in Europe. We concluded that the intra- and inter-attitudinal structure of these attitudes followed a top-down direction, and that the function of the attitudes was value-expressive, which already suggested that they would be utterly resistant to persuasive communication.

The third stage of the investigation was Study 2. Here, we did not so much attempt to find a new, as yet undiscovered way to successfully communicate benefits to consumers. Instead, we tried to identify the mechanisms through which resistance to persuasion operates. Unfortunately, this question was not completely resolved. What we did discover though was that unsuccessful attempts to persuade *will* backfire on the communicator. Given that attitude change by means of persuasive communication appears to be a fruitless and even dangerous task, the final problem yet to be resolved is what else can be done to change European consumers' attitudes towards genetically modified foods.

8.1. Research Questions and Hypotheses

In the preliminary conclusions from the literature review, we had shown surprise that the effects of hedonic factors of GM foods on their acceptance had never been investigated in previous research, even though the experienced taste of a food is generally considered the most important factor in the formation and stabilization of consumer preferences (Brunsø, Fjord & Grunert, 2002; Rozin & Vollmecke, 1986). Hence, it was suggested in Chapter 3 that an alternative way of introducing GM foods to consumers – as *actual food products* instead of an abstract technological concept – would provide the means to build an alternative attitude system around the object of GM foods.

We related this to the general finding that direct experience with attitude objects makes attitudes more accessible, more resistant to change, and more predictive of behavior (Fazio & Zanna, 1978a, 1978b, 1981). Furthermore, comparisons between the effectiveness of product trials and advertising have yielded strong evidence in favor of product trials, indicating substantially increased repeat purchase rates relative to the purely communicative technique of advertising (Kempf & Smith, 1998; Marks & Kamins, 1988; Smith & Swinyard, 1978). If at any rate possible, we concluded, prospective marketers of GM foods should therefore follow this route.

However, the results of Study 2 have demonstrated the strong distortion effects which consumers' preexisting attitudes towards GM foods can exert on incoming information. In the sensory evaluation of foods, judgmental distortion effects have been demonstrated numerous times as well (e.g., Cardello, 1994, 1995, 2003; Tuorila, Meiselman, Bell, Cardello & Hohnson, 1994). Consumers' expectations serve as anchors relative to which sensory information is evaluated. However, Meyers-Levy and Tybout (1989) reported an interesting inertia phenomenon. In a series of product trials, their participants maintained a product evaluation schema from preceding trials although the nature of the product attributes had changed between trials. Applied to the case of a person actually trying a GM food product, two very different outcomes would be predicted, depending on the schema that is activated first.

If the value-expressive attitude system identified in Studies 1 and 2 were activated as a schema prior to the product trial (e.g., by informing the person that they were to taste a GM food), the schema would remain active even at the point where the product sample would be evaluated. Hence, we would predict that the product would be evaluated in terms of a schema that derives all its evaluative anchors from higher-order attitude objects such as environment and technology. The product would not actually contrast with the schema; it would simply not fit into it. Hence, non-commitment would be expected, and no weakening of the evaluative schema.

If, on the other hand, a product-evaluation schema were activated first (e.g., by simply asking a person to try a product sample), and the genetic modification only revealed *after* the hedonic evaluation of the product, the product would still be evaluated in terms of the product schema even though the genetic modification had been revealed. The concept of genetic modification of foods, on the other hand, would be evaluated in terms of the product schema, which should weaken the degree to which it is determined by technology and value associations, and strengthen the degree to which it is determined by product associations. Therefore, we would expect weakened structural consistency in the attitude system that would otherwise have anchored attitudes towards GM foods on general socio-political attitudes. In operational terms, the following hypothesis can be formulated:

- *Hypothesis 1:* If a consumer tastes a food and is only afterwards given the information that the food had been genetically modified, his or her overall evaluation of GM foods should become less dependent on preexisting general socio-political attitudes.

8.2. Method

8.2.1. Participants and Procedure

A total of 746 consumers from Denmark, Finland, Norway and Sweden were recruited for participation in sensory experiments in 2000. All participants were between 17 and 76 years old (mean age = 40). 61% of the participants were female. In Finland and Norway, participants were recruited in cooperation with sports clubs for monetary incentives. In Sweden, the participants were recruited through a research agency. In Denmark, an existing consumer panel was used. Two sessions were conducted with each participant. In the first session, participants were asked to taste eight different samples of hard yellow cheese. These were selected from among popular brands in the Nordic countries. Participants were asked to try each sample and rate their liking of each sample on a nine-point scale. In addition, participants filled in a questionnaire containing Pliner and Hobden's (1992) food neophobia scale, a number of additional items regarding their general eating habits, and demographic information.

Three weeks later, participants returned to the sensory laboratory for the second session, and were given another two cheese samples. One of the two cheese samples was of the same cheese type that the particular consumer had liked best in the first session. The labeling of this sample was experimentally varied between groups. Each participant was assigned at random to one of the groups. Three labeling conditions were imposed:

- "Produced with a genetically modified starter culture. Contains one third of the fat of regular cheese". In this condition, the GM attribute was linked with a health benefit.
- "Produced with a genetically modified starter culture". In this condition, the GM attribute was not linked with a health benefit.
- *No information (control).* In this condition, the cheese was labeled with an arbitrary three-digit code.

After participants had tasted the two cheese samples and rated their liking, they were asked to fill in an additional questionnaire, asking them about their attitudes towards genetically modified foods, their general attitudes towards the environment, and their attitudes towards science and technology. Furthermore, a conjoint task was included were a number of attributes were varied in a fractional factorial design. The attributes included in the design were the following:

- Fat content (regular, low)
- Fat type (regular, more poly-unsaturated fats)
- Calcium content (regular, enriched)
- Zinc content (regular, enriched)
- Price (market price, -25%, +25%)
- Starter culture (GMO still active, GMO inactive, conventional)

The results of the sensory tests have already been published in Lähteenmäki, Grunert, Ueland, Åström, Arvola and Bech-Larsen (2002). The complete results of the conjoint task will be reported in Grunert, Bech-Larsen, Lähteenmäki, Ueland and Åström (in press). Hence, the conjoint data will not be used in this analysis apart from the part-worth estimate for the "GM starter" attribute. After the experiment, participants were issued with a disclaimer stating that the cheeses had not been genetically modified.

8.2.2. Overall Evaluation Measures

Overall technology evaluation. The same measures as in Studies 1 and 2 were used to assess consumers' overall evaluation of genetically modified foods as a technology. These were the three items: (A1) "Applying gene technology in food production is ...", to be answered on a seven-point scale ranging from "extremely bad" to "extremely good", (A2) "Applying gene technology in food production is ...", to be answered on a seven-point scale ranging from "extremely foolish" to "extremely wise", and (A3) "I am strongly ... applying gene technology in food production", to be answered on a seven-point scale ranging from "strongly against" to "strongly for".

8.2.3. General Socio-political Attitude Measures

To assess the degree to which participants' attitudes towards genetically modified foods were dependent on more general attitudes, two of the instruments already used in Study 1 were included again, including (AE) attitude towards environment and nature, and (AT) attitude towards technology. All items were answered on seven-point scales ranging from "strongly disagree" to "strongly agree". Analyses of the cross-cultural validity of the scales indicated that a number of items had strong biases in their factor loadings across the four consumer populations. Hence, abbreviated versions with three items each will be used in the present analyses. The retained items were the following.

Attitude towards environment and nature. Respondents' general attitude towards environment and nature was measured by three items from the "new environmental paradigm" scale by Dunlap and Van Liere (1978), including (AE1) "The balance of nature is very delicate and easily upset by human activities", (AE4) "Modifying the environment for human use seldom causes serious problems", and (AE6) "Mankind was created to rule over the rest of nature" [-]. All items were answered on seven-point scales ranging from "strongly disagree" to "strongly agree".

Attitude towards technology. Respondents' general attitude towards modern technologies was measured by three items adapted from Hamstra (1991), including (AT1) "The degree of civilization of a people can be measured from the degree of its technological development", (AT2) "New technological inventions and applications make up the driving force of the progress of society", and (AT4) "Throughout the ages, technological know-how has been the most important weapon in the struggle for life". All items were answered on seven-point scales ranging from "strongly disagree" to "strongly agree".

8.2.4. Food Neophobia Measures

Food neophobia. In addition, Pliner and Hobden's food neophobia scale was included to measure habitual rejection of unfamiliar foods. Three items were retained from the original ten-item food neophobia scale by Pliner and Hobden (1992), including (FN6) "At dinner parties I will try a new food" [-], (FN7) "I am very particular about the foods I will eat", and (FN9) "I like to try new ethnic restaurants" [-]. All items were answered on seven-point scales ranging from "strongly disagree" to "strongly agree". Means and standard deviations of all measures are given in Table 8.1.

Table 8.1. Means and standard deviations of measures.

Variable	Country				
	Denmark *M (SD)*	Finland *M (SD)*	Norway *M (SD)*	Sweden *M (SD)*	Total *M (SD)*
Overall technology evaluation					
A1	3.38(1.61)	3.29(1.76)	2.83(1.49)	2.70(1.67)	3.05(1.65)
A2	3.80(1.50)	3.43(1.71)	3.04(1.49)	3.02(1.65)	3.32(1.61)
A3	3.31(1.34)	3.06(1.62)	2.82(1.48)	2.75(1.58)	2.99(1.52)
Attitude towards environment and nature					
AN1	5.76(1.15)	6.48(0.94)	5.61(1.25)	5.75(1.34)	5.88(1.23)
AN4	5.19(1.43)	6.18(1.24)	5.11(1.57)	5.62(1.48)	5.49(1.50)
AN6	5.25(1.67)	6.29(1.37)	5.31(1.78)	5.94(1.53)	5.67(1.66)
Attitude towards technology					
AT1	4.19(1.58)	3.69(1.75)	4.37(1.38)	3.97(1.61)	4.07(1.59)
AT2	4.68(1.45)	5.32(1.28)	4.99(1.35)	4.88(1.60)	4.95(1.44)
AT4	4.21(1.47)	4.30(1.57)	4.35(1.50)	3.90(1.55)	4.19(1.53)
Food neophobia					
FN6	1.94(1.15)	1.50(0.98)	2.30(1.24)	1.73(1.22)	1.88(1.19)
FN7	2.32(1.60)	1.84(1.56)	4.13(1.48)	2.06(1.65)	2.63(1.81)
FN9	2.79(1.67)	2.67(1.71)	3.54(1.87)	2.50(1.82)	2.89(1.81)

8.3. Analysis and Results

Since the number of respondents in the control group was too small to allow the setup of a multi-group analysis with a complete structural equation model estimated separately in each experimental group within each country, we were forced to find a solution where the data could be pooled. Hence, we will present our results in two steps. First, we will report analyses ensuring that the parameters of the measurement models were indeed invariant across the four countries. Then, we will present the results of the hypothesis tests on the structural model.

8.3.1. Invariance Analysis of Measurement Model

Model specification. A confirmatory factor analysis model was specified simultaneously in the four country-specific sub-samples, including the four factors attitude towards nature, attitude towards technology, food neophobia, and overall evaluation of GM foods as a technology, each measured by three items. Following the procedure suggested by Steenkamp and Baumgartner (1998), six hierarchically nested models were then estimated. In each step, a further set of constraints on the means-and-covariance structure was relaxed. Model 1 (identity) constrained factor loadings Λ_x, item intercepts τ_x, factor covariances and factor variances Φ, error variances Θ_δ, and latent factor means κ to be invariant across populations. Model 2 (error variance invariance) constrained factor loadings, item intercepts, factor covariances, factor variances, and measurement error variances to be invariant. Model 3 (factor variance invariance) constrained factor loadings, item intercepts, factor covariances, and factor variances to be invariant. Model 4 (factor covariance invariance) constrained factor loadings, item intercepts, and factor covariances to be invariant. Model 5 (scalar invariance) constrained factor loadings and item intercepts to be invariant. Model 6 (metric invariance) constrained the complete matrix of factor loadings to be invariant. Model 7 (configural invariance) imposed an identical simple structure on the data, assuming the same pattern of zero and non-zero loadings to hold in all samples.

Estimation. All models were estimated by means of maximum likelihood using LISREL 8.54 (Jöreskog & Sörbom, 1996; Jöreskog, Sörbom, du Toit & du Toit, 1999, 2003). To account for non-normality in the data, the Satorra-Bentler scaled χ^2 statistic was used in all computations (see Chapter 5.2.5).

Table 8.2. Invariance of measurement model across populations.

		Goodness-of-fit statistics			
No.	Estimated model	Satorra-Bentler χ^2	*df*	*p* <	RMSEA
1	Identity	1223.317	368	.001	.111
2	Error variance invariance	914.393	353	.001	.092
3	Factor variance invariance	636.395	317	.001	.073
4	Factor covariance invariance	643.740	302	.001	.078
5	Scalar invariance	500.182	272	.001	.067
6	Metric invariance	381.922	248	.001	.054
7	Configural invariance	291.723	224	.001	.040

		Stepwise model comparison statistics			
No.	Invariance constraint relaxed	Satorra-Bentler scaled $\Delta\chi^2$	Δdf	*p* <	NFI
1	None				
2	Factor means	308.924	15	.001	.057
3	Error variances	277.998	36	.001	.053
4	Factor variances	7.345	15	*n.s.*	.007
5	Factor covariances	143.558	30	.001	.010
6	Item intercepts	118.260	24	.001	.027
7	Factor loadings	90.199	24	.001	.013

Estimation was based on within-sample covariance matrices, mean vectors and asymptotic covariance matrices computed from the Danish (N = 204), Finnish (N = 169), Norwegian (N = 199) and Swedish (N = 181) sub-samples.

Goodness of fit. Goodness of fit and model comparison statistics are shown in Table 8.2. The overall goodness-of-fit χ^2 indicated significant deviations of model-implied from observed covariance matrices for all models. Like before, we shall discount this result somewhat as the test is overly sensitive in large samples. The RMSEA, as a descriptive measure of model fit, indicated acceptable values (RMSEA < .08) for all models apart from Models 1 (identity) and 2 (error variance invariance). The model comparison statistics showed the same pattern. The explicit $\Delta\chi^2$-test indicated significant improvement of model fit at every step, whereas the NFI, as a descriptive measure of model improvement, indicated that the magnitude of the changes was relatively insubstantial in all steps after the error variance invariance model. Hence, it was decided to accept the next level of invariance, factor variance invariance, as an acceptable level for the measurement model. As explained in Chapter 4.5.2, the invariance level is sufficient for the existence of common interval scales across all four populations.

8.3.2. Structural Model and Hypothesis Tests

Model specification. Hypothesis 1 assumed that direct hedonic experience with a GM food would weaken the structural consistency of the attitude system linking attitudes towards genetically modified foods to general socio-political attitudes. The test of this hypothesis was set up as a moderator analysis, similar to the ones in Studies 1 and 2. The same structural model was specified in the three experimental groups: (a) the GM-and-health-benefit group, where consumers had been told that the cheese they had liked best in the first session had been genetically modified and had an additional health benefit, (b) the GM-but-no-health-benefit group, where consumers had only been told that the cheese they had liked best in the first session had been genetically modified, and (c) the control group, where consumers had not received any such information.

