Risk, Social Trust and Knowledge: Public Perceptions of Gene Technology in Britain

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Thesis submitted for the degree of
Doctor of Philosophy

London School of Economics and Political Science
University of London
January 2005

ABSTRACT

This thesis is about the perception of technological risk in modern societies. The investigation focuses on one risk case, gene technology, with special reference to genetically modified (GM) food, and one particular society, modern Britain. I am concerned firstly with the structure and stability of people's perceptions of risks and, secondly, with some of the factors that underlie these perceptions.

After a brief foreword, chapters two and three present reviews of research on risk perception and on public attitudes towards gene technology in Britain. I argue that public perceptions of risk in relation to new and controversial technologies might be characterised more simply as a special case of social attitudes, rather than as psychological phenomena in their own right.

Following a short discussion of research methodology, two empirical investigations follow that explore the structure of public views on gene technology risk and on GM food risk in particular. The first is a qualitative analysis of focus group discussions with members of the lay public. The second analyses data from a representative panel survey, using structural equation modelling to explore stability and change in perceptions over time.

The second part of the empirical work consists of two studies using data from a newly-designed Internet survey. The first considers the nature and effects of social trust on the perception of GM food risk. The second explores the relationship between scientific and political knowledge, attitudes to science and perception of GM food risk. Both investigations use structural equation modelling to operationalise and test theoretical models. The final chapter contains a summary of the thesis, some conclusions and directions for future research.

ACKNOWLEDGEMENTS

I owe a debt of gratitude to the ESRC Centre for Analysis of Risk and Regulation at the London School of Economics for helping to fund the data collection for the investigation, and also to Dr Chris Fife-Schaw at the Department of Psychology, University of Surrey, for allowing me access to the panel survey data.

I am particularly indebted to members of the *Life Sciences in European Society* research project with whom I have had the privilege and pleasure of working over the past five years and from whom I have learnt a great deal. Martin Bauer and Wolfgang Wagner in particular have always provided much encouragement. Colin Mills and Michael Huber, at LSE, made some extremely helpful and constructive comments as members of my upgrade committee, for which I am also very grateful.

Jon Jackson, Nicky Lindsey and Pat Sturgis have all been very helpful and supportive at various stages in making comments and providing feedback. Miltos Liakopoulos was a source of wisdom while we shared an office at LSE during the early stages of this work and Henrik Svedsater a reliable source of laconic humour! Thanks also to my parents, who have always supported me and let me follow my own path in life, and to Caroline (BK), who over the past five years has shared with me the ups and downs of doing a PhD and much more besides. Proofreading was generously and carefully undertaken by Carole Allum-Grant.

Finally, I would like to thank my supervisor, George Gaskell, without whose help literally none of this would have been possible. More than just a supervisor, George has been, in turn, an inspirational teacher, a sympathetic boss, a stimulating colleague and a valuable friend. Thanks.

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1 FOREWORD

On March 9th 2004, the British Government signalled its approval for the commercial planting of a strain of genetically modified (GM) maize. This announcement represented not only the culmination of three years of scientific field trials but of five years of heated political debate and public controversy. Political fallout from the debate included the sacking of a British Environment Secretary, a moratorium across much of Europe on the commercial planting of GM crops and a complaint by the United States to the World Trade Organisation that the European moratorium was illegal and in breach of agreed principles of free trade. Over the same period there has been an exponential rise in the press and broadcast media's coverage of GM issues, as well as other gene technology-related stories concerning, for example, reproductive cloning and xenotransplantation. Lines have been drawn and protagonists in the debates have attempted to capture public support in a variety of ways: from Monsanto's ill-fated advertising campaign promoting GM food to the destroying of field trial sites by environmental protesters.

Central to these political debates are questions about public opinion. To what extent are citizens concerned about genetic modification and its consequences for future generations? Do consumers think it is safe to eat GM food? Does the public understand the science or, at least, trust the scientists or the Government? How important is trust and 'scientific literacy' for explaining public opinion? These questions are central to the concerns of this thesis. They are also amongst those recently debated in the biggest public consultation on science policy ever held in Britain, under the banner of '*GM Nation?*' That the British Government felt compelled to mount such an exercise is a measure of the importance that public opinion is now perceived to play in the development of sustainable science policy. That the results of this exercise seem to indicate significant worries amongst sections of the public about gene technology is a measure of the importance of developing a social scientific understanding of the nature and causes of public concerns of this kind.

The British public's concern about aspects of gene technology is, in fact, only one instance of a more general question about public perceptions of science, technology and risk. For example, nuclear energy has also been an object of concern for publics in many countries, well before high profile incidents at Chernobyl in the 1980s or even Three-Mile Island at the end of the 1970s. And looking to the future, there are already signs that nanotechnology may perhaps become a scientific and political 'hot potato' before too long.

In fact, the ways in which people perceive these and many other types of risk have been the subject of a great deal of psychological and sociological research since the 1960s. This thesis is a contribution to this longstanding programme of research and is an investigation of public perceptions of gene technology risk in Britain. It is concerned firstly with the structure and stability of people's perceptions of gene technology risk and secondly with examining some of the factors that underlie these perceptions. In considering gene technology as one of many potential new and controversial technologies, this investigation aims also to contribute to the understanding of public perceptions of scientific and technological risk more generally.

The thesis has been written mostly while also working as a researcher on two international research projects on social aspects of gene technology: *European Debates on Biotechnology: Dimensions of Public Concern* (EUDEB, 1997-1999) and *Life Sciences in European Society* (LSES, 2000-2003). Both projects were coordinated in London, at the National Museum For Science and Industry and the London School of Economics and Political Science, where I was employed as researcher, and involved up to 21 separate laboratories in Europe and North America. The projects were both funded by the European Commission under the Fourth and Fifth Framework programmes.

Although I was heavily involved in the design of studies, in data analysis and the writing up of results for publication, I have elected not to make use of most of the considerable volume of data that accrued during these projects. This decision was made partly in order simply to distinguish, for myself, my doctoral work from my collaborative research. More importantly though, the questions that I found that I wanted to ask were, for the most part, not best answered with the data at hand. As a result, I have made use of a variety of data sources in the thesis including some qualitative interviews undertaken as part of the EUDEB and LSES projects, a panel survey from an entirely separate Ministry of Agriculture, Fisheries and Food funded project (to which I was given access by the Principal Investigator) and, finally, a new survey, designed by me and fielded online by political and market research organisation YouGov.

The thesis is organised in the following way. Chapter Two begins with a discussion of what is variously meant by 'risk' and why it has become an important concept across a range of social scientific disciplines. The majority of the chapter is then devoted to an overview of the literature on the public perception of risk, starting with research in cognitive psychology that is concerned with heuristics that people use when estimating probabilities. Next follows a discussion of the development of the 'psychometric' approach to risk perception. The extensions and alternative approaches that have since come to the fore are also reviewed with a particular focus on questions concerning the role of social trust and of differential knowledge amongst the public as explanatory factors for risk perception. At the end of the chapter I argue that risk perceptions in relation to new and controversial technology might better be characterised more simply as attitudes and beliefs about political and social issues, rather than psychological phenomena *sui generis*.

Chapter Three begins with a brief introduction to gene technology and its development since the discovery by Crick and Watson of the 'double helix' structure of DNA in the early 1950s. I then move on to a selective review of the literature on public perceptions of gene technology in Britain that focuses on the types of questions that are relevant to the theoretical concerns of the thesis –

risk perceptions, trust and knowledge. Two strands of research are identified, one based on qualitative, the other on quantitative methods. I compare findings from these two research paradigms and find, perhaps surprisingly, a fairly consistent picture of public attitudes emerging. In presenting this review, the chapter both sets a context in which to locate the empirical results presented in later chapters and brings together the theoretical and substantive components of the research to form a coherent rationale for the analysis carried out in the rest of the thesis.

Chapter Four presents a short overview of the data and methods used in the empirical investigations presented in the thesis. There are four separate, but theoretically linked, studies contained in chapters Five to Eight. In this chapter, the data and analytic procedures used in each of the four studies are briefly described. In so doing, I outline only very roughly the types of questions and hypotheses that are addressed in the four studies, saving a detailed exposition of these for the introduction to each of the empirical chapters themselves. In Chapter Four I also present an introduction to structural equation modelling (SEM), which is the statistical technique upon which much of my analysis throughout the thesis relies. I conclude with a discussion of the rationale for using an Internet survey, its design and some technical issues concerning representativeness and sample weighting.

The next four chapters contain the empirical studies that form the basis of the thesis. Broadly, the first two of these four consist of investigations about the structure and stability of public perceptions of gene technology risk while the final two are investigations into factors underlying these perceptions, focussing firstly on social trust and then on knowledge and information.