The structural model contained the general socio-political attitudes (attitudes toward the environment and attitude towards technology) and food neophobia as latent exogenous factors. Consumers' overall evaluation of GM foods as a technology was specified as a latent endogenous factor. The part-worth of the GM attribute from the conjoint analysis was specified as the error-free indicator of another endogenous factor, "effect of genetic modification of product on choice". Furthermore, three dummy variables were included as manifest exogenous variables to control for possible effects of the factor "country". The framework model is shown in Figure 8.1.

For the moderator analysis, two models were then specified. Model 1 (equal structural consistency) assumed that all model parameters would be invariant across the three groups.

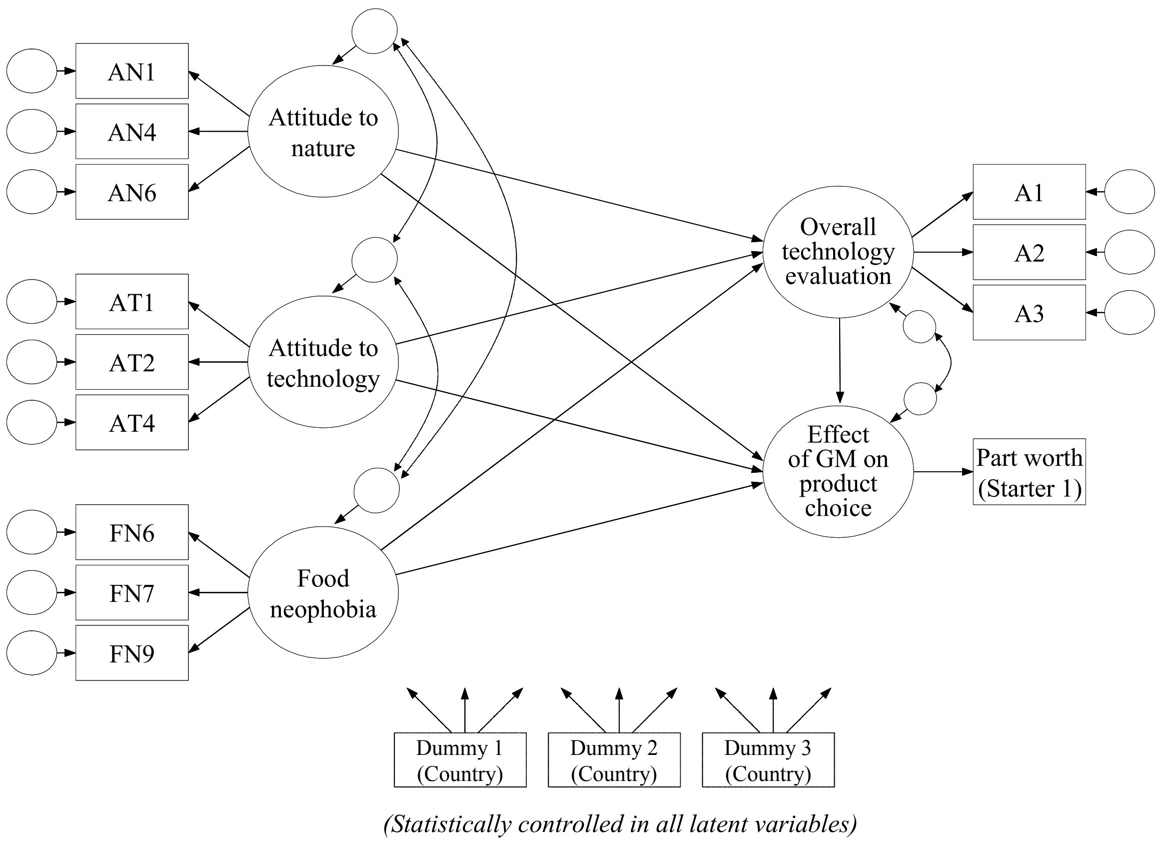

Figure 8.1. Framework model for tests of moderated structural consistency.

Table 8.3. Tests of moderated structural consistency: goodness-of-fit and model comparison statistics.

		Goodness-of-fit statistics			
No.	Estimated model	Satorra-Bentler χ^2	*df*	*p* <	RMSEA
1	Equal consistency	645.26	384	.001	.048
2	Moderated structural consistency	546.47	324	.001	.048
		Stepwise model comparison statistics			
No.	Invariance constraint relaxed	Satorra-Bentler scaled $\Delta\chi^2$	Δdf	*p* <	NFI
1	None				
2	Regression coefficients and equation error variances	98.79	60	.001	.153

Model 2 (moderated structural consistency) allowed the parameters of the structural model to vary between the three groups. These were the regression coefficients linking overall evaluation of GM and effect of GM on product choice to the general socio-political attitudes and food neophobia, as well as the equation errors in the prediction of overall evaluation of GM and effect of GM on product choice. Measurement model parameters were assumed to be invariant across groups

Estimation. The models were estimated as before, but now based on within-sample covariance matrices, mean vectors and asymptotic covariance matrices computed from GM-and-heath-benefit group ($N = 332$), the GM-but-no-health-benefit group ($N = 313$), and the control group ($N = 86$), all pooled from the respective groups in the four countries where the research had been conducted.

Goodness of fit. Goodness of fit and model comparison statistics are shown in Table 8.3. The overall goodness-of-fit χ^2 indicated significant deviation of model-implied from observed covariance matrices for both models. Again, we shall discount this result, as the test is overly sensitive in large samples. The RMSEA, as a descriptive measure of model fit, indicated acceptable values for both models.

Model comparison. The explicit $\Delta\chi^2$-test indicated significant improvement of model fit when the constraints on the structural model were relaxed. Model 2 (moderated structural consistency) fitted significantly better. The NFI indicated that the magnitude of improvement was relatively large, approximately 15%.

Hypothesis evaluation. Estimates of the different structural consistencies are shown in Figure 8.2 in terms of squared multiple correlations in the prediction of the endogenous factors. The structural consistency in the attitude system was substantially weakened in the group where participants had had direct experience with a GM food that also had a health benefit. In the group where no health benefit had been indicated, however, no such effect occurred. Hence, Hypothesis 1 can be accepted, albeit with a qualification: it appears that there must be an additional consumer benefit involved in order to make the direct experience manipulation effective.

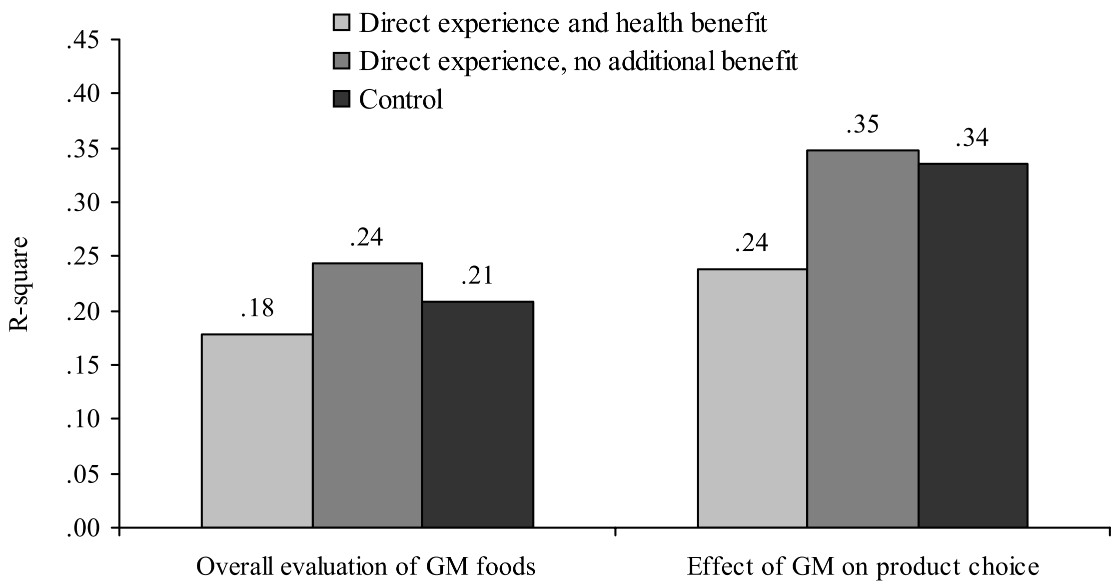

Figure 8.2. Structural consistency and direct experience: degree to which global evaluations of GM foods and effects of genetic modification on product choice are determined by general socio-political attitudes in the three groups defined by different direct-experience conditions (values are squared multiple correlations).

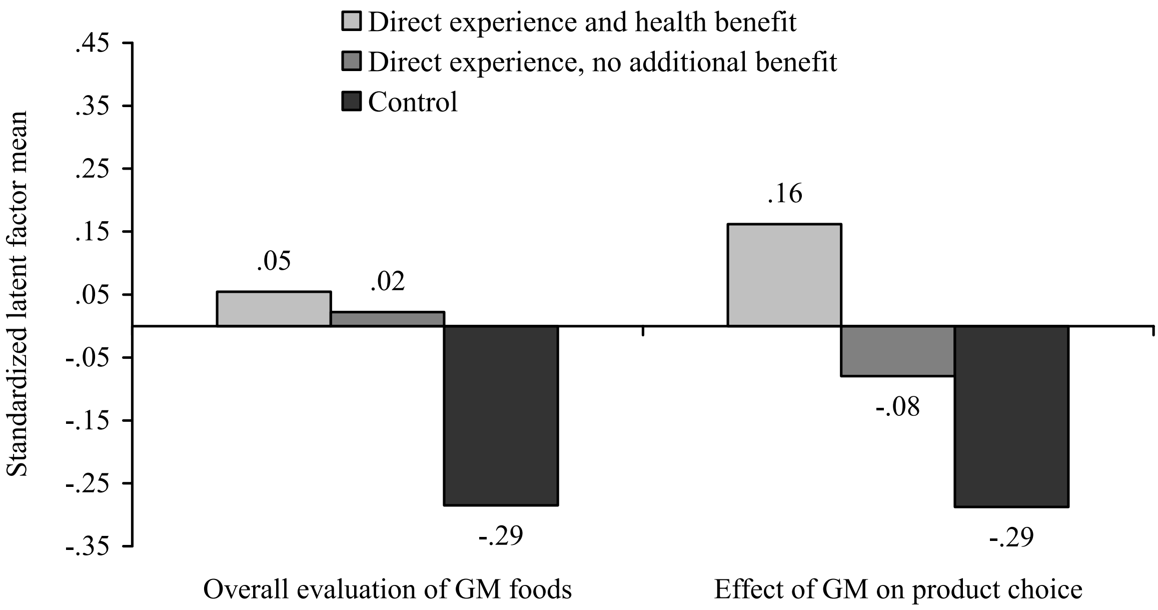

Figure 8.3. Latent means of endogenous factors in the three groups defined by different direct-experience conditions (standardized values).

Finally, estimates of latent means for the endogenous factors within the three experimental groups are shown in Figure 8.3 (standardized values). The pattern is similar to the pattern observed in the structural consistency estimates. Not only could the direct-experience manipulation weaken the degree to which consumers' evaluation of GM foods was dependent on their general socio-political attitudes, it could even raise the absolute level of the attitudes substantially upwards. Analyzed on this level, there also seems to be a weaker difference between the two types of direct-experience manipulations than was observed for the structural consistencies.

8.4. Discussion

In Chapters 3, we noted that in practically all current research on consumer attitudes towards genetically modified foods, the fact that the attitude object is a *food* has virtually been forgotten. Hence, we suggested turning the conceptualization of GM foods back on its feet, understanding them as foods and not just embodiments of a stigmatized technology. The research question guiding Study 3 was therefore, whether direct experience with an actual GM food would be able to convince consumers that these foods are perfectly acceptable products. To this end, a sensory experiment was conducted where consumers tried different cheese samples.

Using experimentally manipulated feedbacks, we convinced one group of consumers that the cheese they had liked best from among the samples had been genetically modified and had a tangible health benefit. Consumers in a second group received the same treatment, but were told that the cheese they had liked best had been genetically modified, but without an additional health benefit. A third group did not receive any such information. Our hypothesis had been that the degree to which consumer attitudes towards GM foods form a structurally coherent system with more general socio-political attitudes, would be weakened in those groups where consumers had been told afterwards that the cheese they had tasted had been genetically modified.

8.4.1. Deconstructing an Evaluative Schema

The hypothesis was partially confirmed. We found indeed that consumers' attitudes towards GM foods were less dependent on general socio-political attitudes, but only under the condition where a health benefit had been claimed as well. In the condition without a health benefit, on the other hand, the structural consistency of the attitude was even slightly *increased* as compared to the control group. This poses a theoretical problem. Our hypothesis had been derived from a particular application of schema theory (Meyers-Levy & Tybout, 1989). It assumed that, in series of judgment tasks, consumers would show a marked unwillingness to switch from one evaluative schema to another. In line with this, we had expected that if consumers first evaluate a product sample in an unbiased way, i.e. as a product, the schema would stay active afterwards. Information about the fact that the product had been genetically modified should then be assimilated towards the product evaluation schema, and not the other way around.

However, it appears that an additional "incentive" has to be involved to obtain this effect. When an additional health benefit was claimed, the hypothesis seemed be correct. When no additional benefit was offered, we obtained the opposite effect we had predicted. Possibly, consumers felt cheated out of their pleasurable hedonic experience, which may have provoked reactance (Festinger, 1957). Alternatively, a biased-assimilation process may have been triggered which worked ex-post, distorting the memory representation of the hedonic experience during the recall phase (Roberts, 1985). More research on the nature of these effects is clearly warranted in the future.

8.4.2. Attitude Change

Our hypothesis had actually only been concerned with different degrees of structural consistency in consumers' attitudes. Although we were not so bold as to actually expect attitude change, we appear to have observed it. In Chapter 3.7.2, we had argued that, in an ideal world, hedonic experience with GM foods could contribute to the formation of an alternative attitude system. Through basic associative learning mechanism, a true bottom-up structure would evolve, based on sensory attributes and hedonic gratifications. Since the different associations would be based on direct experience, the resulting attitude would be easily accessible, resistant to change, and predictive of behavior (Fazio & Zanna, 1978a, 1978b, 1981). We had not really believed that this would be possible, given the strong judgmental distortion effects we had observed in Study 2. But surprisingly, these do not appear to have affected the absolute level of consumers' attitudes very much. In terms of attitude change, enabling consumers to have direct experience with a high-quality product may therefore be *the* road to product acceptance, and in medium terms, maybe to technology acceptance as well.

9. Conclusions and Implications

We began our discussion of consumer attitudes towards genetically modified foods with a short history of the troubled times through which these foods have gone in Europe. Consumer attitudes came to the attention of the players in the debate around the mid-1980s, when governments in several EU member states commissioned technology assessment exercises to help them formulate coherent policy. Since these early days, much has happened. The late 1980s and early 1990s saw the introduction of new legislation, first on the national level, then increasingly on a European level. After an initial calming of the debate, discontent flared up again in the mid-1990s. A number of trigger events led to an escalation of the situation, resulting in a quasi-moratorium on further approval of GM foods in June 1999, imposed by five EU member states. At the time of writing (May 2004), the moratorium has just been lifted. The road is open again for GM foods in Europe.

During the years of the moratorium, however, the commercial stakeholders in the debate – agribusiness companies, food manufacturers, and retailers – have made little effort to prepare themselves for the marketing of actual GM products to consumers. Considerable research was conducted in the1990s, when the moratorium was not an issue yet. However, as we argued after a review of the existing evidence, this research has not solved the fundamental problem: given that we *know* that consumers have critical attitudes towards gene technology, how can we convince them that products resulting from an application of the technology will still be acceptable foods? The aim of the work presented here was to help sketch a way forward. In the following, we will first present a short review of the research we conducted. Then, we will present the key results, and finally, discuss how future promotional activities for GM foods might look.

9.1.1. Review of the Research Presented

The initial phase in the investigation consisted of desk research. We reviewed the existing research on consumer attitudes towards GM foods in Europe and came to a number of preliminary conclusions and unresolved questions. The preliminary conclusions were four. First, attitudes towards GM foods appeared to be strongly related to general socio-political attitudes, in particular to attitudes towards environment and nature, attitudes to science and technology, and trust in the institutions that regulate emerging technologies and manage their risks. Second, the object of consumers' attitudes towards GM foods appeared to be the technology as such, not particular products. Third, beliefs about the consequences of the technology were of relatively low complexity and relatively ill defined. Fourth, attitudes towards GM foods appeared to be utterly resistant to persuasion.

The unresolved questions were five. First, it appeared from the review that the structure of consumer attitudes had been researched in an inconsistent manner. Hence, it was unclear whether attitudes to GM foods were based on independent sets of beliefs (bottom-up) or whether beliefs were derived from heuristic evaluations (top-down). Second, and related to that, it was unresolved whether attitudes towards GM foods were purely derivative of general socio-political attitudes, or whether their formation involved a quasi-rational risk-benefit trade-off. Third, it was not known whether these attitudes served value-expressive purposes for consumers, or whether they merely provided preliminary orientation in a situation of uncertainty, i.e. where consumers did not have enough factual knowledge to form better judgments.

Fourth, it was unknown why consumer attitudes were so resistant to persuasion. We hypothesized that attitudes towards GM foods provided consumers with a schema for the systematic refutation of counter-attitudinal arguments, and that the activation of this schema would lead to distorted perceptions of the credibility of an information source in situations where the source argued against consumers' preexisting attitudes. Finally, we suggested that direct product experience with GM foods could build an alternative attitude system and lessen the degree to which consumer attitudes depended on general socio-political attitudes and values. We framed our research questions in theoretical terms derived from classical theories of social cognition such as Sherif and

Sherif's (1961) social judgment theory, and Katz's (1960) functional approach to the study of attitudes.

We proceeded with the development of the necessary methodology to investigate these questions, and then presented three empirical studies that applied the methodology to empirical data. Study 1 was a large attitude survey, simultaneously conducted in four EU member states. The aim of the analysis was to provide a comprehensive assessment of the structure and function of consumer attitudes towards GM foods. Study 2 was an attitude change experiment that had failed to actually yield any attitude change effects in consumers. It was conducted simultaneously in four EU member states as well. Here, we investigated the processes underlying resistance to persuasive communication and potential boomerang effects that might threaten the credibility of the communicator. Finally, in Study 3 we investigated the effects which actual product experience had on consumers' attitudes.

9.1.2. Key Results: Attitude Structure and Function

The central conclusion from Study 1 was that the attitudes of European consumers towards genetically modified foods are firmly embedded in a system of more general socio-political attitudes. On the inter-attitudinal level, we could show that the system is consistently structured in a top-down manner, where general socio-political attitudes provide an "evaluative template" from which, in a first step, consumers derive their overall evaluations of GM foods as a technology. In a second step, these overall technology evaluations are further concretized into evaluations of the risks and benefits of the technology. On an intra-attitudinal level, we could also show that specific beliefs are derived in the same top-down manner from general, heuristic evaluations.

On neither of the system levels, any evidence for bottom-up processes could be found that would be consistent with the assumptions of belief-based, compositional attitude formation or the existence of the risk-benefit trade-off that is ubiquitously assumed in the literature. We concluded that these attitudes have a value-expressive function for consumers, allowing consumers to maintain a consistent self-concept by aligning their attitudes with more deeply felt, general convictions about the integrity of nature, the course of technological progress, and the balance of power in society. Because such attitudes derive their valence and evaluative strength from attitudes of higher order, they are generally regarded as very strong and nearly impossible to change through simple communication techniques.

9.1.3. Key Results: Judgmental Distortion and Boomerang Effects

The main conclusion from Study 2 concerned boomerang effects. Our hypothesis had been that, if communications from a source fails to convince consumers of its benefit argument, the sheer fact that the source endorsed a benefit argument might already be sufficient to trigger a judgmental distortion process in consumers. And indeed, the data were consistent with the hypothesis. Even when the effect of the source was experimentally controlled, participants' evaluations of the expertise and trustworthiness of the source were significantly dependent on participants' pre-existing attitudes towards the object. This effect was almost twice as large as the effect that the source itself had had.

The pattern in the data made the unsettling suggestion that it may matter much more for the credibility of a source that it communicates the same view on the GM issue that the average consumer has, than who the source actually is. In other words, the boomerang effect appears to be so strong that sources with high credibility would risk losing their credibility altogether if they endorsed, on a broad public scale, arguments that run counter to preexisting attitudes in the general public. Hence, participation in benefit communication campaigns is a strategy that we cannot with a clean conscience recommend to high-credibility sources. It appears likely that their participation in such campaigns would not just leave consumers' attitudes towards GM food unaffected, it might even rob them of one of their main assets.

9.1.4. Key Results: Building an Alternative Attitude System through Direct Experience

The first conclusion from Study 3 was that, through direct experience, consumer attitudes towards GM foods can indeed be "decoupled" from the value-expressive system of general attitudes that had caused the strong judgmental distortion effects in Study 2. However, there was a caveat: only when an additional, tangible consumer benefit was offered, our hypothesis seemed to work, and consumers judged GM foods less through the lens of their general attitudes. When no additional benefit was offered, however, we obtained the opposite effect than we had predicted. Hence, if GM products are supposed to help overcome biased judgments, they will indeed have to be products of superior quality. We had not really believed that this would be possible, but surprisingly, direct experience did indeed manage to change consumers' attitudes to GM foods. Hence, the second main conclusion from Study 3 is that enabling consumers to have direct experience with a high-quality product may be *the* road to product acceptance, and in medium terms, maybe even to technology acceptance.

9.1.5. Direct Promotion of GM Foods

The obvious question is now, of course, whether the massive launch of GM foods in Europe and their promotion through direct point-of-sale activities, like the handing out of free product samples, will indeed be a viable strategy. The first barrier to such a strategy is the potential of stakeholder conflict. Even if retailers can be convinced by food manufacturers that the strategy will work, would a concerted campaign by NGOs not lead to the same situation as the launch of Nestlé's Butterfinger did in 1998? We think that such a conflict situation may indeed occur if a product can be singled out and targeted by a protest campaign. If whole sets of products were launched by manufacturers and supermarkets in coordinated schemes, the potential leverage of such protest campaigns would likely be dissipated to a point of harmlessness.

The other question is whether the presence of a GM label on a product will invoke a judgmental bias in consumers' product experience. This is indeed not unlikely to happen if labels were attended to by consumers. However, research suggests that this is not generally the case (see Heroux, Laroche & McGown, 1988; Mathios, 2000). In situations of massive media coverage, heightened issue awareness might still be prompted in consumers though, posing a possible threat to the success of the strategy.

9.1.6. The Future of Communications about GM Foods

The results of the research presented here might easily be misconstrued in the way that we appear to suggest the abandoning of all communication about GM foods that addresses consumers. This is by no means something we would recommend. For one thing, it is rather unlikely that consumer organizations and environmental groups will change their policies to such an extent that they will openly participate in benefit communication campaigns such as those that triggered the large boomerang effects in Study 2. The strategic implications of the direct-experience findings, on the other hand, are only meaningful for commercial actors in consumer markets, i.e. food manufacturers and retailers. For governmental bodies, already involving consumers in the early stages of the development of regulatory policy may be a similar way to gain more recognition for their policies. Such an approach has indeed been outlined in a number of recent consumer policy papers (e.g., Frewer, Lassen, Kettlitz, Beekman & Berdal, 2004). Research is in the pipeline that will elucidate the mechanisms through which inclusive, participatory policy formation might affect the acceptability of the resulting instruments. Should this turn out to be a promising road, a means may have been found that may render two decades of regulatory struggle, as observed in the case of GM foods in Europe, unnecessary in the future.

References

Abelson, R. P. (1995). Attitude Extremity. In R. E. Petty & J. A. Krosnick (Eds.), *Attitude strength: Antecedents and consequences* (pp. 25-41). Mahwah, New Jersey: Lawrence Erlbaum.

Ajzen, I. (1989). Attitude structure and behavior. In A. R. Pratkanis & S. J. Breckler & A. G. Greenwald (Eds.), *Attitude structure and function* (pp. 241-274). Hillsdale, NJ: Lawrence Erlbaum Associates.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50,* 179-211.

Ajzen, I. (2001). Nature and operation of attitudes. *Annual Review of Psychology, 52*, 27-58.

Akaike, H. (1974). A new look at statistical model identification. *IEEE transactions on Automatic Control, 19,* 716-723.

Akaike, H. (1987). Factor analysis and AIC. *Psychometrika, 52,* 317-332.

Alhakami, A. S., & Slovic, P. (1994). A psychological study of the inverse relationship between perceived risk and perceived benefit. *Risk Analysis, 14*, 1085-1096.

Allison, N. K. (1978). Development of a test for consumer alienation from the marketplace. *Journal of Marketing Research, 15,* 565-575.

Alwin, D. F., (1976). Attitude scales as congeneric tests: A re-examination of an attitude-behavior model. *Sociometry, 39,* 377-383.

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two step approach. *Psychological Bulletin, 103*(3), 411-423.

Anderson, J. R. (1983). *The architecture of cognition*. Cambridge, MA: Harvard University Press.

Anderson, L. R., & Fishbein, M. (1965). Prediction of attitude from the number, strength, and evaluative aspect of beliefs about the attitude object: A comparison of summation and congruity theories. *Journal of Personality and Social Psychology, 2*(3), 437-443.

Anderson, N. H. (1968). A simple model for information integration. In R. P. Abelson, E. Aronson, W. J. McGuire, T. M. Newcomb, M. J. Rosenberg, & P. H. Tannenbaum (Eds.), *Theories of cognitive consistencies: A sourcebook* (pp. 731-743). Chicago: Rand McNally.

Anderson, N. H. (1971). Integration theory and attitude change. *Psychological Review, 78*(3), 171-206.

Bäckström, A., Pirttilä-Backman, A. M., & Tuorila, H. (2003). Dimensions of novelty: a social representation approach to new foods. *Appetite, 40*, 299-307.

Bagozzi, R. P. (1978). The construct validity of the affective, behavioral, and cognitive components of attitude by analysis of covariance structures. *Multivariate Behavioral Research, 13*, 9-31.

Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Science, 16*(1), 74-94.

Bauer, M. & Gaskell, G. (1999). Towards a paradigm for research on social representation. *Journal for the Theory of Social Behaviour,* 163–187.

Bauer, M. (1997). *Resistance to new technology: Nuclear power, information technology, biotechnology* (2nd Edition), Cambridge: Cambridge University Press.

Bauer, M. W. & Bonfadelli, H. (2002). Controversy, media coverage and public knowledge. In M. W. Bauer & G. Gaskell (Eds.), *Biotechnology: The making of a global controversy* (pp. 149-178). Cambridge: Cambridge University Press.

Bauer, M. W. & Gaskell, G. (2002). The biotechnology movement. In M. W. Bauer & G. Gaskell (Eds.), *Biotechnology: The making of a global controversy* (pp. 379-404). Cambridge: Cambridge University Press.

Bauer, M. W., Petkova, K. & Boyadjjewa, P. (2000). Public knowledge of and attitudes to science: Alternative measures. *Science, Technology and Human Values, 25,* 1.

Baumgartner, H., & Homburg, C. (1996). Applications of structural equation modeling in marketing and consumer research: A review. *International Journal of Research in Marketing, 13*(2), 139-161.

Bem, D. J. (1967). Self-perception: An alternative interpretation of cognitive dissonance phenomena. *Psychological Review, 74,* 183-200.

Bentler, P. M. (1990). Comparative fit indices in structural equation models. *Psychological Bulletin*, *107,* 238–246.

Bentler, P., & Bonnett, D. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin, 88,* 588-606.

Berg, P. (1974). Potential biohazards of recombinant DNA molecules. *Science, 185,* 303.

Berger, I. E. (1992). The nature of attitude accessibility and attitude confidence: A triangulated experiment. *Journal of Consumer Psychology, 1*(2), 103-124.

Berger, I. E., & Mitchell, A. A. (1989). The effect of advertising on attitude accessibility, attitude confidence, and the attitude-behavior relationship. *Journal of Consumer Research, 16*(3), 269-279.

Bettman, J. R. (1975). Information integration in consumer risk perception: A comparison of two models of component conceptualization. *Journal of Applied Psychology, 60*, 381-385.

Bier, V. M. (2001). On the state of the art: Risk communication with the public. *Reliability Engineering and System Safety, 71,* 139-150.

Biotechnology and the European Public Concerted Action Group (1998). Europe ambivalent on biotechnology. *Nature, 387,* 845-847.

Bizer, G. Y., & Krosnick, J. A. (2001). Exploring the structure of strength-related attitude features: The relation between attitude importance and attitude accessibility. *Journal of Personality and Social Psychology, 81*(4), 566-586.

Bollen, K. A. (1989). *Structural equations with latent variables*. Chichester: Wiley.

Bollen, K. A. (1990). Overall fit in covariance structure models: Two types of sample size effects. *Psychological Bulletin, 107,* 256-259.

Bollen, K. A., & Long, J. S. (1992). Tests for structural equation models. *Sociological Methods and Research, 21*(November), 123-131.

Borre, O. (1989). *Befolkningens holdning til gentechnologi. Diffusion eller mobilisering?* (TeknologiNaevnets rapporter 1989/3). Copenhagen: TeknologiNaevnet.

Borre, O. (1990). *Befolkningens holdning til genteknologi II. Kommunikation og tillid.* (TeknologiNaevnets rapporter 1990/4). Copenhagen: TeknologiNaevnet.

Borre, O. (1990). Public opinion on gene technology in Denmark 1987 to 1989. *Biotech Forum Europe, 7*(6), 471-477.

Bozdogan, H. (1987). Model selection and Akaike's information criterion (AIC): The general theory and its analytical extensions. *Psychometrika, 52,* 345-370.

Breckler, S. J. (1984). Empirical validation of affect, behavior, and cognition as distinct components of attitude. *Journal of Personality and Social Psychology, 47*, 1191-1205.

Breckler, S. J., & Wiggins, E. C. (1989). On defining attitude and attitude theory: Once more with feeling. In A. R. Pratkanis & S. J. Breckler & A. G. Greenwald (Eds.), *Attitude structure and function* (pp. 407-427). Hilldale, NJ: Lawrence Erlbaum Associates.

Bredahl, L. (1998). *Consumers' cognitions with regard to genetically modified foods: Results of a qualitative study in four countries* (MAPP working paper no. 59). Aarhus: Aarhus School of Business.

Bredahl, L. (1999). Consumers' cognitions with regard to genetically modified food. Results of a qualitative study in four countries. *Appetite, 33*, 343-360.