Chapter Five presents an exploratory analysis of people's beliefs about, attitudes towards and representations of various applications of gene technology. A series of focus group interviews were conducted and the results transcribed, coded and thematically analysed to give an indicative picture of lay people's discourse about gene technology. As part of this general goal, a more specific focus is on how people talk about uncertainty and possible dangers from gene technology and how this relates to the perspectives on risk and gene technology that were discussed in Chapters Two and Three. As well as adding breadth and depth to how lay perceptions are structured and can be understood, the results also help to generate further hypotheses and research questions that are addressed in subsequent chapters.

In Chapter Six, I investigate the structure and stability of perceptions of GM food risk using longitudinal data from a panel survey and SEM. The two preliminary aims for this analysis are, firstly, to evaluate how well the psychometric dimensions measure people's attitudes towards GM food risk and, secondly, to evaluate whether people actually hold stable attitudes towards GM food risk over time or whether, as appears possible given the results from Chapter Five, people tend to generate only ill-considered, labile 'off-the-top-of-the-head' opinions in surveys and other interviews. To do this, I employ a psychological model based on the state-trait distinction and parameterise and fit it using SEM. Overall, the results from this chapter do not support the notion that citizens hold no meaningful, stable views about GM food risk but do not either lend much support for the psychometric paradigm's dimensions as organising psychological mechanisms for these views.

Chapter Seven is an investigation of the dimensionality of what might be termed 'hazard-related' social trust and its effect on the perception of risks. Quite a lot of work has been carried out in recent years on the role of trust in explaining perceptions of risk but less work has been done on the nature of this trust. As in the last chapter, the substantive focus is again on GM food and crops. Using data from the Internet survey, I test hypotheses that I derive from several theories of trust, most notably that due to Earle and Cvetkovitch (1995). The principal objective of the analysis is to evaluate this perspective against other more traditional conceptualisations of hazard-related trust. Results tend largely to support Earle and Cvetkovitch's model, although other aspects of trust also play a part in influencing risk perception.

Chapter Eight is the final empirical chapter and focuses on the relationship between knowledge, attitudes and risk perception. More specifically, I investigate the links between different domains of knowledge, political and scientific, and the perception of risks from GM food. I develop and test a social psychological model of risk perception that derives in part from the 'public understanding of science' (PUS) literature. In this literature are several competing theoretical and epistemological perspectives on the role of scientific and other kinds of knowledge in the formation of attitudes towards science. The objectives of the analysis are to evaluate these perspectives using a quantitative approach and to link insights from PUS with risk research in an empirical model. Results are supportive of the overall structure of the hypothesised model but do not support the notion that political knowledge is relevant to the formation of attitudes towards science.

Chapter Nine presents a short recapitulation of the research problem and the contribution that the thesis makes to the existing literature. A brief summary of the findings for each of the four empirical chapters is given, along with some caveats and limitations relevant to the research. Some general conclusions and thoughts on directions for future research bring the chapter, and the thesis, to a close.

2 THE PUBLIC PERCEPTION OF RISK

In this chapter I first introduce the notion of risk and why it has become important across a range of social scientific disciplines. The majority of the chapter is then devoted to sketching out an overview of the literature on the public perception of risk. This starts with a brief look at research in cognitive psychology that is concerned with heuristics that people use when estimating probabilities. I then describe the development of the 'psychometric' approach to risk perception and the extensions and alternative approaches that have since come to the fore. At the end of the chapter I argue that risk perceptions in relation to new and controversial technology might better be characterised more simply as attitudes and beliefs about political and social issues, rather than psychological phenomena *sui generis*.

2.1 Risk: an issue for social science

Risk has become something of a buzzword for the social sciences in recent times. Most visibly, it was Ulrich Beck's 'Risk Society' (Beck, 1992) that placed notions of risk as important for the understanding of what Anthony Giddens (1991) referred to as 'high modernity'. In this view:

> *To live in the universe of high modernity is to live in an environment of chance and risk, the inevitable concomitants of a system geared to the domination of nature and the reflexive making of history. Fate and destiny have no formal part to play in such a system…*

High modernity is characterised by the production and distribution of risks from an increasingly complex technico-scientific system. It is one where every citizen is exposed, in some degree or other, to technological dangers such as radioactivity, airborne and waterborne pollution, hazards from mass transportation such as airline, automobile or train crashes. Beck's account is panoramic, vivid and wide-ranging, which no doubt partially explains its popularity. However, it is a theoretical account of the way risks are generated, defined and perceived in modern societies that is often rather difficult to imagine being operationalised and tested with empirical data. As David Goldblatt has remarked, 'it is designed to be provocative rather than comprehensive, stimulating rather than strictly analytical' (Goldblatt, 1996 p.187). For this reason, and the fact that it is very much a 'macro-level' theory as opposed to a social psychological one, Beck's account is mentioned here to raise pertinent issues rather than as a basis for organising the empirical work of this thesis.

Douglas and Wildavsky (Douglas & Wildavsky, 1982), some years before Beck's 'Risk Society' was published, approached the problem of risk and modern society from a cultural perspective (of which more later) but nevertheless seem to come to similar conclusions as to the types of risks that face modern western societies. They identify four groups of risks: foreign affairs (foreign attack, war, loss of national power); crime (failure of law and order, civil unrest); pollution (abuse of technology, environmental danger); economic failure (loss of prosperity). Beck is mostly concerned with technological and environmental risks. Douglas and Wildavsky, on the other hand, cast the net a little wider. But all share the assumption that the nature of modern societies is such that risks in some way multiply with the increasing complexification of societal systems of production, consumption, governance and technological control.

Implicit also is the notion that more knowledge leads to more risk. How can this be? As Douglas and Wildavsky (1982 p.3) note:

> *The advance of science increases human understanding of the natural world. By opening up new realms of knowledge, however, science simultaneously can increase the gap between what is known and what it is desirable to know.*

This hints at what underlies nearly all the social scientific interest in risk as a concept, namely that, whatever else risk may refer to, it is to some degree a social or psychological construct that requires it to be viewed through a social scientific lens. The focus of this thesis is on technological risks, specifically those relating to gene technology. New technologies such as this are developed with the objective of producing desirable outcomes through the control or modification of natural processes. The type of risk associated with this kind of technology conforms to Beck's ideal type of late modern risk (Beck, 1992 p.23). Firstly, it is invisible and its consequences are likely to be irreversible. Secondly, and more importantly, so the argument goes, such risks are based on 'causal interpretations' meaning that, initially at least, they depend upon scientific knowledge claims that are in principle open and contested. Thus they are particularly prone to construction and redefinition by the most important social actor groups – the mass media, the scientific and legal professions, regulatory authorities. This phenomenon is amply visible in new media tags such as 'blame culture', used to describe the political wrangling and media interest that inevitably follow in the wake of what might formerly have been considered unavoidable accidents. Daily Telegraph columnist W.F. Deedes (2001), commenting on a recent spate of train crashes in Britain characterised this view succinctly enough:

> *The blame culture has grown stronger since [the 1950s]. There is no such thing as an accident or mishap these days. Someone must have blundered, and so heads must roll…Our own inner philosophy has undergone a change. We find it harder to take in our stride the blows that life suddenly delivers. Science replacing religion has something to do with it. In our homes, in the air, on road and rail, we expect modern devices to afford us protection against life's hazards.*

In short, whatever the ontological status of, for example, risks to the environment from GM crops or from nuclear waste or rail travel or violent crime, risk has come to be seen as an important epistemic concept by social scientists. And, increasingly, it is one that has relevance for understanding many contemporary political controversies. For instance, why is it that, despite initially rather intensive media coverage, there has not, at the time of writing, been a major political controversy about potential risks to health from using mobile telephones, while in the case of GM foods the debate has been widespread, highly politicised and rumbles on in many European countries (Durant & Lindsey, 1999; Gaskell, Allum *et al.*, 2000; Liakopoulos, 2000). In both cases there is little or no evidence for the positive existence of danger to health and/or environment. Equally, in neither case can the future discovery of danger be ruled out. So how can one account for the difference in the trajectory of the debate and the differing levels of public concern about these technological innovations? Subjective risk judgments are implicated in both cases but with widely divergent outcomes. Understanding the ways in which people conceptualise risks, perceive them as more or less serious, and how these factors affect behaviour has become a major area of research in social science. Equally, for governments and industry, risk communication and risk management have become key concerns.

Risk research within the social sciences, then, is a 'hot topic'. The notions of risk and risk perceptions as social scientific constructs can be brought to bear on a multitude of substantive topics and across academic disciplines. Sociology, economics, psychology and anthropology all have literatures in which risk features in some way. This is partly a result of the number of definitions of risk that exist. Whilst the apparent malleability of the concept may be attractive to researchers in search of theoretical coat hangers for their work, the same feature can also lead to conceptual confusion. Before addressing these issues in more detail, and in order to situate the recent social scientific research on risk, I briefly outline the history of the usage of the word 'risk' and its changing social and cultural significance.

2.2 Origins of 'risk'

The word risk derives from the early Italian word *risicare*, which means 'to dare'. In this sense of the word, it speaks to the idea of choices, decisions that may carry downsides but are made in order to reap a possible gain. Bernstein

(Bernstein, 1996, p2) regards the connection between 'daring' behaviour and rational analysis as a central feature of modernity:

> *The ability to define what may happen in the future and to choose among alternatives lies at the heart of contemporary societies…the capacity to manage risk, and with it the appetite to take risk and make forward-looking choices, are key elements of the energy that drives the economic system forward.*

Bernstein, in his account of the origin of modern understandings of risk focuses on the development of probability theory. This he sees as the means by which social and individual decision-making has become more rational. He does not equate this with the idea that we as people are becoming more rational, but simply that 'our understanding of risk enables us to make decisions in a rational mode' (Bernstein, 1996 p.4).

This account begins in earnest in the 17th century, with the exchange of seven letters between Blaise Pascal and Pierre de Fermat, two mathematicians. The exchange concerned what became known as the *problem of points*: two players agree to play a series of fair games until one of them has won a specified number of games. The play is suddenly interrupted. One player has won more games than the other. How should the stakes be divided? The problem was, of course, one of prediction. What would have happened had the agreed number of games been played? How should the evidence of the completed games be employed in making such a prediction? By the middle of the 18th century, probability theory had developed to the extent that a flourishing insurance market had sprung up in London. In order to make money from insuring a vessel and its cargo, insurance underwriters needed a workable estimate of the probability that it would reach its destination intact. The realisation that 'fate' and 'chance' were not entirely capricious was not lost on Leibniz who wrote to Bernoulli that 'Nature has established patterns originating in the return of events, but only for the most part' (Bernstein, 1996 p.4). During the past 200 years, from Bernoulli's Law of Large Numbers to Bayes' theorem, Galton's regression to the mean and Markowitz's portfolio theory, this account of risk is synonymous with the development of techniques for rational decision making in the face of uncertain futures. A such, it is an account of the harnessing of 'upside' risk for economic and social gain.

A complementary story is told by Judith Green (1995). She traces 'the accident' as it has been constructed through history. Green defines accidents as misfortunes that satisfy two criteria. Firstly, the event must have been unmotivated (or, at least seen as such). In other words, no person or agency willed the event to take place. Secondly, it must be unpredictable. If it were predictable and it was also not intended, the accident would most likely have been prevented or the conditions for its existence would not come about.

Accidents, in contemporary times, have become highly contentious. As technological systems and social dependencies have become more complex and interrelated, new forms of catastrophe become possible. A breakdown or accident in one part of a technological system can have far-reaching consequences. The Amoco Cadiz oil spill, the Chernobyl nuclear accident, HIV-contaminated blood transfusions are all modern examples of where complex interdependencies have led to widely dispersed harm to the environment and to public health. Such widespread harm would simply not have been possible in previous, less technologically sophisticated times. It is the historical trajectory of accidents and their cultural significance that is the focus of Green's account

So, while Bernstein characterises risk chiefly as opportunity, Green looks at risk from the perspective of accidental losses. She traces a parallel story of risk that centres around historical discourses of accidents. The reason, according to Green, that this is relevant is because the accident is not only a pivotal category of misfortune in contemporary times, but that the accident is a blank slate, on which various cultural concerns about uncertainty, responsibility and culpability are inscribed (Green, 1995 p.196).

Green follows Hacking's interpretation of the development of probability or 'chance' (Hacking, 1987). Prior to 1650, in the West, the 'accident', as we might understand the term today, simply did not exist. There was no room for chance in a universe governed by an omnipotent God. After this time, Enlightenment thinking and its discourse of science transformed the notion of the accident. New ways of explaining the world, through deduction, evidence and, increasingly, statistical reasoning, meant that accidents came to mark the boundary of rational explanation. They represented, in some sense, a residual category of event, or, as Green (1995 p.197) puts it, 'Rationality…produced a space for accidental events at the margin of its explanatory reach'. By the end of the nineteenth century, the idea that some events like train crashes, or being struck down by illness were inexplicable, or, at least, random and unpredictably distributed, was a marker of modernity. Indeed, its absence in the cosmologies of 'primitives' like those studied by Levy-Bruhl (Levy-Bruhl & Clare, 1923) or Evans-Pritchard (Evans-Pritchard, 1937) was seen as one of the defining points of difference between the 'primitive' and the 'modern' mind. For the 'primitive' mind, every 'accidental' event is invested with ulterior meaning. Causes of misfortune are ascribed to angry Gods, witchcraft or some such. Mere coincidence is not an admissible category. Rational explanation (so the argument goes), that is the characteristic mode of thought of the 'modern mind', has limits due to present ignorance that do not make it necessary to think beyond coincidences leading to unanticipated negative events. That is to say, some things are simply 'bad luck'.

During the middle of the Twentieth century, again there is a shift. Green suggests that the probabilistic revolution in science and in the philosophy of science also filtered into other forms of discourse - business, governmental, legal. At this point, deterministic laws and ways of understanding the world are replaced by 'autonomous laws of chance' (Green, 1995 p.198). In this new climate, discourses of risk management and containment flourish. Accidents become reconfigured as the outcome of complex sets of risk factors. The regulation of mass transport, energy and public health for example, can all now be technically oriented around (amongst other things) the prevention of accidents. In a sense, this is the point at which the accounts of Bernstein and Green converge. For Bernstein, profits and economic growth can be maximised through the use of quantitative models and probabilistic models. The same logic underpins the present state of risk management, where the 'accident' is becoming to be seen as a failure of systems or individuals to take the necessary steps to prevent misfortune.

Interestingly, then, if the analyses of Green and Bernstein hold, the present situation has almost led us back to Levy Bruhl's primitive cosmology, superimposed on contemporary Western societies. In harnessing the power of probabilistic ways of viewing the world, we return to a state where all misfortunes have 'causes' where some person or agency is culpable. For this reason, amongst others, is risk currently an important issue for social scientific investigation and for policymakers and governments in modern states.

2.3 Probability and cognitive heuristics

In the following section, I review the main currents of empirical work within social and psychological studies of risk. Much of this work refers to the 'perception of risk' by the public and by experts. For reasons that will, I hope, become clear by the end of this chapter, the analogy of 'perception' of an object (in this case an 'objective risk') may not necessarily be appropriate. However, in much of the literature, this phrase is used. For now, I draw attention to this caveat but for simplicity's sake I shall generally use the phrase throughout the thesis in the widest possible sense, as is the convention in the literature.

In formal conceptions of risk, the notion of probability plays an essential role. It is no surprise, therefore, that some of the seminal work on risk perception flowed from the work of Tversky and Kahneman, who were engaged in empirical work on subjective probability judgment. The genealogy of their approach can be traced back to several earlier research programmes initiated during the 1950s (Kahneman, Slovic, & Tversky, 1982 p.xi). Paul Meehl (1954) presented evidence showing that experts' intuitive judgments in clinical settings were consistently outperformed by simple statistical analysis of manifest cues in predicting significant behavioural criteria. The significance of this for Tversky and Kahneman's programme is that experts' belief in their own abilities to successfully predict outcomes tends to be at odds with their objective record. A related research programme was pursued by Ward Edwards, who introduced Bayesian concepts into psychological research (Edwards, 1965; Edwards, Lindman, & Savage, 1963). The Bayesian method for statistical inference and decision-making under uncertainty was taken up as a normative model against which, once again, 'expert' judgment was compared and found lacking. The discovery of non-random biases in experts' judgments of probability led directly to Tversky and Kahneman's work on the prevalence and nature of bias in people's inductive inferences in general.

The most complete summary of Tversky and Kahneman's approach is contained in the collection of articles reprinted in book form in 1982 (Kahneman, Slovic, & Tversky, 1982). The main contention is that people do not follow the principles of probability theory when judging the likelihood of uncertain events but instead employ heuristics or 'rules of thumb'. Often these heuristics lead to fairly good estimates of the probability of an event. Often, though, they do not.

The procedure followed by Tversky and Kahneman is to use very simple examples where the statistical properties of the distribution are well known – e.g. tosses of a coin, the distribution of people's heights within the population – and compare subjects' estimations with those made according to the principles of probability theory. The heuristics and biases observed under these conditions are also thought to apply to the way people estimate the probability of events that cannot be statistically estimated, even though one might question whether generalising to contexts outside of the laboratory in this way is entirely justifiable.