Bredahl, L. (2001). Determinants of consumer attitudes and purchase intentions with regard to genetically modified foods: Results of a cross-national survey. *Journal of Consumer Policy, 24*, 23-61.

Bredahl, L., Grunert, K. G., & Frewer, L. J. (1998). Consumer attitudes and decision-making with regard to genetically engineered food products: A review of the literature and a presentation of models for future research. *Journal of Consumer Policy, 21*, 251-277.

Browne, M. W. (1984). Asymptotically distribution-free methods for the analysis of covariance structures. *British Journal of Mathematical and Statistical Psychology, 37*, 62-83.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen & J. S. Long (Eds.), *Testing structural equation models*. Newbury Park, CA: Sage.

Brüggemann, A., & Jungermann, H. (1998). Abstrakt oder konkret: Die Bedeutung der Beschreibung von Biotechnologie für ihre Beurteilung. *Zeitschrift für Experimentelle Psychologie, 45*(4), 303-318.

Brunsø, K., Fjord, T. A., & Grunert, K. G. (2002). *Consumers' food choice and quality perception* (MAPP working paper no. 77). Aarhus: Aarhus School of Business.

Brunsø, K., Scholderer, J. & Grunert, K. G. (2004). Closing the gap between values and behavior: A means-end theory of lifestyle. *Journal of Business Research, 57,* 665-670.

Burns, W. J., Slovic, P., Kasperson, R. E., Kasperson, J. X., Renn, O., & Emani, S. (1993). Incorporating structural models into research on the social amplification of risk: Implications for theory construction and decision making. *Risk Analysis, 13,* 611-623

Busch, L., Lacy, W. B., Burkhardt, J., & Lacy, L. R. (1991). *Plants, power, and profit: Social, economic, and ethical consequences of the new biotechnologies*. Oxford: Blackwell.

Buttel, F. H. (2000). The recombinant BGH controversy in the United States: Toward a new consumption politics of food? *Agriculture and Human Values, 17*, 5-20.

Byrne, B. M., Shavelson, R. J. & Muthén, B. (1989). Testing for the equivalence of factorial covariance and mean structures: the issue of partial measurement invariance. *Psychological Bulletin, 105,* 456-466.

Cardello, A. V. (1994). Consumer expectations and food acceptance. In H. J. H. MacFie & D. M. H. Thomsen (Eds.), *Measurements of food preferences* (pp. 253-297). London: Blakie Academic & professional.

Cardello, A. V. (1995). Food quality: Relativity, context and consumer expectations. *Food Quality & Preference, 6*, 163-170.

Cardello, A. V. (2003). Consumer concerns and expectations about novel food processing technologies: effects on product liking. *Appetite, 40*, 217-233.

Cartwright, D., & Harray, F. (1956). Structural balance: A generalization of Heider's theory. *Psychological Review, 63*, 277-293.

Cavalieri, L. (1985). *The double-edged helix: Genetic engineering in the real world.* New York: Praeger.

Chaiken, S. (1987). The heuristic model of persuasion. In M. P. Zanna & J. M. Olson & C. P. Herman (Eds.), *Social influence: The Ontario Symposium* (pp. 3-39). Hillsdale, NJ: Lawrence Erlbaum.

Chaiken, S., & Baldwin, M. W. (1981). Affective-cognitive consistency and the effect of salient behavioral information on the self-perception of attitudes. *Journal of Personality and Social Psychology, 41*(1), 1-12.

Chaiken, S., Pomerantz, E. M., & Giner-Sorolla, R. (1995). Structural consistency and attitude strength. In R. E. Petty & J. A. Krosnick (Eds.), *Attitude strength: Antecedents and consequences* (pp. 387-412). Mahwah, New Jersey: Lawrence Erlbaum.

Cooper, R. G. & Kleinschmidt, E. J. (1987). *Success factors in new product innovation. Industrial Marketing Management, 16,* 215-233.

Cote, J. A., & Wong, J. K. (1985). The effect of time and situational variables on intention-behaviour consistency In E. C. Hirschman & M. B. Holbrook (Eds.), *Advances in consumer research* (Vol. 12, pp. 374). Provo, UT Association for Consumer Research

Crano, W. D. (1995). Attitude strength and vested interest. In R. E. Petty & J. A. Krosnick (Eds.), *Attitude strength: Antecedents and consequences* (pp. 131-158). Mahwah, New Jersey: Lawrence Erlbaum.

Cudeck, R. (1989). Analysis of correlation matrices using covariance structure models. *Psychological Bulletin, 105*(2), 317-327.

Da Costa, M. C., Deliza, R., Rosenthal, A., Hedderley, D., & Frewer, L. (2000). Non conventional technologies and impact on consumer behavior. *Trends in Food Science & Technology, 11*, 188-193.

Daamen, D. D. L., van der Lans, I. A., & Midden, C. J. H. (1990). Cognitive structures in the perception of modern technologies. *Science, Technology & Human Values, 15*(2), 202-225.

Davidson, A. R., Yantis, S., Norwood, M., & Montano, D. E. (1985). Amount of information about the attitude object and attitude-behavior consistency. *Journal of Personality and Social Psychology, 49*, 1148-1198.

Davison, A., Barns, I., & Schibeci, R. (1997). Problematic publics: a critical review of surveys of public attitudes to biotechnology. *Science, Technology & Human Values, 22*(3), 317-348.

Day, G. S. (1972). Evaluating models of attitude structure. *Journal of Marketing Research, 9*, 279-286.

Day, G. S. (1973). Theories of attitude structure and change In S. Ward & S. Robertson (Eds.), *Consumer behavior: Theoretical sources* (pp. 303-353). Englewood Cliffs, NJ: Prentice Hall

DeBono, K. G. (1987). Investigating the social-adjustive and value-expressive functions of attitudes: Implications for persuasion processes. *Journal of Personality and Social Psychology, 52,* 279–287.

Dillon, W. R., & Kumar, A. (1985). Attitude organization and the attitude-behavior relation: a critique of Bagozzi and Burnkrant's reanalysis of Fishbein and Ajzen. *Journal of Personality and Social Psychology, 49*(1), 33-46.

Dreyer, M. & Gill, B. (2000). Germany: Elite precaution alongside continued public opposition. *Journal of Risk Research, 3,* 219-226.

Dunlap, R. E., & Van Liere, K. D. (1978). "The New Environmental Paradigm": A proposed measurement instrument and preliminary results. *Journal of Environmental Education*, *9*, 10-19.

Dwyer, L. & Mellor, R. (1991). New product process activities and project outcomes. *R&D Management, 21,* 31-42.

Eagly, A. E. (1967). Involvement as a determinant of response to favourable and unfavourable information. Journal of Personality and Social Psychology, 7 (3).

Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes.* Fort Worth, TX: Harcourt Brace Jovanovich.

Eagly, A. H., Chaiken, S. (1995) Attitude strength, attitude structure and resistance to change. In R. E. Petty & J. A. Krosnick (Eds.), *Attitude strength: Antecedents and consequences* (pp. 413-432). Mahwah, New Jersey: Lawrence Erlbaum.

Eagly, A. H., Wood, W. & Chaiken, S. (1978). Causal inferences about communications and their effect on opinion change. *Journal of Personality and Social Psychology, 36,* 424–435.

Earle, T. C. & Cvetkovich, G. T. (1995). *Social trust and the management of risk.* Westport, CT: Praeger.

Edwards, J. D., & Ostrom, T. M. (1971). Cognitive structure of neutral attitudes. *Journal of Experimental Social Psychology, 7,* 36-47.

Einsiedel, E. & Eastlick, D. (2000). Consensus conferences as deliberative democracy – a communications perspective. *Science Communication, 21,* 223-234.

Einsiedel, E. F. (2000). Understanding 'publics' in the public understanding of science. In M. Dierkes, & C. v. Grote (Eds.), *Between understanding and trust. The public, science and technology* (pp. 205-216). Amsterdam: Harwood Academic Publishers.

Einsiedel, E., Jelsøe, E. & Breck, T. (2001). Publics at the technology table – The consensus conference in Denmark, Canada and Australia. *Public Understanding of Science, 10,* 1-6.

Ellahi, B. (1994). Genetic engineering for food production - what is it all about? *British Food Journal, 96*(8), 13-23.

Ellahi, B. (1996). Genetic modification for the production of food: the food industry's response. *British Food Journal, 98*(4/5), 53-72.

ENTRANSFOOD Network (in press). Genetically modified crops in the EU: Food safety assessment, regulation, and public concerns. Luxembourg: Office for Official Publications of the European Communities.

European Commission (1997). *Eurobarometer 46.1: Europeans and modern biotechnology.* Luxembourg: Office for Official Publications of the European Communities.

European Commission (1997). *The Europeans and modern biotechnology – Eurobarometer 46.1*. Luxembourg: Office for Official Publications of the European Communities.

European Commission (2002). *Eurobarometer 55.2: Europeans and Modern Technology*. Luxembourg: Office for Official Publications of the European Communities.

European Commission (2002). *Life sciences and biotechnology – A strategy for Europe.* Brussels: CEC.

European Council (1990a). *Council Directive No. 90/219 on the Contained Use of GMOs.* Luxembourg: Office for Official Publications of the European Communities.

European Council (1990b). *Council Directive No. 90/220 on the Deliberate Release of GMOs*. Luxembourg: Office for Official Publications of the European Communities.

Fazio, R. H. (1986). How do attitudes guide behavior? In R. M. Sorrentino & E. T. Higgins (Eds.), *The handbook of motivation and cognition. Foundations of social behavior* (pp. 204–243). New York: Guildford Press.

Fazio, R. H. (1989). On the power and functionality of attitudes: The role of attitude accessibility. In A. R. Pratkanis, S. J. Breckler & A. G. Greenwald (Eds.), *Attitude structure and function* (pp. 153-179). Hillsdale, NJ: Erlbaum.

Fazio, R. H. (1995). Attitudes as object-evaluation associations: Determinants, consequences, and correlates of attitude accessibility. In R. E. Petty & J. A. Krosnick (Eds.), *Attitude strength: Antecedents and consequences* (pp. 247-282). Mahwah, NJ: Lawrence Erlbaum.

Fazio, R. H., & Zanna, M. P. (1978a). Attitudinal qualities relating to the strength of the attitude-behavior relationship. *Journal of Experimental Social Psychology, 14*, 398-408.

Fazio, R. H., & Zanna, M. P. (1978b). On the predictive validity of attitudes: The roles of direct experience and confidence. *Journal of Personality, 46*, 228-243.

Fazio, R. H., & Zanna, M. P. (1981). Direct experience and attitude-behavior consistency. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 14, pp. 161-202). New York: Academic Press.

Fazio, R. h., Chen, J., McDoal, E., & Sherman, S. (1982). Attitude accessibility, attitude-behavior consistency, and the strength of the object-evaluation association. *Journal of Experimental Social Psychology, 18*, 339-357.

Fazio, R. H., Sanbonmatsu, D. M., Powell, M. C., & Kardes, F. R. (1986). On the automatic activation of attitudes. *Journal of Personality and Social Psychology, 50*, 229-238.

Feldman, J. M., & Lynch, J., John G. (1988). Self-generated validity and other effects of measurement on belief, attitude, intention, and behavior. *Journal of Applied Psychology, 73*, 421-435.

Festinger, L. (1954). A theory of social comparison processes. *Human Relations, 7*, 114-140.

Festinger, L. (1957). *Theory of cognitive dissonance.* Palo Alto, CA: Stanford University Press.

Fife-Schaw, C., & Rowe, G. (1996). Public perceptions of everyday food hazards: a psychometric study. *Risk Analysis, 16,* 487-500.

Fife-Schaw, C., & Rowe, G. (2000). Extending the application of the psychometric approach for assessing public perceptions of food risk: Some methodological considerations*. Journal of Risk Research, 3,* 167 -179.

Fischhoff, B. (1995). Risk perception and communication unplugged: twenty years of process. *Risk Analysis, 15,* 137-145.

Fischhoff, B., Slovic, P., Lichtenstein, S., Read, S., & Combs, B. (1978). How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits. *Policy Sciences, 9*, 127-152.

Fishbein, M. A. (1963). An investigation of the relationships between beliefs about an object and the attitude toward that object. *Human Relations, 16*, 233-239.

Fishbein, M. A. (1966). The relationships between beliefs, attitudes, and behavior. In S. Feldman (Ed.), *Cognitive consistency, motivational antecedents and behavioral consequents* (pp. 199-223). New York & London Academic Press.

Fishbein, M. A., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Fishbein, M., & Hunter, R. (1964). Summation versus balance in attitude organization and change. *Journal of Abnormal and Social Psychology, 69*, 505-510.

Fiske, S. T., & Neuberg, S. L. (1990). A continuum of impression formation, from category-based to individuating processes: Influences of information and motivation on attention and interpretation. In M. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 23, pp. 1-74). New York: McGraw-Hill.

Fiske, S. T., & Taylor, S. E. (1991). *Social cognition.* New York: Random House.

Flynn, J., Slovic, P. & Mertz, C. K. (1993). Decidedly different: Expert and public views of risks from a radioactive waste repository. *Risk Analysis, 13,* 643–648.

Freedman, J. L. (1968). How important is cognitive consistency? In R. P. Abelson, E. Aronson, W. J. McGuire, T. M. Newcomb, M. J. Rosenberg, & P. H. Tannenbaum (Eds.), *Theories of cognitive consistencies: A sourcebook* (pp. 497-503). Chicago, IL: Rand McNally.

Frewer, L. F., Lassen, J., Kettlitz, B., Scholderer, J., Beekman, V., & Berdal, K. G. (2004). Societal aspects of genetically modified foods. *Food and Chemical Toxicology,42,* 1181-1193.

Frewer, L. F., Miles, S., & Marsh, R. (2002). The media and genetically modified foods: Evidence in support of social amplification of risk. *Risk Analysis, 22*, 701-711.

Frewer, L. J. (1998). Public perception of genetically modified foods. *Pesticide Outlook, 98*(5), 11-15.

Frewer, L. J., & Shepherd, R. (1994). Attributing information to different sources: Effects on the perceived qualities of information, on the perceived relevance of information, and on attitude formation. *Public Understanding Science, 3*, 385-401.

Frewer, L. J., & Shepherd, R. (1995). Ethical concerns and risk perceptions associated with different applications of genetic engineering: Interrelationships with the perceived need for regulation of the technology. *Agriculture and Human Values, 12*, 48-57.

Frewer, L. J., Hedderley, D., Howard, C., & Shepherd, R. (1997). 'Objection' mapping in determining group and individual concerns regarding genetic engineering. *Agriculture and Human Values, 14*, 67-79.

Frewer, L. J., Howard, C., & Shepherd, R. (1995). Genetic engineering and food: What determines consumer acceptance? *British Food Journal, 97*(8), 31-36.

Frewer, L. J., Howard, C., & Shepherd, R. (1996). The influence of realistic product exposure on attitudes towards genetic engineering of food. *Food Quality and Preference, 7*, 61-67.

Frewer, L. J., Howard, C., & Shepherd, R. (1997). Public concerns in the United Kingdom about general and specific applications of genetic engineering: Risk, benefit, and ethics. *Science, Technology & Human Values, 22*, 98-124.