The 'representativeness' heuristic suggests that people tend to evaluate the chance of X as originating from Y to the extent that X resembles Y. This tendency appears to act as a means by which probabilities are evaluated to the extent that other relevant information is overlooked. In one study (Kahneman, Slovic, & Tversky, 1982 p.34) subjects were asked which of two sequences of births of girls and boys in a family is more likely – BBBGGG or GBBGBG. Subjects viewed the former as significantly less likely than the latter. The suggestion is that the latter sequence appears to be more representative of randomness, and this is why people judge it as the more likely sequence even though both are, in fact, equally likely.

People have also been shown to ignore so-called 'base-rate information'. In one experiment subjects were asked to judge the likelihood that several individuals were lawyers or engineers, given a brief description of their personality. One experimental group was told that the individuals whom they were asked to assess had been sampled from a pool of 70 lawyers and 30 engineers; for the other group the proportions were reversed. This information had little or no effect on the way subjects made judgments. The only substantial criterion employed appeared to be the extent to which the descriptions of the individuals resembled the stereotypes associated with lawyers and engineers. Even when given a neutral description that bore no relation to characteristics that might distinguish the two professions, people in both experimental groups judged it equally likely that the individual was an engineer or lawyer, ignoring the prior probabilities of .7 and .3 arising from the stated distributions of the sample population.

The 'availability' heuristic suggests that the size of a class tends to be judged by the ease with which instances of it can be retrieved from memory. This means that those events that are easily retrieved are judged more numerous or more likely than those which are more difficult to retrieve. For example, an experiment was carried out where subjects were read out lists of well known personalities. In some lists the male personalities were relatively more famous than the women; in others the women were more famous. There were the equal numbers of men and women in all lists. Subjects asked to judge whether there were more men or women in each list incorrectly judged that there were a greater number of the sex that included the more famous personalities (Kahneman, Slovic, & Tversky, 1982 p.13). A similar phenomenon is observed when people try to imagine hypothetical risks. Where a particular danger is easy to imagine, perhaps because it has been discussed in the press in great detail, its probability of occurrence tends to be judged as higher than one that cannot be conceptualised so easily.

Kahneman and Tversky's 'prospect theory' (Kahneman & Tversky, 1979) elaborated a general framework for understanding why people's actual behaviour, in relation to risky decision making, departs from the predictions of rational choice theory. Prospect theory suggests that we tend to over-estimate low probability events and underestimate those with a high probability. That something is conceivable appears to be sufficient to give it a reality beyond its objective probability. The implications for new technologies are that even a hint of potential problems may loom significantly in the public mind if the status quo is acceptable and secure. This is because possible costs are weighed more heavily than possible equivalent benefits when risk is framed as a potential gain (people are 'risk averse' for gains). These tendencies are at odds with the predictions of pure subjective expected utility theories of behaviour. Instead, prospect theory suggests what one might call an 'if it ain't broke, don't fix it' approach to risk.

2.4 The psychometric approach

During the period when Kahneman and Tversky's research programme was developing, Chauncey Starr published what became a seminal paper in the history of risk research and one which set the terms of reference for what became known as the 'psychometric' approach to the study of risk perception (Slovic, Lichtenstein, & Fischoff, 1979; Starr, 1969). Starr used an approach borrowed from economics known as 'revealed preference' theory. The theory in essence assumes that people's real preferences, which cannot, of course, be directly observed, are revealed in their economic behaviour. In other words, the economic choices that individuals and, by extension, societies make are indicative of what is actually preferred, notwithstanding the various constraints that may be faced.

Starr proposed that the existing distribution of risks from natural and human-generated hazards revealed the nature of societal preferences according to the implicit calculus of risks and benefits that led to such a distribution. Although Starr's paper has since been criticised on several grounds (see Hornig, 1992; see Slovic, Lichtenstein, & Fischoff, 1979), it introduced several concepts that were taken up and empirically investigated by psychologists interested in people's subjective perceptions of these risks.

Natural hazards such as flooding or lightning strikes are viewed differently from technologically generated ones. Levels of risk below those associated with natural hazards are, according to Starr, ignored. The concept of 'risk acceptability' was coined, and the data suggested that whether or not a risk was acceptable or not does not simply depend on its presumed magnitude or the seriousness of the consequences but on a number of other factors too. The acceptability of a technological risk depends on its judged benefits – at least within certain limits. Whether or not a risk is taken voluntarily or involuntarily was shown to be one of the determinants of risk acceptability. Chronic and catastrophic risks are evaluated differently. In fact, although Starr's paper is often seen as seminal, much the same conclusions were reached much earlier with the work of Gilbert White and colleagues. Following studies of people's responses to flood warnings and other natural hazards such as blizzards and earthquakes, it was realised that people's estimates of the severity of the consequences and the likelihood of occurrence diverged from expert judgments according to the kind of hazard being judged. It was also noted that people's 'adjustments' in relation to natural disasters mostly did not follow the axioms of expected utility theory (Burton, White, & Kates, 1978). To some extent, then, the revealed preference approach of Starr and the empirical observation of behaviours by Burton et al were already converging.

Despite this, one of the key criticisms levelled at the revealed preference approach was that its theoretical assumption – that individual preferences are accurately revealed in social and economic outcomes – is fundamentally mistaken. This critique formed the basis of subsequent work by Green and Brown (1980), Otway and Cohen (1975) and, most importantly, by the Decision Research group at the University of Oregon (1978). This early work by the Oregon group showed that people's ideas of what is meant by risk and, consequently, what could be described as 'acceptable risk' were multi-dimensional concepts. The simple expedient of measuring risk magnitudes in terms of the number of fatalities per year was shown to be inadequate (Royal Society, 1992; Slovic, 1987) as it failed to capture the way people – both experts and the lay public - actually understood the term. It was, during the late 1970s, (and still is) possible to argue, as Kahneman and Tversky had originally done, that lay perceptions of risk are subject to 'biases' akin to making systematic errors in estimating knowable probability distributions. However, the most important result of the 'psychometric' programme of risk perception research has been 'to demonstrate that the public's viewpoint must be considered not as error but as an essential datum' (Royal Society, 1992 p.91).

2.4.1 Empirical research using the psychometric approach

The psychometric approach to risk perception research is an individual-based approach. With this focus, it stands in apparent contrast to other social, anthropological and cultural approaches (Beck, 1992; Douglas, 1992; Douglas & Wildavsky, 1982; Giddens, 1990; Luhmann, 1993; Rayner, 1992; Thompson, 1980; Wildavsky & Dake, 1990). It is a research paradigm that aims to elicit judgments about risks from individuals who are confronted by risk stimuli. In fact it is more appropriate to refer to these stimuli as hazard stimuli because one of the main objectives of risk perception research using this approach is to measure not only the quantitative judgments of persons about risks – for example how likely is the risk to lead to an undesirable outcome – but also the qualitative dimensions of what is subjectively understood by the term 'risk' in relation to one or more hazards.

As I have already noted, the term 'risk perception' is rather unfortunate in some respects for the precise reason that it implies that there is something 'out there' called 'risk' that can be 'perceived'. Whilst this may have been the way in which this research was originally conceptualised, as an exploration of people's biases in judging probabilities, it is rarely any longer understood in this way. Paul Slovic (1992), one of the key researchers in this area, makes it clear that the term 'risk' is always left deliberately undefined as it is the structure of people's judgments, representations and preferences that cluster around the term that constitute the object of enquiry.

In a recent empirical review, Rohrmann (1999) sees the psychometric approach as constituted by four principal intentions:

- to establish 'risk' as a subjective concept, not an objective entity
- to include technical/physical and social/psychological aspects in risk criteria
- to accept opinions of 'the public' (i.e. laypeople, not experts) as the matter of interest
- to analyse the cognitive structure of risk judgments, usually employing multivariate statistical procedures such as factor analysis, multi-dimensional scaling or multiple regression

In addition to these intentions, researchers have gradually extended the range of risk determinants to include ‘worldviews’, mainly under the ‘cultural theory’ rubric (e.g. Langford, Georgiou, Bateman, Day, & Turner, 1998; e.g. Peters & Slovic, 1996; Sjoberg, 1995; Wildavsky & Dake, 1990), moral reasoning and moral development (Sjoberg & Drottz-Sjoberg, 1991; Sjoberg & Drottz-Sjoberg, 1993; Sjoberg & Winroth, 1986), emotions (Sjoberg & Winroth, 1986; Slovic, 1999).

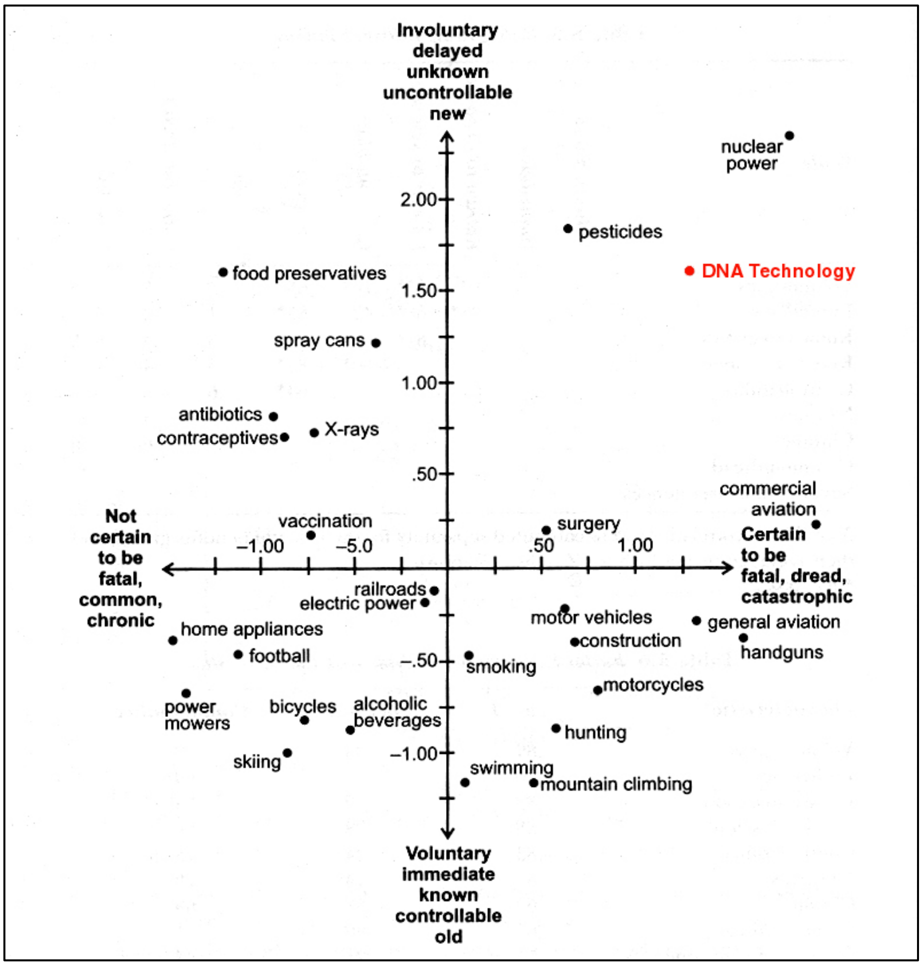
Most studies using a purely psychometric approach employ what has now become a standardised methodology. Following the early work of the Oregon group, respondents are asked, via self-completion questionnaire, telephone or face to face interview, to rate hazards (risk objects or stimuli) on various characteristics. Many studies employ a large number of hazards, with the exemplar being that of Slovic, Lichtenstein and Fischoff (1980) in which respondents rated 90 hazards along 18 risk characteristics (see figure 2.1). The data configuration is a three-dimensional array of hazards, characteristics and respondents. In addition to these variables, background and person-related variables may also be collected.

Hazards that have been rated vary according to the focus of the study. As already mentioned, the 'classic', and rather general, investigation of Slovic *et al* (1980) presented respondents with 90 hazards. As can be seen from figure 2.1, hazards included large scale technologies whose risks might be perceived at the societal, environmental and personal level such as nuclear power (this was a very 'hot topic' at the time when psychometric risk research was becoming established), fossil electric power, space exploration. Transport hazards included motor vehicles, railways, jumbo jets and recreational boating. As well as technological hazards, risks associated with personal behaviours were included, for example downhill skiing, smoking and sunbathing. Antisocial activities such as crime and terrorism were rated as were various drugs and foodstuffs. Many of these hazards or risk sources have been used in later studies (e.g. Bastide, Moatti, Pages, & Fagnani, 1989; Brun, 1992; e.g. Sjoberg, 1996).

There have also been many investigations with more domain-specific foci, e.g. occupational hazards (Greening, 1997; Sjoberg & Drottz-Sjoberg, 1991); risky behaviours or activities (Benthin, Slovic, & Severson, 1993; Holtgrave & Weber, 1993); food risks (Fife-Schaw & Rowe, 1996; Sparks & Shepherd, 1994); hazardous chemicals (Slovic, Malmfors, Mertz, Neil, & Purchase, 1997); consumer products (Schuetz & Wiedemann, 1998; Schuetz, Wiedemann, & Gray, 1995). In most studies, even those with a narrow range of hazards, respondents rate some risks to which they are themselves exposed and some to which they are not, and of which they have little or no knowledge. Increasingly it is possible to see that one or both of two super-ordinate classes of hazards are involved in most psychometric studies. One is the class of hazards involving personal or societal exposure to dangers to health and well-being, and to financial and physical assets. The other concerns environmental dangers that do not necessarily physically threaten people directly but threaten the state of the environment, possibly with consequences for future generations (Rohrmann, 1999). Environmental risks are, almost by definition, human or technology-induced dangers. Personal and societal risks can be divided between natural hazards, such as earthquakes, floods, radon gas in residential buildings, and human-generated hazards which could include anything from faulty consumer goods to violent crime.

It is convenient to divide risk judgments into those designed to elicit risk magnitude and those that reveal the subjective, qualitative structure, the collection of representations or mental imagery that constitute the risk related to a particular hazard. In most psychometric studies, respondents judge each of a range of hazards according to a number of both characteristics and measures of magnitude.

Figure 2.1 Qualitative dimensions of risk perception (from Slovic et al 1980)



The earliest and least sophisticated of these measures of risk magnitude is to ask respondents to estimate the number of fatalities per year associated with the hazard being considered. The most influential study of this kind was conducted by members of the Oregon group in 1978 (Lichtenstein, Slovic, Fischoff, Layman, & Combs, 1978). In this context it becomes clear why the term 'risk perception' originally gained currency. If one makes the assumption that there is an objective risk of a given magnitude as revealed in the yearly accident statistics, it then makes sense to refer to someone's more or less reliable and accurate 'perception' of the risk. Paradigmatically this resonates with an earlier tradition of psychophysical research in psychology that measured physical responses to controlled stimuli such as sound sources of varying frequency or light sources of different wavelengths or intensities. However, with the realisation that the real 'risk' is not a given datum, under the control of the researcher, but, rather, a subjective construction to be explored, the emphasis now is on measuring the magnitude of subjective risk along a number of dimensions.

Figure 2.1 shows the now famous factor-space diagram adapted from Slovic *et al* (1980). Because the approach taken in this study in many ways set the parameters for a multitude of replications and further studies, it is worth exploring a little. On the diagram can be seen the range of hazards rated across different risk characteristics, shown at the base. Each hazard is mapped onto the space demarcated by the two factors that are derived from the collection of risk characteristics that were rated. What this diagrammatic representation shows is that different types of risks are judged according to quite a complex set of qualitative dimensions. Apparently the concept of risk means more to people than an estimate of its probability of occurrence. Starr (1969) had already noted that whether exposure to a risk is voluntary or involuntary is related to its acceptability. Here it can be seen that a much wider range of risk qualities are significant.

The two factors shown have been labelled as 'dread' risk and 'unknown' risk by Slovic *et al*. A third, 'exposure to risk' is not shown. 'Dread' risk is characterised by the perception of uncontrollability and the idea that the danger might be of a global, catastrophic nature, fatal, a high risk to future generations, an involuntary risk and one that is perceived as affecting the perceiver. Also significant for this factor is whether or not the risk is seen as increasing, not easily reduced and inequitable. Hazards that score highly on this factor are, amongst others, nerve gas, nuclear weapons and terrorism; those at the other end of the scale include home appliances, sunbathing and cosmetics. The second factor, 'unknown' risk is composed of qualities such as observability, whether a risk is known to those exposed or to science and whether the effect of a hazard is delayed or immediate. DNA research and space exploration are high on this factor, while handguns and fire fighting are low. The characteristics used to rate risks here have subsequently been widely used in psychometric risk studies. A number of these risk characteristics relate to whether the threat is to the individual or to many people simultaneously. This distinction is explicitly utilised in some studies where hazards are rated according to the risks they pose for the respondent personally, for people in general and for society as a whole.

From the large number of empirical studies carried out using this paradigmatic approach, some relatively common results emerge. The factor structure shown in figure 2.1 shows two dimensions – 'dread' and 'unknown' risk. This correlational structure is found in many studies, although there are exceptions (Brun, 1992; Johnson & Tversky, 1984). Ratings about the magnitude of risks are systematically related to this structure. Higher ratings of risk magnitudes are associated with the top right quadrant of figure 2.1. This has led researchers to the idea that risks are appraised by people along only two or three perceptual dimensions. As I shall describe later on, this conclusion is questionable from a methodological perspective. But it is also questionable from a theoretical perspective. To say that 'dreadedness' is a perceptual dimension is a rather odd claim that arises from the very empirically driven research that has taken place. In one sense, 'dread' might be considered as an emotional or affective response. Placing it alongside cognitive beliefs about numbers of fatalities and the rarity or otherwise of the risk does not make much sense theoretically, although empirically it is clear that these beliefs tend to be correlated. In fact, despite empirical support for the structure of beliefs about a range of hazards, it is probably fair to say that the social psychological basis for this is still theoretically underspecified. This is a point to which I return towards the end of this chapter.