Frewer, L. J., Howard, C., & Shepherd, R. (1998). The importance of initial attitudes on responses to communication about genetic engineering in food production. *Agriculture & Human Values, 15*, 15-30.

Frewer, L. J., Howard, C., Hedderley, D. & Shepherd, R. (1997). Elaboration likelihood model and communication about food risks. *Risk Analysis, 17,* 759-770.

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

Frewer, L. J., Howard, C., Hedderley, D., & Shepherd, R. (1997). Consumer attitudes towards different food-processing technologies used in cheese production - the influence of consumer benefit. *Food Quality and Preference, 8,* 271-290.

Frewer, L. J., Howard, C., Hedderley, D., & Shepherd, R. (1998). Methodological approaches to assessing risk perceptions associates with food-related hazards. *Risk Analysis, 18*, 95-102.

Frewer, L. J., Howard, C., Hedderley, D., & Shepherd, R. (1999). Reactions to information about genetic engineering: Impact of credibility, perceived risk immediacy and persuasive content. *Public Understanding of Science, 8*, 1-15.

Frewer, L. J., Miles, S., & Marsh, R. (2002). The GM foods controversy. A test of the social amplification of risk framework. *Risk Analysis, 22*, 701-711.

Frewer, L. J., Scholderer, J., & Bredahl, L. (2003). Communicating about the risks and benefits of genetically modified foods. *Risk Analysis, 23*, 117-1133.

Frewer, L. J., Shepherd, R., & Sparks, P. (1994). Biotechnology and food production: Knowledge and perceived risk. *British Food Journal, 96*(9), 26-32.

Frewer, L. J., Shepherd, R., & Sparks, P. (1994). The interrelationship between perceived knowledge, control and risk associated with a range of food-related hazards targeted at the individual, other people and society. *Journal of Food Safety, 14*, 19-40.

Frewer, L., & Shepherd, R. (1995). Ethical concerns and risk perceptions associated with different applications of genetic engineering: Interrelationships with the perceived need for regulation of the technology. *Agriculture and Human Values, 12*(1), 48-57.

Frewer, L., Scholderer, J., & Lambert, N. (2003). Consumer acceptance of functional foods: Issues for the future. *British Food Journal, 105*, 714-731.

Frewer, L., Scholderer, J., Downs, C., & Bredahl, L. (2000). *Communicating about the risks and benefits of genetically modified foods: Effects of different information strategies* (MAPP working paper 71).

Frewer, L., Shepherd, R., & Sparks, P. (1994). Biotechnology and food production: Knowledge and perceived risk. *British Food Journal, 96*(9), 26-32.

Frey, D. (1986). Recent research on selective exposure to information. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 19). New York: Academic Press.

Galloux, J. P., Mortensen, A. T., De Cheveigne, S., Allansdottir, A. Chatjouli, A., & Sakellaris, G. (2002). The institutions of bioethics. In M. W. Bauer & G. Gaskell (Eds.), *Biotechnology: The making of a global controversy* (pp. 129-148). Cambridge: Cambridge University Press.

Gaskell, G. (2001). Attitudes and social representations. In K. Deaux, K.& G. Philogene (Eds.), *Representations of the social* (pp. 228-241). Oxford: Blackwell.

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

Gaskell, G., Allum, N., & Stares, S. (2003). *Eurobarometer 58.0: Europeans and biotechnology in 2002.* Luxembourg: Office for Official Publications of the European Communities.

Gaskell, G., Bauer, M. W., Durant, J., & Allum, N. C. (1999). Worlds apart? The reception of genetically modified foods in Europe and the US. *Science, 285*, 384-387.

Gaskell, G., Thompson, P., & Allum, N. (2002). Worlds apart? Public opinion in Europe and the USA. In M. W. Bauer & G. Gaskell (Eds.), *Biotechnology: The making of a global controversy* (pp. 351-378). Cambridge: Cambridge University Press.

Gerbing, D. W., & Anderson, J. C. (1993). Monte Carlo evaluations of goodness-of-fit indices for structural equation models. In K. A. Bollen & J. S. Long (Eds.), *Testing Structural Equation Models* (pp. 40-65). Newbury Park, California: SAGE Publications.

Goldberger, A. S. (1964). *Econometric theory*. New York: Wiley.

Goldberger, A. S. (1971). Econometrics and psychometrics: A survey of communalities. *Psychometrika, 36*(2), 83-107.

Golding, D., Krimsky, S., & Plough, A. (1992). Evaluating risk communication: Narrative versus technical information about radon. *Risk Analysis, 12*, 27-35.

Goldsmith, R. E., Freiden, J., & Henderson, K. V. (1997). The impact of social values on food-related attitudes. *British Food Journal, 99*(9).

Gray, P. C. R., & Wiedemann, P. M. (1998). *The interactive construction of risks: How lay people construct genetic engineering risks and benefits in social settings.* Paper presented at the Society of Risk Analysis Annual European Conference, Paris, 11-14 October 1998.

Greenwald, A. G. (1989). Why are attitudes important? In A. R. Pratkanis, S. J. Breckler & A. G. Greenwald (Eds.), *Attitude structure and function* (pp. 1-10). Hillsdale, NJ: Erlbaum.

Gross, S. J., & Nimann, C. M. (1975). Attitude-behavior consistency: A review. *Public Opinion Quarterly, 39*, 358-368.

Grunert, K. G. (2002). Current issues in the understanding of consumer food choice. *Trends in Food Science &Technology, 13*, 275-285.

Grunert, K. G., & Bech-Larsen, T., Lähteenmäki, L., Ueland, Ø., & Åström, A. (in press). Attitudes towards the use of GMOs in food production and their impact on buying intention: The role of positive sensory experience. *Agribusiness*.

Grunert, K. G., & Grunert, S. C. (1995). Measuring subjective meaning structures by the laddering method: Theoretical considerations and methodological problems. *International Journal of Research in Marketing, 12*, 209-225.

Grunert, K. G., Bech-Larsen, T., & Bredahl, L. (2000). Three issues in consumer quality perception and acceptance of dairy products. *International Dairy Journal, 10*, 575-584.

Grunert, K. G., Bredahl, L., & Scholderer, J. (2003). Four questions on European consumers' attitudes to the use of generic modification in food production. *Innovative Food Science and Emerging Technologies, 4*, 435-445.

Grunert, K. G., Hartvig Larsen, H., Madsen, T. K., & Baadsgaard, A. (1996). *Market orientation in food and agriculture*. Boston: Kluwer.

Grunert, K. G., Lähteenmäki, L., Nielsen, N. A., Poulsen, J. B., Ueland, O., & Åström, A. (2001). Consumer perceptions of food products involving genetic modification: Results from a qualitative study in four Nordic countries. *Food Quality and Preference, 12*, 527-542.

Gutteling, J. M., Olofsson, A., Fjæstad, B., Kohring, M., Goerke, A., *et al.* (2002). Media coverage 1973-1996: Trends and dynamics. In M. W. Bauer & G. Gaskell (Eds.), *Biotechnology: The making of a global controversy* (pp. 95-128). Cambridge: Cambridge University Press.

Hackman, J. R., & Anderson, L. R. (1968). The strength, relevance, and source of beliefs about an object in Fishbein's attitude theory. *Journal of Social Psychology, 76*, 55-67.

Halpern-Felsher, B. L., Millstein, S. G., Ellen, J. M., Adler, N. C., Tschann, J. M., & Biehl, M. (2001). The role of behavioral experience in judging risks. *Health Psychology, 20*(2), 120-126.

Hampel, J. & Pfenning, U. (1999). Einstellungen zur Gentechnik. In J. Hampel & O. Renn (Eds.), *Gentechnik in der Öffentlichkeit:Wahrnehmung und Bewertung einer umstrittenen Technologie* (pp. 28-55). Frankfurt/Main: Campus.

Hampel, J. (1999). *Die europäische Öffentlichkeit und die Gentechnik: Einstellungen zur Gentechnik im internationalen Vergleich*. Stuttgart: Center for Technology Assessment.

Hamstra, A. (1995). *Consumer acceptance of model for food biotechnology: Final report*. The Hague: The SWOKA Institute.

Hamstra, A. (1998). *Public opinion about biotechnology. A survey of surveys*. The Hague: European Federation of Biotechnology.

Hamstra, A. M. (1991). *Biotechnology in foodstuffs. Towards a model of consumer acceptance*. The Hague: The Swoka Institute.

Hamstra, A. M. (2000). Studying public perception of biotechnology: Helicopter and microscope? In M. Dierkes, & C. v. Grote (Eds.), *Between understanding and trust. The public, science and technology* (pp. 179-202). Amsterdam: Harwood Academic Publishers.

Hamstra, A. M., & Smink, C. (1996). Consumers and biotechnology in the Netherlands. *British Food Journal, 98*, 34-38.

Hamstra, A.M. & Feenstra, M.H. (1989). *Consument en biotechnologie. Kennis en meningsvorming van consumenten over biotechnologie* (SWOKA onderzoeksrapport nr.85). Den Haag: SWOKA.

Hansen, J., Holm, L., Frewer L., Robinson, P., & Sandøe, P., (2003). Beyond the knowledge deficit: Recent research into lay and expert attitudes to food risks. *Appetite, 41,* 111-121.

Harlander, S. K. (1991). Social, moral and ethical issues in food biotechnology. *Food Technology* (May), 152-159.

Hass, J. W., Bagley, G. S., & Rogers, R. W. (1975). Coping with energy crisis: Effects of fear appeals upon attitudes toward energy consumption. *Journal of Applied Psychology, 60*(6), 754-756.

Haugtvedt, C. P., Schumann, D. W., Schneier, W. L., & Warren, W. L. (1994). Advertising repetition and variation strategies: Implications for understanding attitude strength. *Journal of Consumer Research, 21*(1), 176-189.

Hauser, R. M., & Goldberger, A. S. (1971). The treatment of unobserved variable sin path analysis. In H. L. Costner (Ed.), *Sociological methodology* (pp. 81-117). San Francisco, CA: Jossey-Bass.

Heider, F. (1944). Social perception and phenomenal causality. *Psychological Review, 51*, 358-374.

Heider, F. (1946). Attitudes and cognitive organization. *Journal of Psychology, 21*, 107-112.

Heider, F. (1958). *The psychology of interpersonal relations*. New York: Wiley.

Heijs, W. J. M., & Midden, C. J. H. (1995). *Biotechnology: Attitudes and influencing factors (3rd survey)*. Eindhoven: Eindhoven University of Technology.

Herek, G. M. (2000). The social construction of attitudes: Functional consensus and divergence in the US public's reaction to AIDS. In G. R. Maio & J. M. Olson (Eds.), *Why we evaluate: Functions of attitudes.* Mahwah, NJ: Erlbaum.

Heroux, L., Laroche, M., & McGown, K. L. (1988). Consumer product label information processing: An experiment involving time pressure and distraction. *Journal of Economic Psychology, 9*, 195-214.

Homer, P., & Kahle, L. R. (1988). A structural equation test of the value-attitude-behavior hierarchy. *Journal of Personality and Social Psychology, 54*(4), 638-646.

Hovland, C. J. & Mandell, W. (1952) An experimental comparison of conclusion drawing by the communicator and by the audience. *Journal of Abnormal and Social Psychology, 47,* 581–588.

Hovland, C. J. & Weiss, W. (1952). The influence of source credibility on communication effectiveness. *Public Opinion Quarterly, 15,* 635–650.

Hovland, C. J., Harvey, O. J., & Sherif, M. (1957). Assimilation and contrast effects in reactions to communication and attitude change. *Journal of Abnormal and Social Psychology, 55,* 244-252.

Hovland, C. J., Janis, I. & Kelley, H. (1953). *Communication and persuasion*. New Haven, CT: Yale University Press.

Hu, L. T., Bentler, P. M. & Kano, Y. (1992). Can test statistics in covariance structure analysis be trusted? *Psychological Bulletin, 112,* 351-362.

Hunt, S., Frewer, L.J. & Shepherd, D. (1999). Public trust in sources of information about radiation risks in the UK. *Journal of Risk Research, 2,* 167-180.

Hurling, R. & Shepherd, R. (2003). Eating with your eyes: Effect of appearance on expectations of liking. *Appetite, 41,* 167-174.

Hursti, U. K. K., & Magnusson, M. K. (2003). Consumer perceptions of genetically modified and organic foods. What kind of knowledge matters? *Appetite, 41,* 207-209.

INRA Europe (1991). *Eurobarometer 34.1: Opinions of Europeans on biotechnology in 1991.* Luxembourg: Office for Official Publications of the European Communities.

INRA Europe (1993). *Eurobarometer 39.1: Biotechnology and genetic engineering – What Europeans think about it*. Luxembourg: Office for Official Publications of the European Communities.

INRA Europe (2000). *Eurobarometer 52.1: The Europeans and Biotechnology.* Luxembourg: Office for Official Publications of the European Communities.

Insko, C. A., & Schopler, J. (1967). Triadic consistency: A statement of affective-cognitive-conative consistency. *Psychological Review, 74*, 361-376.

Jaccard, J., Radecki, C., Wilson, T., & Dittus, P. (1995). Methods for identifying consequential beliefs: Implications for understanding attitude strength. In R. E. Petty & J. A. Krosnick (Eds.), *Attitude strength - Antecedents and consequences* (pp. 337-359). Mahwah, NJ: Lawrence Erlbaum.

James, J., Harvey S. (2003). The effect of trust on public support for biotechnology: Evidence from the U.S. biotechnology study, 1997-1998. *Agribusiness, 19*, 155-168.

Jensen, K. K., & Sandoe, P. (2002). Food safety and ethics. The interplay between science and values. *Journal of Agricultural and Environmental Ethics, 15,* 245 -253.

Johnson, B. (1999). Exploring dimensionality in the origins of hazard-related trust. *Journal of Risk Research, 2,* 307-324.

Johnson, B. B., & Slovic, P. (1995). Presenting uncertainty in health risk assessment: Initial studies of its effects on risk perception and trust. *Risk Analysis, 15*, 485-494.

Johnson, B. T. & Eagly, A. H. (1989). The effects of involvement on persuasion: A meta-analysis. *Psychological Bulletin, 106,* 290-314.

Johnson, E. J., & Tversky, A. (1984). Representations of perceptions of risks. *Journal of Experimental Psychology: General, 113*(1), 55-70.

Joly, P. B. & Assouline, G. (2001). Assessing public debate and participation in technology assessment in Europe (Final report to the European Commission). Grenoble: INRA.

Jöreskog, K. G. (1971). Simultaneous factor analysis in several populations. *Psychometrika, 36*(4), 409-426.

Jöreskog, K. G. (1993). Testing structural equation models. In K. A. Bollen & J. S. Long (Eds.), *Testing Structural Equation Models* (pp. 294-316). Newbury Park, California: SAGE Publications.

Jöreskog, K. G., & Sörbom, D. (1996). *LISREL 8: User's reference guide* (2nd ed.). Chicago, IL: Scientific Software International, Inc.

Jöreskog, K. G., & Sörbom, D. (1996). *PRELIS 2: User's reference guide*. Chicago, IL: Scientific Software International.

Jöreskog, K. G., Sörbom, D., du Toit, S., & du Toit, M. (1999). *LISREL 8: New statistical features*. Chicago, IL: Scientific Software International.

Jöreskog, K. R. (1970). A general method for analysis of covariance structures. *Biometrika, 57,* 239-251.

Jörsekog, K. R., & Goldberger, A. S. (1975). Estimation of a model with multiple indicators and multiple causes of a single latent variable. *Journal of the American Statistical Association, 70,* 631-639.

Judd, C. M. & Brauer, M. (1995) Repetition and evaluative extremity. In R. E. Petty, J. A. Krosnick (Eds.), *Attitude strength: Antecedents and consequences* (pp. 43-72). Hillsdale, NJ: Erlbaum.

Judd, C. M., & Kenny, D. A. (1981). Process analysis: Estimating mediation in treatment evaluations. *Evaluation Review, 5,* 602-619.

Judd, C. M., & Kenny, D. A. (1982). Research design and research validity. In D. Bringberg & L. H. Kidder (Eds.), *Forms of validity in research*. San Francisco: Jossey-Bass Inc., Publishers.

Judd, C. M., Krosnick, J. A., & Milburn, M. A. (1981). Political involvement and attitude structure in the general public. *American Sociological Review, 46*(October), 660-669.

Jungermann, H. (1997). When you can't do it right: Ethical dilemmas of informing people about risks. *Risk, Decision and Policy, 2*, 131-145.

Jungermann, H., Pfister, H.-R., & Fischer, K. (1996). Credibility, information preferences, and information interests. *Risk Analysis, 16*, 251-261.

Kajanne, A., & Pirttilä-Backman, A.-M. (1996). Toward an understanding of laypeople's notions about additives in food: Clear-cut viewpoints about additives decrease with education. *Appetite, 27*, 207-222.

Kallgren, C. A., & Wood, W. (1986). Access to attitude-relevant information in memory as a determinant of attitude-behavior consistency. *Journal of Experimental Social Psychology, 22*, 328-338.

Kasperson, R. E., Renn, O., Slovic, P., Brown, H. S., Emel, J., Goble, R., Kasperson, J. X., & Ratick, S. (1988). The social amplification of risk: A conceptual framework. *Risk Analysis, 8,* 177-187.

Katz, D. (1960). The functional approach to the study of attitudes. *Public Opinion Quarterly, 24,* 163-204.

Katz, D., & Stotland, E. (1959). A preliminary statement of a theory of attitude structure and change. In S. Koch (Ed.), *Psychology: A study of science* (Vol. 3, pp. 423-475). New York: McGraw Hill.

Keeney, R. L. & Raiffa, H. (1976). Decisions with multiple objectives: Preferences and value tradeoffs. New York: Wiley.

Keith, J. E., Jackson Jr., D. W., & Crosby, L. A. (1990). Effects of alternative types of influence strategies under different channel dependence structures. *Journal of Marketing, 54*(3), 30-41.

Kempf, D. S., & Smith, R. E. (1998). Consumer processing of product trial and the influence of prior advertising: A structural modeling approach. *Journal of Marketing Research, 35*(August), 325-338.

Kerlinger, F. M. (1984). *Liberalism and conservatism: The nature and structure of social attitudes.* Hillsdale, NJ: Erlbaum.

Klüver, L. (1995). Consensus conferences at the Danish Board of Technology. In S. Joss (Ed.), *Public participation in science: The role of consensus conferences in Europe*. London: Science Museum.

Koivisto Hursti, U.-K., & Magnusson, M. K. (2003). Consumer perceptions of genetically modified and organic foods. What kind of knowledge matters? *Appetite, 41*, 207-209.

Krantz, D. H., Luce, R. D., Suppes, P. & Tversky, A. (1971). *Foundations of measurement. Volume 1: Additive and polynomial representations.* New York: Academic Press.

Krimsky, S. (1991). *Biotechnics and society: The rise of industrial genetics.* New York: Praeger.

Krosnick, J. A. (1991). Response strategies for coping with the cognitive demands of attitude measures in surveys. *Applied Cognitive Psychology, 5*, 213-236.

Krosnick, J. A., & Alwin, D. F. (1987). An evaluation of a cognitive theory of response-order effects in survey measurement. *Public Opinion Quarterly, 51*(2), 201-219.

Kunda, Z. (1999). *Social cognition.* Cambridge, MA: MIT Press.

Kuznesof, S., & Ritson, C. (1996). Consumer acceptability of genetically modified foods with special reference to farmed salmon. *British Food Journal, 98*, 39-47.

Lähteenmäki, L., Grunert, K. G., Ueland, O., Åström, A., Arvola, A., & Bech-Larsen, T. (2002). Acceptability of genetically modified cheese presented as real product alternative. *Food Quality & Preference, 13*, 523-533.

Lassen, J., Allansdottir, A., Liakopoulas, M., Mortensen, A., & Olofsson, A. (2002). Testing times: the reception of Roundup Ready soya in Europe. In M. W. Bauer & G. Gaskell (Eds.), *Biotechnology: The making of a global controversy* (pp. 279-312). Cambridge: Cambridge University Press.

Lassen, J., Madsen, K.H. & Sandøe, P. (2002). Ethics and genetic engineering - lessons to be learned from genetically modified foods. *Bioprocess Biosystems Engineering, 24,* 263-271.

Lawley, D. N. (1958). Estimation in factor analysis under various initial assumptions. *British Journal of Statistical Psychology, 11,* 1-12.

Levidow, L. & Carr, S. (2000). UK: Precautionary commercialization? *Journal of Risk Research, 3,* 261-270.

Levidow, L., & Marris, C. (2001). Science and governance in Europe: Lessons from the case of agricultural biotechnology. *Science and Public Policy, 28,* 345-360.

Levidow, L., Carr, S. & Wield, D. (2000). Genetically modified crops in the European Union: Regulatory conflict and precautionary opportunities. *Journal of Risk Research, 3,* 189-208.

Liska, A. E. (1984). A critical examination of the causal structure of the Fishbein/Ajzen attitude-behavior model. *Social Psychology Quarterly, 47*(1), 61-73.

Little, T. D. (1997). Mean and covariance structures (MACS) analyses of cross-cultural data: Practical and theoretical issues. *Multivariate Behavioral Research, 32,* 53-76.

Loken, B., Joiner, C., & Peck, J. (2002). Category attitude measures: Exemplars as inputs. *Journal of Consumer Psychology, 12*(2), 149-161.

Lord, C. G., Ross, L. & Lepper, M. R. (1979). Biased assimilation and attitude polarization: The effects of prior theories on subsequent considered evidence. *Journal of Personality and Social Psychology, 37,* 2098-2109.

Lord, F. M. (1959). Problems in mental test theory arising from errors of measurement. *Journal of the American Statistical Association, 54,* 472-479.

Lord, F. M., & Novick, M. R. (1968). *Statistical theories of mental test scores.* Reading: Addison Wesley.

Louviere, J. J. (1994). Conjoint analysis. In R. P. Bagozzi (Ed.), Advanced methods of marketing research (pp. 223–259). Cambridge, MA: Lexington.

MacCallum, R. (1986). Specification searches in covariance structure modeling. *Psychological Bulletin, 100,* 107-120.

MacCallum, R. C., Wegener, D. T., Uchino, B. N., & Fabrigar, L. R.(1993). The problem of equivalent models in applications of covariance structure analysis. *Psychological Bulletin, 114,* 185-199.

Madsen, K. H., Lassen, J., Holm, P. B., Sandøe, P. (2002). Ranking genetically modified organisms according to familiarity. *Journal of Agricultural and Environmental Ethics, 15,* 267-278.

Magnusson, M. K., & Hursti, U.-K. K. (2002). Consumer attitudes towards genetically modified foods. *Appetite, 39*(1), 9-24.

Maio, G. R. & Olson, J. M. (1995). Relations between values, attitudes, and behavioral intentions: The moderating role of attitude function. *Journal of Experimental Social Psychology, 31,* 266–285.

Maio, G. R., & Olson, J. M. (2000, Eds.). *Why we evaluate: Functions of attitudes.* Mahwah, NJ: Erlbaum.

Mardia, K. V., Kent J. T. & Bibby, J. M. (1980). *Multivariate analysis*. New York: Academic Press.

Marks, L. J., & Kamins, M. A. (1988). The use of product sampling and advertising: Effects of sequence of exposure and degree of advertising claim exaggeration on consumers belief strength, belief confidence, and attitudes. *Journal of Marketing Research, 25*, 266-282.

Marks, L. J., & Kamins, M. A. (1988). The use of product sampling and advertising: Effects of sequence of exposure and degree of advertising claim exaggeration on consumers belief strength, belief confidence, and attitudes. *Journal of Marketing Research, 25*, 266-282.

Martin, S. & Tait, J. (1992). Attitudes of selected public groups in the UK to biotechnology. In J. Durant (Ed.), *Biotechnology in public. A review of recent research* (pp. 28-41). London: Science Museum.

Mathios, A. D. (2000). The impact on mandatory disclosure regulation on product chioice: An analyis of the salad dressing market. *Journal of Law and Economics, 43*(2), 651-677.

McCarthy, M., & Vilie, S. (2002). *Irish consumer acceptance of the use of gene technology in food production.* In J. H. Tienekens (Ed.), Paradoxes in chains and networks (pp. 176-187). Wageningen: Wageningen Academic Publishers.

McGuire, W. J. (1969). The nature of attitudes and attitude change. In G. Linzey & E. Aaronson (Eds.), *The handbook of social psychology* (Vol. 3, pp. 136-314), Reading MA, Addison Wesley.

McGuire, W. J. (1985). Attitudes and attitude change. In G. Lindzey & E. Aronson (Eds), *The handbook of social psychology* (3rd Edition, Vol. 2, pp. 233–346). New York: Random House.

McGuire, W. J. (1986). The vicissitudes of attitudes and similar representational constructs in twentieth century psychology. *European Journal of Social Psychology, 16*, 89-130.

McGuire, W. J. (1989). The structure of individual attitudes and attitude systems. In A. R. Pratkanis, S. J. Breckler, & A. G. Greenwald (Eds.), *Attitude structure and function* (pp. 37-69). Hillsdale, NJ: Lawrence Erlbaum Associates.

McGuire, W. J. (1990). Dynamic operation of thought systems. *American Psychologist, 45,* 504-512.

McGuire, W. J., & McGuire, C. V. (1991). The content, structure and operation of thought systems. In R. S. Wyer & T. Srull (Eds.), *Advances in social cognition* (Vol. 4, pp. 1-78). Hillsdale, NJ: Erlbaum.

Meiselman, H. L., Johnson, J. L., Reeve, W., & Crouch, J. E. (2000). Demonstrations of the influence of the eating environment on food acceptance. *Appetite, 35,* 231-237.

Mela, D. (2000). Why do we like what we like? *Journal of the Science of Food and Agriculture, 81,* 10-16.

Mela, D. (2001). Development and acquisition of food likes and dislikes. In L. J. Frewer, E. Risvik & H. Schifferstein (Eds.), *Food, people and society: A European perspective on consumers' food choices* (pp. 9-22). Berlin: Springer.

Meredith, W. (1993). Measurement invariance, factor analysis, and factorial invariance. *Psychometrika*, *58,* 525-543.

Meyers-Levy, J., & Tybout, A. M. (1989). Schema congruity as a basis for product evaluation. *Journal of Consumer Research, 16*, 39-54.

Midden, C., Boy, D., Einsiedel, E., Fjæstad, B., Liakopoulos, M., *et al.* (2002). The structure of public perceptions. In M. W. Bauer & G. Gaskell (Eds.), *Biotechnology: The making of a global controversy* (pp. 203-224). Cambridge: Cambridge University Press.

Miles, S. & Frewer, L. J. (2002). *QPCRGMOFOOD Work Package 6: Socio-economic impact of GM regulation and GM detection* (Report to the European Commission). Norwich: Institute of Food Research.

Miles, S., & Frewer, L. J. (2001). Investigating specific concerns about different food hazards. *Food Quality and Preferences, 12*, 47-61.

Miles, S., Braxton, D.S. & Frewer, L. J. (1999). Public perceptions about microbiological hazards in food. *British Food Journal, 101,* 744-762.

Millar, M. G., & Tesser, A. (1986). Effects on affective and cognitive focus on the attitude-behavior relation. Journal of Personality and Social Psychology, 51, 270-276.

Millar, M. G., & Tesser, A. (1990). Attitudes and behavior: The cognitive-affective mismatch hypothesis. *Advances in Consumer Research, 17,* 86-90.

Millar, M. G., & Tesser, A. (1992). The role of beliefs and feelings in guiding behaviour: The mismatch model. In L. L. Martin & A. Tesser (Eds.), *The construction of social judgments* (pp. 277-300). Hillsdale, NJ: Erlbaum.

Miller, D. (1999). Risk, science and policy: Definitional struggles, information management, the media and BSE. *Social Science & Medicine, 49,* 1239-1255.

Ministerie van O&W (1985). *Maatschappelijke aspecten van de biotechnologie. Deelstudies 2, perceptie en acceptatie van biotechnologie, een oriënterend kwalitatief onderzoek.* Den Haag: Ministerie van O&W.

Motherway, B. (2000), Ireland: Contested precaution and challenged institutions. *Journal of Risk Research, 3,* 255-260.

Murphy, G. L., & Lassaline, M. E. (1997). Hierarchical structure in concepts and the basic level of categorisation. In K. Lamberts & D. Shanks (Eds.), *Knowledge, concepts, and categories* (pp. 93-131). London: Psychology Press.

Nelson, P. (1970). Information and consumer behavior. *Journal of Political Economy, 78,* 311–329.

Nielsen, T. H., Jelsøe, E., & Öhmann, S. (2002). Traditional blue and modern green resistance. In M. W. Bauer & G. Gaskell (Eds.), *Biotechnology: The making of a global controversy* (pp. 179-202). Cambridge: Cambridge University Press.

Norman, R. (1975). Affective-cognitive consistency, attitudes, conformity, and behavior. *Journal of Personality and Social Psychology, 32*(1), 83-91.

O'Keefe, D. (2002). *Persuasion: Theory and research.* Thousand Oaks, CA: Sage.

Office of Technology Assessment at the German Parliament (1993). *Technikfolgen-Abschätzung zu neuen Biotechnologien. Auswertung ausgewählter Studien ausländischer parlamentarischer TA-Einrichtungen*. Bonn: Deutscher Bundestag.

Olsen, S. O. (1999). Strength and conflicting valence in the measurement of food attitudes and preferences. *Food Quality and Preference, 10*(6), 483-494.

Olson, J. C. & Dover, P. (1976). Effects of expectation creation and disconfirmation on belief elements of cognitive structure. *Advances in Consumer Research, 3,* 168-175.

Olson, J. C. & Jacoby, J. (1972). Cue utilization in the quality perception process. In Association for Consumer Research (Ed.), *Proceedings of the Third Annual Conference of the Association for Consumer Research* (pp. 167-179). Chicago: ACR.

Olson, J. C. (1978). Inferential belief formation in the cue utilization process. *Advances in Consumer Research, 5,* 706-713.

Orth, B. (1985). Bedeutsamkeitsanalysen bilinearer Einstellungsmodelle. *Zeitschrift fur Sozialpsychologie, 16*, 101-115.

Ostrom, T. M., & Brock, T. C. (1968). A cognitive model of attitudinal involvement. In R. P. Abelson, E. Aronson, W. J. McGuire, T. M. Newcomb, M. J. Rosenberg, & P. H. Tannenbaum (Eds.), *Theories of cognitive consistency: A sourcebook* (pp. 373-383). Chicago, IL: Rand-McNally.