In terms of the relative rating of risks of the various hazards that have been studied, the most risky are smoking, nuclear power, asbestos production and automobiles (Rohrmann, 1999). Gene or DNA technology has been included in some studies (Fife-Schaw & Rowe, 1996; Siegrist, Cvetkovich, & Roth, 2000; Slovic, Lichtenstein, & Fischoff, 1980). These provide evidence that gene technology is rated as highly risky, at a comparable level to nuclear power. In general, technological risks to the environment and to human health are viewed as more risky than naturally occurring events such as floods or earthquakes.

The same holds for risk acceptability. In general, what constitutes an acceptable level of risk is higher for natural than for technologically induced risks. Personal, private risk taking activities such as driving or smoking, which are undertaken voluntarily and are more familiar, are seen as less risky and more acceptable still. Risks that are seen to have catastrophic potential, that are thought to impact unfairly on certain people and are unfamiliar to the public and scientists all tend to be rated as 'riskier', more probable and more serious than others. People typically overestimate the dangerousness of air or rail travel and underestimate the dangerousness of cigarette smoking, relative to the actual fatalities, reported year on year.

2.4.2 Problems with the psychometric approach

The core assumptions of the psychometric approach, the two or three dimensional factor structure, the generalisability of these dimensions across groups and individuals, are not often questioned. The factor-space diagram shown in figure 2.1 has become emblematic, and the risk dimensions of 'dread', 'unknown', 'exposure' have been lent support by the results of a large number of studies since 1980. However, there are a number of criticisms of the methods that have been employed to produce these results. These are briefly addressed now.

A great number of studies have been carried out with convenience samples. Often these are rather small. In fact the seminal investigation by Slovic *et al* (1980) was carried out using a convenience sample of 76 members of the League of Women Voters (and their husbands) in Oregon, USA. Small sample sizes are quite normal for experimentally based research, but for correlational analyses larger and more representative samples are desirable, if not essential. Statistical inferences made from non-probability samples of any kind are also to be treated with caution. Although in much of the literature significance levels and standard errors are reported, where probability samples are not employed point estimates may be biased and standard errors inaccurate. The generalisability of results is therefore limited. Having said that, there are a number of investigations in the literature that have employed large probability samples (e.g. Bastide, Moatti, Pages, & Fagnani, 1989; Krewski, Slovic, Bartlett, Flynn, & Mertz, 1995; e.g. Slovic, Flynn, Mertz, Mays, & Poumadere, 1996). The results from these have not been greatly at variance with the type of results found in many smaller studies. One might, therefore, have some confidence in the results from smaller sample studies where they are broadly consonant with the larger sample investigations.

Great significance has been attached in the literature to the factorial structure of risk characteristics originally found by Slovic *et al*. This structure, with its dimensions of 'dread' and 'unknown' risk, has been reproduced, or at least approximated, many times since. However, some critical attention has been focused on the methodology employed by Slovic and his colleagues, which involved aggregating into mean scores the respondents' ratings of risk characteristics (Arabie & Maschmeyer, 1988; Johnson & Tversky, 1984; Marris, Langford, Saunderson, & O'Riordan, 1997). This procedure yields a single, mean score for each characteristic (e.g. familiarity, catastrophic potential) applied to each hazard rated. Using this technique, each hazard's factor score locates it in the 'perceptual space' defined by the two or three factors which account for some proportion of the variance in the full set of characteristics rated. This is, though, what might be termed a hazard-centric approach, aiming as it does to develop 'personality profiles' (Slovic, 1992) of hazards, with the implication that they are perceived in the same way by heterogeneous collections of individuals and groups. Johnson and Tversky (1984) and Langford *et al* (Langford, Marris *et al.*, 1999) have made attempts to circumvent this problem by developing new methodologies based on similarity/dissimilarity ratings in the former case and multilevel modelling in the latter. In spite of these attempts, the hazard-centric approach is still dominant, a fact which calls into question the social psychological validity of the results of such research and the kinds of inferences that can legitimately be made.

This methodological criticism also reflects the serious substantive criticism raised by social and cultural approaches to risk research. In its original formulation, the psychometric approach, by aggregating individual differences data, carries the assumption that the cognitive dimensions along which perceptions of risk are structured are invariant. That is to say they are 'hard-wired' in human brains. This assumption was rather naively adopted from Tversky and Kahneman's work on cognitive heuristics. While these researchers do provide some evidence for the universalism of these heuristics and systematic biases in judging probabilities (although for a criticism of this see Joffe, 1999), applying the same logic to the study of risky societal technologies is, in light of the discussion so far, unwarranted. The substantive and methodological weaknesses of the original psychometric approach are described aptly by Marris *et al* (1997, p304):

> *this approach treated risk, or rather "risky" technologies, activities and products, as external objects with a set of predefined qualities and drawbacks, and ignored the possibility that social, cultural and institutional factors might affect the way in which risks are understood and evaluated by individual members of the public*

Indeed, this realisation is reflected in the more recent emergence of socio-cultural approaches to risk perception. In the following section I outline these approaches and review some key findings.

2.5 Beyond the psychometric paradigm

2.5.1 Cultural theory

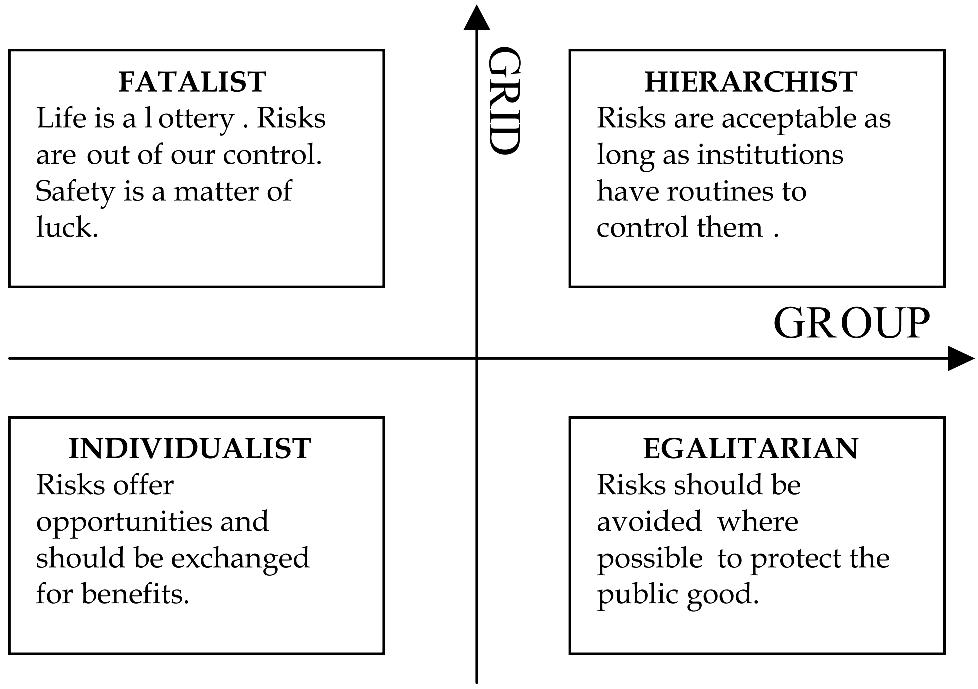
In the early work within the psychometric paradigm, the implicit situation underlying the research is as follows: there is a hazardous situation out there in the real world that acts as a stimulus to people (e.g. eating a GM tomato). These people perceive the hazard and make an estimate of the risk attached to it. Their perceptions are expected to be structured along a number of dimensions. These dimensions are more or less the same for everybody. The assumption that perceptions are for all people uniformly triggered by objective states of affairs and that human risk perceptions are homogenously structured along the same dimensions is challenged by the so-called 'cultural theory' approach to risk.