Otway, H. (1987). Expert risk communication and democracy. *Risk Analysis, 7,* 125-129.

Palda, K. S. (1966). The hypothesis of a hierarchy of effects: A partial evaluation. *Journal of Marketing Research*, *3,* 12-24.

Pardo, R., Midden, C., & Miller, J. D. (2002). Attitudes toward biotechnology in the European Union. *Journal of Biotechnology, 98*, 9-24.

Peter, J. P., & Ryan, M. J. (1976). An investigation of perceived risk at the brand level. *Journal of Marketing Research, 13*(May), 184-188.

Peter, J. P., Olson, J. C., & Grunert, K. G. (1999). *Consumer behaviour and marketing strategy - European edition*. Maidenhead: McGraw-Hill.

Peters, H. P. (1998). Is the negative more relevant than the positive? Cognitive responses to TV programs and newspaper articles on genetic engineering. *Paper presented at the 5th International Conference on Public Communication of Science and Technology (PCST),* Berlin, September 17-19, 1998.

Peters, H. P. (2000). From information to attitudes? Thoughts on the relationship between knowledge about science and technology and attitudes toward technologies. In M. Dierkes, & C. v. Grote (Eds.), *Between understanding and trust. The public, science and technology* (pp. 265-286). Amsterdam: Harwood Academic Publishers.

Petty, R. E. & Cacioppo, J. T. (1984). Source factors and the elaboration likelihood model of persuasion. *Advances in Consumer Research, 11,* 668–672.

Petty, R. E. & Cacioppo, J. T. (1986). *Communication and persuasion: Central and peripheral routes to attitude change.* New York: Springer.

Petty, R. E., & Cacioppo, J. T. (1981). *Attitudes and persuasion: Classic and contemporary approaches*. Dubuque: W.C. Brown.

Petty, R. E., Cacioppo, J. T. & Schumann, D. (1983). Central and peripheral routes to advertising effectiveness: The moderating role of involvement. *Journal of Consumer Research, 10,* 135-146.

Petty, R. E., Wegener, D. Y., & Fabrigar, L. R. (1997). Attitudes and attitude change. *Annual Review of Psychology, 48,* 609-47.

Pliner, P. & Hobden, K. (1992). Development of a scale to measure the trait of food neophobia in humans. *Appetite, 19,* 105–120.

Posavac, S. S., Sanbonmatsu, D. M., & Ho, E. A. (2002). The effects of the selective consideration of alternatives on consumer choice and attitude-decision consistency. *Journal of Consumer Psychology, 12*(3), 203-213.

Powell, D., & Leiss, W. (1997). *Mad cows and mother's milk: The perils of poor risk communication*. Montreal: McGill-Queen's University Press.

Pras, B., & Summers, J. O. (1978). Perceived risk and composition models for multi-attribute decisions. *Journal of Marketing Research, 15*, 429-437.

Pratkanis, A. R. (1989). The cognitive representation of attitudes. In A. R. Pratkanis, S. J. Breckler, & A. G. Greenwald (Eds.), *Attitude structure and function* (pp. 71-98). Hillsdale, NJ: Lawrence Erlbaum Associates.

Pratkanis, A. R., Breckler, S. J., & Greenwald, A. G. (1989, Eds.). *Attitude structure and function*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Presidential/Congressional Commission on Risk Assessment and Risk Management (1997a). *Framework for environmental health risk management*. Washington DC: Presidential/Congressional Commission on Risk Assessment and Risk Management.

Presidential/Congressional Commission on Risk Assessment and Risk Management (1997b). *Risk assessment and risk management in regulatory decision-making*. Washington DC: Presidential/Congressional Commission on Risk Assessment and Risk Management.

Priester, J. R. & Petty, R. E. (1995). Source attributions and persuasion: Perceived honesty as a determinant of message scrutiny. *Personality and Social Psychology Bulletin, 21,* 637–654.

Priester, J. R. & Petty, R. E. (1995). Source attributions and persuasion: Perceived honesty as a determinant of message scrutiny. *Personality and Social Psychology Bulletin, 21,* 637-654.

Prislin, R. (1985). Affective-cognitive attitude structure and cognitive dissonance. *Psychologische Beiträge, 27*, 255-264.

Purdue, D. (1995). Whose knowledge counts: Experts, counter experts and the lay public. *The Ecologist, 25,* 170-172.

Raats, M. M., Shepherd, R., & Sparks, P. (1995). Including moral dimensions of choice within the structure of the theory of planned behavior. *Journal of Applied Social Psychology, 25*(6), 484-494.

Ratneshwar, S., & Chaiken, S. (1991). Comprehension's role in persuasion: The case of its moderating effect on the persuasive impact of source cues. *Journal of Consumer Research, 18*(1), 52-62.

Reddy, S. K., & LaBarbera, P. A. (1985). Hierarchical models of attitude. *Multivariate Behavioral Research, 20*(4), 451-475.

Regan, D. T., & Fazio, R. (1977). On the consistency between attitudes and behavior: Look to the method of attitude formation. *Journal of Experimental Social Psychology, 13*, 28-45.

Renn, O. (1992). The social arena concept of risk debates. In S. Krimsky & D. Golding (Eds.), *Social theories of risk* (pp. 179-196). Westport CT: Praeger.

Renn, O. (1998a). Risk management: The need to integrate risk assessment and perception. *Reliability Engineering and System Safety, 59,* 49-62

Renn, O. (1998b). The role of risk communication and public dialogue for improving risk management. *Risk, Decision and Policy, 3*, 5-30.

Renn, O., Burns, W., Kasperson, R. E., Kasperson, J. X. & Slovic, P. (1992). The social amplification of risk: Theoretical foundations and empirical application. *Social Issues, 48,* 137-160

Renn, O., Levine, D. (1991). Credibility and trust in risk communication. In R. E. Kasperson, R.E. & P.J.M. Stallen (Eds.), *Communicating risks to the public* (pp. 175-218). Dordrecht: Kluwer.

Reynolds, T. J., & Craddock, A. B. (1988). The application of the MECCAS model to the assessment of advertising strategy. *Journal of Advertising Research, 29*(April/May), 43-54.

Reynolds, T. J., & Gutman, J. (1984). Laddering: Extending the repertory grid methodology to construct attribute-consequence-value hierarchies. In R. E. Pitts & A. G. Woodside (Eds.), *Personal values and consumer psychology*. Lexington, MA: Lexington Books.

Reynolds, T. J., & Gutman, J. (1988). Laddering theory, methods, analysis, and interpretation. *Journal of Advertising Research, 18*(1), 11-31.

Rip, A. (1988). Should social amplification of risk be counteracted? *Risk Analysis, 8,* 193-197.

Roberts, J. V. (1985). The attitude-memory relationship after 40 years: A meta-analysis of the literature. *Basic and Applied Social Psychology*, *6,* 221-241.

Robinson, C. (1997). Genetically modified foods and consumer choice. *Trends in Food Science & Technology, 8*(March), 84-88.

Rock, D.A., Werts, C.E., & Flaugher, R.L. (1978). The use of analysis of covariance structures for comparing the psychometric properties of multiple variables across populations. *Multivariate Behavioral Research*, 13, 403-418.

Roe, B., Teisl, M. F., Levy, A. S., Boyle, K., Messonnier, M. L., Riggs, L. T., Herrmann, M. J., & Newman, F. M. (2001). Consumers' assessment of the food safety problem for meals prepared at home and reactions to food safety labeling. *Journal of Food Products Marketing, 6*(4), 9-26.

Rohrmann, B. (1992). The evaluation of risk communication effectiveness. *Acta Psychologica, 81*, 169-192.

Rokeach, M. (1968). *Beliefs, attitudes, and values: A theory of organization and change.* New York: Free Press.

Ronis, D. L., Yates, J. F., & Kirscht, J. P. (1989). Attitudes, decisions, and habits as determinants of repeated behaviour. In A. R. Pratkanis, S. J. Breckler, & A. G. Greenwald (Eds.), *Attitude structure and function* (pp. 213-239). Hillsdale, NJ: Lawrence Erlbaum.

Rosenberg, M. J. (1956). Cognitive structure and attitudinal affect. *Journal of Abnormal and Social Psychology, 53*, 367-372.

Rosenberg, M. J. (1965). Inconsistency arousal and reduction in attitude change. In I. D. Steiner & M. Fishbein (Eds.), *Current studies in social psychology* (pp. 121-134). New York: Holt, Rienhart & Winston.

Rosenberg, M. J. (1968). On reducing the inconsistency between consistency theories. In R. P. Abelson, E. Aronson, W. J. McGuire, T. M. Newcomb, M. J. Rosenberg, & P. H. Tannenbaum (Eds.), *Theories of cognitive consistencies: A sourcebook* (pp. 827-833). Chicago, IL: Rand McNally.

Rosenberg, M. J., & Abelson, R. P. (1960). An analysis of cognitive balancing. In M. J. Rosenberg, C. I. Hovland, W. J. McGuire, R. P. Abelson (Eds.), *Attitude organization and change* (pp. 112-163). New Haven: Yale University Press .

Rowe, G. & Frewer, L. J. (2000). Public participation methods: An evaluative review of the literature. *Science, Technology and Human Values, 25,* 3-29.

Roy, A. & Joly, P. B. (2000). France: Broadening of precautionary expertise? *Journal of Risk Research, 3,* 247-254.

Rozin, P. & Vollmecke, T. A. (1986). Food likes and dislikes. *Annual Review of Nutrition, 6,* 433-456.

Rozin, P. (1990). Acquisition of stable food preferences. *Nutrition Reviews, 48*(February), 106-113.

Rozin, P., & Vollmecke, T. A. (1986). Food likes and dislikes. *Annual Review of Nutrition, 6*, 466-456.

Rozin, P., Levin, P. M., & Fallon, A. E. (1986). Psychological factors influencing food choice. In C. Ritson & L. Gofton & J. McKenzie (Eds.), *The food consumer* (pp. 241-257). Chichester: Wiley.

Rust, R. T., Lee, C., & Valente Jr., E. (1995). Comparing covariance structure models: A general methodology. *International Journal of Research in Marketing, 12*(4), 279-292.

Saba, A., & Vassallo, M. (2002). Consumer attitudes toward the use of gene technology in tomato production. *Food Quality and Preference, 13*, 13-21.

Saba, A., Moles, A., & Frewer, L. J. (1998). Public concerns about general and specific applications of genetic engineering: a comparative study between the UK and Italy. *Nutrition & Food Science, 28,* 19-29.

Saba, A., Rosati, S., & Vassallo, M. (2000). Biotechnology in agriculture: perceived risks, benefits and attitudes in Italy. *British Food Journal, 102*(2), 114-121.

Salter, B. & Frewer, L. J. (in press). The changing governance of biotechnology – The politics of public trust. *Science, Technology and Human Values*.

Satorra, A. & Bentler, P. (1999). A scaled difference chi-square statistic for moment structure analysis *(UCLA Statistics Series No. 260)*. Los Angeles: University of California.

Satorra, A. (2000). Scaled and adjusted restricted tests in multi-sample analysis of moment structures. In R. D. H. Heijmans, D. S. G. Pollock & A. Satorra (Eds.), *Innovations in multivariate statistical analysis* (pp. 233-247). London: Kluwer.

Schifferstein, H. (2001). Effects of product beliefs on product perception and linking. In L. Frewer & E. Risvik & H. Schifferstein (Eds.), *Food, People and Society* (pp. 73-97). Heidelberg: Springer Verlag, Berlin.

Schlegel, R. P., & Ditecco, D. (1982). Attitudinal structures and attitude behaviour relation. In M. P. Zanna & E. T. Higgins & C. P. Herman (Eds.), *Consistency in social behaviour* (pp. 17-49). Hillsdale, NJ: Erlbaum.

Scholderer, J. (2000). Kampagnen zur Gentechnik und ihre Wirkung auf Verbraucher. In T. von Schell (Ed.), *Inszenierungen zur Gentechnik. Konflikte, Kommunikation und Kommerz* (pp. 214-222). Wiesbaden, Köln: Westdeutscher Verlag.

Scholderer, J., & Balderjahn, I. (1999). Consumer information strategies for genetically modified food products. In L. Hildebrandt & D. Annacker & D. Klapper (Eds.), Marketing and Competition in the Information Age. *Proceedings of the 28th EMAC Conference,* Berlin, 11–14 May 1999 (CD-ROM).. Brussels: European Marketing Academy.

Scholderer, J., & Frewer, L. (2003). The biotechnology communication paradox: Experimental evidence and the need for a new strategy. *Journal of Consumer Policy, 26*, 125-157.

Scholderer, J., & Grunert, K. G. (2001a). Does generic advertising work? A systematic evaluation of the Danish campaign for fresh fish. *Aquaculture Economics and Management, 5*(5/6), 253-272.

Scholderer, J., & Grunert, K. G. (2001b). Structure versus level: A unified approach to campaign evaluation. In E. Breivik, A. W. Falkenberg & K. Grønhaug (Eds.), *Rethinking European marketing. Proceedings of the 30th EMAC Conference*. Brussels: EMAC (CD-ROM).

Scholderer, J., Balderjahn, I., & Will, S. (1998). *Communicating the risks and benefits of genetically engineered food products to the public: The view of experts from four European countries* (MAPP working paper no. 57). Aarhus: The Aarhus School of Business.

Scholderer, J., Balderjahn, I., Bredahl, L., & Grunert, K. G. (1999). The perceived risks and benefits of genetically modified food products: Experts versus consumers. *European Advances in Consumer Research, 4,* 123–129.

Scholderer, J., Bredahl, L. & Frewer, L. (2000). Ill-founded models of consumer choice in communication about food biotechnology. In F. van Raaij (Ed.), *Marketing communications in the new millennium: New media and new approaches* (pp. 129–152). Rotterdam: Erasmus University.

Scholderer, J., Brunsø, K. & Grunert, K. G. (2002). Means-end theory of lifestyle: A replication in the UK. *Advances in Consumer Research, 29,* 551-557.

Scholderer, J., Grunert, K. G. & Brunsø, K. (in press). A method for additive bias correction in cross-cultural surveys. *Journal of Business Research.*

Schultz, P. W., & Zelenzny, L. (1999). Values as predictors of environmental attitudes: Evidence for consistency across 14 countries. *Journal of Environmental Psychology, 19*, 255-265.

Schütz, H., Wiedemann, P. M., & Gray, P. C. R. (1999). Die intuitive Beurteilung gentechnischer Produkte – kognitive und interaktive Aspekte. In J. Hampel & O. Renn (Eds.), *Gentechnik in der Öffentlichkeit:Wahrnehmung und Bewertung einer umstrittenen Technologie* (pp. 133-169). Frankfurt/Main: Campus.

Schütz, H., Wiedemann, P. M., & Gray, P. C. R. (2000). *Risk perception: Beyond the psychometric paradigm*. Jülich: Jülich Research Center Ltd.

Schwartz, S. H., & Bilsky, W. (1987). Toward a universal psychological structure of human values. *Journal of Personality and Social Psychology, 53*, 550-562.

Sears, D. O. (1993). Symbolic politics: A sociopsychological theory. In S. Iyengar, & W. J. McGuire (Eds.), *Explorations in political psychology* (pp. 113-149). Durham, NC: Duke University Press.

Shepherd, R. (2001). Does taste determine consumption? Understanding the psychology of food choice. In L. Frewer, E. Risvik & H. Schifferstein (Eds.), *Food, people and society: A European perspective on consumers' food choices* (pp. 117-128). Berlin: Springer.

Sherif, M. & Hovland, C. I. (1961). Soc*ial judgment: Assimilation and contrast effects in communication and attitude change.* New Haven, CT: Yale University Press.

Sherif, M. (1935). A study of some social factors in perception. *Archives of Psychology, 27,* 1-60.

Sherif, M., & Sherif, C. W. (1967) Attitudes as the individual's own categories: The social judgment-involvement approach to attitude and attitude change. In: M. Sherif & C. W. Sherif (Eds.), *Attitude, ego-involvement, and change* (pp. 105-139). New York: Wiley.

Sherman, S. J., Judd, C. M., & Park, B. (1989). Social cognition. *Annual Review of Psychology, 40*, 281-326.

Sheth, J. N., & Venkatesan, M. (1968). Risk-reduction processes in repetitive consumer behavior. *Journal of Marketing Research, 5*, 307-310.

Siegrist, M. (1998). Belief in gene technology: The influence of environmental attitudes and gender. *Personality and Individual Differences, 24,* 861 -866.

Siegrist, M. (1999). A causal model explaining the perception and acceptance of gene technology. *Journal of Applied Social Psychology, 29,* 2093-2106.

Siegrist, M. (2000). The influence of trust and perceptions of risks and benefits on the acceptance of gene technology. *Risk Analysis, 20*, 195-204.

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

Simon, H. A. (1959). Theories of decision-making in economics and behavioral science. *American Economic Review, 49*, 253-283.

Simonson, I., Carmon, Z., Dhar, R., Drolet, A., & Nowlis, S. M. (2001). Consumer research: In search of identity. *Annual Review of Psychology, 52,* 249-75.

Sivacek, J., & Crano, W. D. (1982). Vested interest as a moderator of attitude-behavior consistency. *Journal of Personality and Social Psychology, 43*(2), 210-211.

Sjöberg, L. (1999). Risk perception by the public and by experts: A dilemma in risk management. *Human Ecology Review, 6*, 1-9.

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

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

Sjöberg, L. (2000c). The methodology of risk perception research. *Quality and Quantity, 34,* 407-418.

Sjoberg, L. (2001). Limits of knowledge and the limited importance of trust. *Risk Analysis, 21,* 201–210.

Sjöberg, L. (2002a). Are received risk perception models alive and well? *Risk Analysis, 22,* 665-670.

Sjöberg, L. (2002b). Policy implications of risk perception research: A case of the emperor's new clothes? *Risk Management: An International Journal, 4,* 11-20.

Sjöberg, L. (2002c). The allegedly simple structure of experts' risk perception: An urban legend in risk research. *Science, Technology and Human Values, 27,* 443-459.

Sjöberg, L., Truedsson, J., Frewer, L. J. & Prades, A. (2000). Through a glass darkly: Experts' and the public's mutual risk perception. In M. P. Cottam, D. W. Harvey, R. P. Pape & J. Tait (Eds.), *Foresight and precaution* (Vol. 1, pp. 1157–1162). Rotterdam: Balkema.

Slovic, P. (1992). Perception of risk: Reflections on the psychometric paradigm. In S. Krimsky & D. Golding (Eds.), *Social theories of risk* (pp. 117-152). Westport CT: Praeger.

Slovic, P. (1993). Perceived risk, trust and democracy. *Risk Analysis, 13*, 675-682.

Slovic, P. (2000). *The perception of risk.* London: Earthscan.

Slovic, P., Fischoff, B., & Lichtenstein, S. (1980). Facts and fears: Understanding perceived risk. In R. C. Schwing & W. A. Albers (Eds.), *Societal risk assessment: How safe is safe enough?* (pp. 181-214). New York, NY: Plenum Press.

Slovic, P., Malmfors, T., Krewski, D., & Mertz, C. K. (1995). Intuitive toxicology. *Risk Analysis, 15,* 661-675.

Smink, C., Hanning, C., & Homan, E. (1998). *Social acceptance of genetic modification of animals. Research among Dutch people*. Leiden: SWOKA.

Smith, R. E. & Swinyard, W. R. (1983). Attitude-behavior consistency: The impact of product trial versus advertising. *Journal of Marketing Research, 20,* 257-267.

Sobel, M., & Bornstedt, G. (1985). Use of null models in evaluating the fit of covariance structure models. In N. Tuma (Ed.), *Sociological methodology* (pp. 152-178). San Francisco: Jossey-Bass.

Sörbom, D. (1974). A general method for studying differences in factor means and factor structure between groups. *Journal of math. statist. Psychology, 27*, 229-239.

Sparks, P., & Shepherd, R. (1994). Public perceptions of food-related hazards: Individual and social dimensions. *Food Quality & Preference, 5*, 185-194.

Sparks, P., & Shepherd, R. (1994). Public perceptions of the potential hazards associated with food production and food consumption: An empirical study. *Risk Analysis, 14*(5), 799-806.

Sparks, P., Shepherd, R., & Frewer, L. J. (1994). Gene technology, food production, and public opinion: A UK study. *Agriculture and Human Values, 11*(1), 19-28.

Sparks, P., Shepherd, R., & Frewer, L. J. (1995). Assessing and structuring attitudes toward the use of gene technology in food production: The role of perceived ethical obligation. *Basic and Applied Social Psychology, 16*(3), 267-285.

Spearman, C. (1904). "General intelligence," objectively determined and measured. *American Journal of Psychology, 15,* 201-293.

Stallen, P. J., & Meertens, R. W. *Value orientations, evaluations and beliefs concerning nuclear energy* (internal report 77 SO 02). Nijmegen: University of Nijmegen.

Steenkamp, J.-B. E. M., & Baumgartner, H. (1998). Assessing measurement invariance in cross-national consumer research. *Journal of Consumer Research, 25,* 78-90.

Steger, M. A. E., Pierce, J. C., Steel, B .S., & Lovrich, N. P. (1989). Political culture, postmaterial values, and the new environmental paradigm: A comparative analysis of Canada and the United States. *Political Behavior*, *11,* 233-254.

Steiger, J. H. (1990). Structural model evaluation and modification: An interval estimation approach. *Multivariate Behavioral Research, 25,* 173-180.

Steiger, J. H. (1998). A note on multiple sample extensions of the RMSEA fit index. *Structural Equation Modeling, 5*, 411-419.

Steiger, J. H., Shapiro A. & Browne, M. W. (1985). On the multivariate asymptotic distribution of sequential chi-square statistics. *Psychometrika*, *50,* 253-264.

Sternthal, B., Phillips, L. W. & Dholakia, R. (1978). The persuasive effect of source credibility: A situational analysis. *Public Opinion Quarterly, 42,* 285–314.

Straughan, R. (1991). Genetic manipulation for food production: Social and ethical issues for consumers. *British Food Journal, 92*(7), 13-26.

Sutton, S. (1982). Fear arousing communications: A critical examination of theory and research. In J. Eiser (Ed.), *Social psychology and behavioral medicine* (pp. 303-337). New York: Wiley.

Tanaka, J.S. (1987). How big is big enough? Sample size and goodness of fit in structural equation models with latent variables. *Child Development, 58,* 134-146.

Tesser, A. (1978). Self-generated attitude change. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 11, pp. 289-338). San Diago, CA: Academic Press.

Tesser, A. Martin, L. & Mendolia, M. (1995). The impact of thought on attitude extremity and attitude-behavior consistency. In R.E. Petty & J.A. Krosnick (Eds.), *Attitude strength: Antecedents and consequences* (pp. 73-92). Hillsdale NJ: Erlbaum.

Tesser, A., & Shaffer, D. R. (1990). Attitudes and attitude change. *Annual Review of Psychology, 41,* 479-523.

Thomsen, C. J., Borgida, E., & Lavine, H. (1995). The causes and consequences of personal involvement. In R. E. Petty & J. A. Krosnick (Eds.), *Attitude Strength: Antecedents and Consequences* (pp. 191-214). Mahwah, NJ: Lawrence Erlbaum.

Thurstone, L. L. (1934). The vectors of mind. *Psychological Review, 41,* 1-32.

Todt, O. & Lujan, J. L. (2000). Spain: Commercialization drives public debate and precaution. *Journal of Risk Research, 3,* 237-246.

Toft, J. (2000). Denmark: Potential polarization or consensus? *Journal of Risk Research, 3,* 227-236.

Torgersen, H., Hampel, J., Bergmann-Winberg, M. L., Bridgeman, E., Durant, J., *et al.* (2002). Promise, problems and proxies: twenty-five years of regulation and debate in Europe. In M. W. Bauer & G. Gaskell (Eds.), *Biotechnology: The making of a global controversy* (pp. 21-94). Cambridge: Cambridge University Press.

Tucker, L., & Lewis, C. (1973). A reliability coefficient for maximum likelihood factor analysis. *Psychometrika, 38,* 1-10.

Tuncalp, S., & Yavas, U. (1984). Comparing multiattribute attitude models by predictive efficacy. *Der Markt, 23*(2), 53-59.

Tuorila, H., Meiselman, H. L., Bell, R., Cardello, A. V., & Hohnson, W. (1994). Role of sensory and cognitive information in the enhancement of certainty and liking for novel and familiar foods. *Appetite, 23*, 231-246.

Tybout, A. M., & Scott, C. A. (1983). Availability of well-defined internal knowledge and the attitude formation process: information aggregation versus self-perception. *Journal of Personality and Social Psychology, 44*, 474-491.

Urban, D. (1999). Wie stabil sind Einstellungen zur Gentechnik? Ergebnisse einer regionalen Panelstudie. In J. Hampel & O. Renn (Eds.), *Gentechnik in der Öffentlichkeit:Wahrnehmung und Bewertung einer umstrittenen Technologie* (pp. 133-169). Frankfurt/Main: Campus.

Urban, D., & Hoban, T. J. (1997). Cognitive determinants of risk perceptions associated with biotechnology. *Scientometrics, 40,* 299-331.

Uzogara, S. G. (2000). The impact of genetic modification of human foods in the 21st century: A review. *Biotechnology Advances, 18,* 179–206.

Van den Daele, W. (1997). Risikodiskussion am "Runden Tisch" – Participative Technikfolgenabschätzung zu gentechnicsh erzeugten herbizidresistenten Pflanzen. In R. Martinsen (Ed.), *Politik und Biotechnologie* (pp. 281-301). Baden-Baden: Nomos Verlagsgesellschaft.

Van der Pligt, J., & Vries, N. K. D. (1998). Belief importance in expectancy-value models of attitudes. *Journal of Applied Social Psychology, 28*(15), 1339-1354.

Verdurme, A., & Viaene, J. (2003). Consumer beliefs and attitude towards genetically modified food: Basis for segmentation and implications for communication. *Agribusiness, 19*, 91-113.

Wagner, W., Kronberger, N., Allum, N., De Cheveigné, S., Diego, C., et al. (2002). Pandora's genes: images of genes and nature. In M. W. Bauer & G. Gaskell (Eds.), *Biotechnology: The making of a global controversy* (pp. 244-278). Cambridge: Cambridge University Press.

Weick, K. L. (1967). Dissonance and task enhancement: A problem for compensation theory? *Organizational Behavior and Human Performance, 2,* 175-216.

Weinstein, N. D., & Klein, W. M. (1995). Resistance of personal risk perceptions to debiasing interventions. *Health Psychology, 14*, 132-140.

Wicker, A. W. (1969). Attitudes versus action: The relationship of verbal and overt behavioural responses to attitude objects. *Journal of Social Issues, 25,* 41-78.

Wicker, A. W. (1971). An examination of the "other variables" explanation of attitude-behavior inconsistency. *Journal of Personality and Social Psychology, 19*(1), 18-30.

Wilkinson, J. (1989). The reorganisation of the world food system: Biotechnology and new patterns of demand. In B. Traill (Ed.), *Prospects for the European Food System* (pp. 99-121). London: Elsevier Applied Science.

Williams, L. J., Bozdogan, H., & Aiman-Smith, L. (1996). Inference problems with equivalent models. In G. A. Marcoulides & R. E. Schumacker (Eds.), *Advanced structural equation modeling: Issues and techniques* (pp.279-314). Mahwah, NJ: Erlbaum.

Wilson, E. J., Lilien, G. L., & Wilson, D. T. (1991). Developing and testing a contingency paradigm of group choice in organizational buying. *Journal of Marketing Research, 28*(4), 452-466.

Wilson, T. D., & Hodges, S. D. (1992). Attitudes as temporary constructions. In L. L. Martin & A. Tesser (Eds.), *The construction of social judgments* (pp. 37-65). Hillsdale, NJ: Erlbaum.

Wold, H. & Jureen, L. (1953). *Demand analysis.* New York: Wiley.

Wood, W. & Eagly, E. A. (1981). Stages in the analysis of persuasive messages: The role of causal attributions and message comprehension. *Journal of Personality and Social Psychology, 40,* 246-259.

Wood, W. (2000). Attitude change: Persuasion and social influence. *Annual Review of Psychology, 51,* 539-570.

Wright, S. (1918). On the nature of size factors. *Genetics, 3,* 367-374.

Wyer, R. S., & Hartwick, J. (1984). The recall and use of belief statements as bases for judgments: Some determinants and implications. *Journal of Experimental Social Psychology, 20*(1), 65-85.

Wynne, B. (2001). Expert discourses of risk and ethics on genetically modified organisms: The weaving of public alienation. *Politeia, 17*(62), 51–76.

Yi, Y. (1989). An investigation of the structure of expectancy-value attitude and its implications. *International Journal of Research in Marketing, 6*(2), 71-83.

Yuan, K. H., & Bentler, P. M. (1997). Mean and covariance structure analysis: theoretical and practical improvements. *Journal of the American Statistical Association*, *92,* 767-774.

Zanna, M. P. (1989). Attitude-behavior consistency: Fulfilling the need for cognitive structure. *Advances in Consumer Research*, 16, 318-320.

Zanna, M. P., Olson, J. M., & Fazio, R. H. (1980). Attitude-behavior consistency: An individual difference perspective. *Journal of Personality and Social Psychology, 38*(3), 432-440.

Zechendorf, B. (1994). What the public thinks about biotechnology. *Biotechnology, 12*(September), 870-875.

Zwick, M. (1999). Gentechnik im Verständnis der Öffentlichkeit – Intimus oder Mysterium? In J. Hampel & O. Renn (Eds.), *Gentechnik in der Öffentlichkeit: Wahrnehmung und Bewertung einer umstrittenen Technologie* (pp. 133-169). Frankfurt/Main: Campus.

Appendix 1

Definition of the term “gene technology” used in Study 1

Information about Gene Technology

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 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 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.

Appendix 2

“Balanced/general information” used as stimulus material in Study 2:

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 supply the pesticides to which 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 labeling 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.

Feeding the world

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 the 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.

Appendix 3

Product-specific information (beer version) used as stimulus material in Study 2:

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.

Appendix 4

Product-specific information (yoghurt version) used as stimulus material in Study 2:

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.

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 get blue eyes or whether a plant will be able to resist a certain pesticide.