Rayner argues that while the psychometric approach is based on a model of perception rather akin to seeing or hearing (people are passive recipients of an independent stimulus), in cultural theory the model of perception is more akin to touch or taste, like 'a baby, groping or sucking on the world for information' (Rayner, 1992). Rayner's contention originates largely in the work of Mary Douglas. She offers an explanation for why different social groups have different attitudes towards technological and natural dangers. In her earlier work, Douglas claims that the content of beliefs about purity, danger and taboo in any given culture are essentially arbitrary. Within a particular culture these arbitrary beliefs become fixed and henceforth serve to organise and reinforce social relations according to hierarchies of power. In her book, Purity and Danger, (Douglas, 1966), she advances the idea that different cultures denote certain activities as taboo not because of objective harm that may arise from carrying out these activities but as a way of maintaining and reinforcing the moral, political, religious or social order that binds members of that culture. She cites the example of the ancient Israelites who, on the command of Leviticus, prohibited the consumption of pork. Pork was not, in fact, dangerous to eat, but its prohibition served as means of reinforcing and maintaining a monotheistic society against the polytheistic nomadic culture that surrounded it (Douglas, 1966; Rayner, 1992). Douglas and Wildavsky cite the example of the Hima of Africa who think that it is risky for women to come into contact with cattle. This belief functions to maintain a set of hierarchical relations in that culture regarding the role of women rather than reflecting any objective risks. In Western societies the picture is necessarily more complex but, according to Douglas and Wildavsky, the same principles apply. An individual's beliefs about what constitutes an important risk is in part indicative of their place in society.

Others, such as Rayner, have argued that this phenomenon is true not only at the societal level but can also be observed within smaller organisations such as firms, political parties and non-governmental organisations. The implication of this for the social study of risk is rather important because it shifts the emphasis away from biases in perception of objective risks towards more fundamental types of intergroup cleavages. In the cultural theory view, people's conception of what constitutes danger, or a risk, varies according to the way their social relations are organised. People select risks as being important or trivial because in so doing they reinforce the established social relations within the culture in which they are located. Douglas and Wildavsky proposed four prototypical cultural types within modern industrialised societies. These are located along two dimensions that describe firstly the degree of social incorporation constituted within the culture and secondly the nature of these social interactions. This analytic framework is known as grid/group, where grid is defined as a measure of the constraining classifications that bear upon members of any social grouping and group as the degree of social interaction and the extent to which people rely on social networks (Rayner 1992). The four 'cultural biases' or 'stereotypes' are summarised in figure 2.2.

At high grid and high group, the modal form of organisation is hierarchical, where all individuals are strongly reliant on others but where movement between levels of authority is strongly constrained. In terms of risk perception, the key concern is for control and management. Rules and procedures are favoured responses to risk. For the egalitarian, there is an emphasis on strong cooperative relations and equality. The response to risk is highly precautionary, concerned to minimise possible harms by avoidance of risky activities rather than control and management. At low group and grid, the individualist sees risks as opportunities for gain. Market mechanisms are favoured rather than bureaucratic regulation. Potential losses can be mitigated by insurance. Finally, the fatalist perspective is that of the 'atomised individual'. Risks are seen as inevitable and whether or not one can avoid harm is simply a matter of luck.

Figure 2.2 Cultural theory's four stereotypes



Most of the empirical work that has been carried out using cultural theory has followed the example of Karl Dake who developed a set of questionnaire items designed to tap the four 'cultural biases'(Brenot, Bonnefous, & Marris, 1998; Dake, 1991, 1992; Langford, Georgiou, Bateman, Day, & Turner, 1998; Marris, Langford, & O'Riordan, 1998; Sjoberg, 1996; Wildavsky, 1984). These have been used in many studies as independent variables, or as a way of classifying people into one of cultural theory's stereotypes. In most of these studies, people's scores on the scales designed to measure the four 'cultural biases' tend to correlate weakly with perception of risks of various hazards. In general, environmental hazards are seen as more serious and more likely to cause damage by egalitarians. Crime-related risks are seen as greater by hierarchists.

Unfortunately, individualists and hierarchists are often empirically barely distinguishable, which calls into question the classificatory value of the theory. In fact, classification is never really achieved in these investigations, as most people exhibit some degree of concordance with the all the beliefs expressed in the four scales. So, while it is clear that the values expressed in the cultural theory inspired scales do tap into attitudes or values related to perception of technological and other risks, it is not clear what are the advantages or, indeed, the veracity of the four-way classificatory system proposed. There is a certain circularity of argument: for instance, egalitarians might perceive GM crops as more risky than individualists because they see nature as 'fragile' (Adams, 1995). But if one's worldview is that nature is fragile, it is almost tautological to say that cultural theory 'predicts' that such people will perceive more risk in tampering with nature. The prediction is at least partially entailed by the premise. In quantitative operationalisations of cultural theory it is difficult to avoid some semantic overlap between concepts. For an excellent review of these conceptual and methodological difficulties, see Boholm (1996).

Cultural theory introduced the idea that features of the 'perceiver' of risks as well as the nature of the hazards themselves could help explain risk perception. Since then, other factors that explain interindividual and intergroup differences in risk perception have been incorporated into risk research. The most important of these are discussed in the following section.

2.5.2 The role of trust

Recent work on risk perception has focused increasingly on the role of trust. In, part this is due to the relative failure of risk communication strategies based on twenty years of research in the field (Cvetkovich & Lofstedt, 1999). It is also a consequence of the gradual widening over time of the scope of explanation for perceptions of risk in the literature. Alongside the rather specialised academic field of risk perception research, the concept of trust has found its way into political and academic agendas in some more general contexts. For instance, Putnam's work on declining trust and social capital in the US and in Italy

(Putnam, 2000) has been influential inside and outside of academic circles. While Putnam's thesis mainly concerns declining interpersonal trust, trust in institutions, and in more distal social actors, is the prime focus of research on trust and technological risks. Public anxieties in the UK about GM food, BSE, rail safety, mobile phone transmitter masts and a host of other risks could be explained not so much by the particular characteristics of the hazards themselves but by a lack of trust or confidence in those responsible. In some cases, it appears, the relevant authorities have lost their very legitimacy in addition to being simply distrusted. The recent re-nationalisation, in all but name, of the UK rail authority Railtrack, is a prime example of an institution that suffered a catastrophic loss of public confidence in managing risks and, as a private company, was no longer perceived as the legitimate guardian of public transportation safety.

Empirical research on the role of trust in risk perception has been on the increase since the early 1990s. An early article by William Freudenburg (1993) looked at the effect of trust on the concerns of local citizens about the proposed siting of a nuclear waste facility in Nevada. Freudenburg additionally coined the term 'recreancy' as a specific form of mistrust relevant in cases of potential risk within complex technological systems. The concept of recreancy is intended to capture the idea that people in positions of responsibility with respect to potentially hazardous situations can sometimes fail to 'carry out their responsibilities with the degree of vigor necessary to merit the societal trust they enjoy' (Freudenberg, 1993 p.909). The idea is not necessarily that individual actors are incompetent, self-interested or villainous, but that the complex division of labour that characterises modern systems of technological control makes disastrous outcomes possible even where no individual can be held fully culpable. Freudenburg's operationalisation of the recreancy concept was rather weak in that it did not really distinguish between recreancy and trust as a broad concept. However, its predictive power in attitudinal surveys measuring concern about the nuclear waste sites was high, even controlling for a range of sociodemographic and other variables.

Slovic investigated the asymmetrical effects of trust building and trust destroying information (Slovic, 1993). He notes that although the risks associated with medicines and X-rays are real, people tend typically not to have concerns about them because doctors and the medical professions are generally trusted. In the case of government and industry officials managing industrial technologies like pesticides and nuclear power, there is little trust. Risks are concomitantly a greater source of concern (Slovic, 1993 p.676). Using questionnaire experiments, Slovic shows that the effect of negative information on trust 'destruction' is much greater than positive information on 'trust building'. The conclusion is that trust is difficult to earn but easy to lose.

Various other questionnaire studies have been carried out that show that trust in government and other risk management agencies or institutions is correlated with risk perceptions in relation to hazardous waste (Biel & Dahlstrand, 1995; Bord & O'Connor, 1992; Pijawka & Mushkatel, 1991). Recently, Sjoberg has criticised the idea that trust is important for risk perception due to the low 'explanatory power' of trust measures in predicting people's risk ratings (Sjoberg, 2001). He makes this claim because measures of trust in surveys account for typically only 10 percent of the variance in risk perception of a range of hazards, compared to other variables that are more highly correlated such as belief in 'unknown effects'. This is a foolish canard, if one is interested in theoretical explanation and not simply predictive 'power' (see King, 1986 for a statistical explanation of why this approach is generally meaningless). It is not difficult to obtain high correlations between survey items, depending on how semantically proximal they are. Belief that there are effects that remain unknown to risk managers is likely to be quite highly correlated with the level of stated risks because the two concepts overlap. A reinterpretation of Sjoberg's review leads to the conclusion that trust, as one amongst other variables, is without doubt an important factor in people's perception of technological risks. In the case of GM food, recent empirical work has indicated that trust is a particularly relevant factor. For example, Priest in the USA and Gaskell et al in

Europe found that trust in governments, shops and industry, in relation to their behaviour concerning GM food, is a good predictor of risk perceptions, even while taking into account other sociodemographic and attitudinal factors (Gaskell, Allum *et al.*, 2001; Priest, 2001).

2.5.3 Conceptualising trust

The empirical research points to trust as an important variable in relation to risk perception. What is missing in much of this research, though, is an adequate theoretical basis to inform the design of measures of trust and to make sense of results (but see Frewer, Scholderer, & Bredahl, 2003; but see Poortinga & Pidgeon, *2003*; White, Pahl, Buehner, & Haye, 2003 for very recent work that begins to address the issue). Two types of contexts for trust can be identified. The first is interpersonal trust, where one is dealing with face-to-face encounters. There is an extensive social psychological literature in this area that sees trust as trait-like property of individuals that gives rise to generalised expectancies about other people's behaviour (Rotter, 1971). General 'trustingness' has been occasionally examined with regard to risk perception (e.g. Sjoberg, 2001) and the usual result is that little or no relationship exists between the perception of specific risks and generalised trust.

Another way of defining trust in relation to risk is as social trust. This is the more relevant aspect of trust in relation to risk perception. Here the idea is that trust relates to beliefs and expectations that some possibly remote institution or actor will act in a particular way in a particular context. It is primarily distinguished from interpersonal trust in that it does not relate to direct cooperation or reliance between individuals. Luhmann has suggested that, from a functionalist perspective, social trust enables societies to tolerate increasing uncertainty due to progressive technological complexification. Thus he states that trust 'reduces social complexity by going beyond available information and generalising expectations of behaviour in that it replaces information with an internally guaranteed security' (Luhmann, 1979 p.93). Although Luhmann is writing about social systems, the idea that trust reduces the need for information can be just as relevant at a social psychological level too. By trusting someone else to make decisions on the basis of relevant information in situations of potential risk, one reduces one's own cognitive load.

Bernard Barber shares Luhmann's perspective on trust concerning its function – the reduction of complexity – but distinguishes between two types of expectation that comprise social trust. In his framework, trust, as a general concept, has more than one dimension. The first is the expectation that actors or institutions will perform their role in a technically competent manner. The second is that actors or institutions will demonstrate 'fiduciary responsibility'. That is to say they are expected to act with special concern for other's interests above their own (Barber, 1983 p.14). In relation to risk perception, a lack of trust that leads people to see risks as greater could be based on expectations about risk managers' competencies or their fiduciary responsibility. It remains an empirical matter as to the relationship between these two attributes, both as public perceptions and in reality.

Another conception of trust has recently been proposed and tested empirically in a number of studies on the perception of risks of gene technology and several other controversial technological hazards. Earle and Cvetkovitch (1995) share the general assumption of Luhmann and Barber that the function of trust is to reduce complexity. However, they point out that in Barber's twin conception of trust, people actually require rather a lot of information about actors and institutions in order to decide whether or not to grant trust. So while the function of such trust may be a reduction of cognitive complexity, the basis on which it would granted would itself require considerable cognitive effort. Earle and Cvetkovitch claim that social trust is based on what they call salient value similarity (SVS). This is a 'groundless' trust, needing no justification. Rather than deducing trustworthiness from direct evidence, people infer it from 'value-bearing narratives'. These could be information shortcuts, available images, schema and the like. Essentially, people trust institutions that tell stories expressing salient values that are similar to their own. Salient values consist of 'the individual's sense of what the important goals (ends) and/or processes (means) that should be followed in a particular situation' (Siegrist, Cvetkovich, & Roth, 2000 p.355). This yields a general basis for trust only to the extent that situations are perceived as being similar. Hence one might think that equal sharing is a salient value in relationships with family members but that competitiveness is important in business situations. Similarity of values between trustor and trustee is inferred from the trustee's words, actions, perceived cultural/social group membership. The key point is that trust is conferred not on the basis of a detailed appraisal of the likely competence and fiduciary responsibility of the actor but on the perception of shared salient values and a quick, non-cognitive appraisal.

A number of studies by Michael Siegrist and others have operationalised these concepts and tested them in relation to the perception of risks (Siegrist, 1999; Siegrist & Cvetkovich, 2000; Siegrist, Cvetkovich, & Gutscher, 2001; Siegrist, Cvetkovich, & Roth, 2000). In general, these results suggest that the perception of shared values is strongly related to expressions of social trust and confidence in risk managers or institutions responsible for the deployment of risky technologies. In another study (Earle & Cvetkovich, 1999), it was shown that not only is the perception of shared values that relate to social trust, but that people holding different types of worldview are most likely to trust those that express similar worldviews in the presentation of risk narratives.

What is missing from these studies, though, is the incorporation of other putative dimensions of trust, such as those of fiduciary responsibility and technical competence. If Earle and Cvetkovitch's thesis is that trust is 'groundless', based on value bearing narratives rather than a rational assessment of the likely performance characteristics of the actor in question, this could, in principle be tested empirically. In later chapters I shall return to this question, in relation to gene technology risk, and evaluate the claims of Earle and Cvetkovitch and Barber, operationalised within a survey-based framework.

2.5.4 Risk, knowledge and ignorance

It is a common notion that people are more worried about many technological risks than they would be if only they were better informed. Without the correct information and understanding of the science or technology, people fall back on superstition and irrational fears, so the argument goes. In fact, this 'commonsense' notion that scientific knowledge is necessarily correct or incorrect is to some extent a fiction in itself. Particularly in the case of large scale environmental science, contestation and conflict is the norm within the scientific and policy arenas (Ravetz, 1987). Perhaps not altogether surprisingly therefore, empirical research on risk perception and public knowledge is somewhat mixed in its conclusions. In some studies, on perceptions of nuclear power risk, those that gave more correct answers to factual knowledge questions concerning nuclear energy were less concerned about dangers, while others found no relationship or that anti-nuclear people knew more (Johnson, 1993). A recent study that considered 25 different hazards including gene technology, showed no significant correlation between risk ratings and self-assessed knowledge, (Siegrist & Cvetkovich, 2000). Recently, Gaskell and others report that in Europe, perceptions of 'riskiness for society' of medical applications of gene technology are greater amongst those who are less interested and knowledgeable about genetics. In the case of GM food, no differences are found (Gaskell, Allum *et al.*, 2001). This contrasts with overall support for applications and perceptions of benefits. Those that are more knowledgeable tend to be more supportive and see more benefits from both medical gene technology and GM food and crops.

These results overlap with more general findings in the interdisciplinary area of public understanding of science (PUS). In this field, the relationship between knowledge and attitudes has been fiercely contested over the past decade (Gregory & Miller, 1998). On the one hand is the so called 'deficit model', where public fears about new technology are based on ignorance (Layton, Jenkins, McGill, & Davey, 1993; Wynne, 1991; Ziman, 1991). Whilst the deficit model is to some extent a simplification, or even something of a 'straw man', it quite evidently underlies many programmatic statements from the scientific community when the misplaced fears of a scientifically illiterate public and mass media are bemoaned (Evans & Durant, 1995). The simple logic of the deficit model is supported by a fair weight of empirical evidence for a robust but not especially strong positive correlation between 'textbook' scientific knowledge and favourability of attitude toward science (e.g. Bauer, Durant, & Evans, 1994; Evans & Durant, 1995; Gaskell, Allum *et al.*, 2001; Grimston, 1994; e.g. McBeth & Oakes, 1996; Miller, Pardo, & Niwa, 1997; Sturgis & Allum, 2000; Sturgis & Allum, 2001). What some of this research also suggests is that the link between knowledge and attitudes towards science and technology is stronger when general attitudes to science rather than specific attitudes to particular technologies are examined. For instance, Evans and Durant (1995) found that whilst textbook knowledge of general science was positively correlated with favourable attitudes to science in general, for morally contentious technologies, the correlation was negative. Recently it has been suggested that the measure of general attitude to science used by Evans and Durant is not sufficiently reliable that it should be used to make secure inferences about attitudes (Pardo & Calvo, 2002). Whilst the measurement of attitudes to science could and should be improved, the number of independent replications of the same general findings gives cause for some confidence that the measurement scale is reasonably robust.

The deficit model has come in for sustained criticism on a number of grounds. Firstly, the assumption that so-called 'irrational' fears of lay publics are based on lack of scientific understanding has been strongly challenged by a number of commentators. As mentioned earlier in this chapter, there are other factors thought to account for differences in people's perceptions of technological risk: social trust, worldviews, values. In none of these conceptions is the perception of risk dependent primarily on one's level of scientific understanding. Another criticism of the deficit model and the way in which it has been approached via quantitative survey research focuses on the selection of appropriate measures of scientific understanding (Hayes & Tariq, 2000; Peters, 2000). The argument is made that proponents and opponents in scientific controversies are likely to select different domains of knowledge as being relevant or important (Peters, 2000). The normative assumptions behind the selection and development of knowledge measures such as those of Evans and Durant may not necessarily correspond with those of all protagonists in any given scientific controversy. Peters (2000), for example, criticises some of the knowledge measures used in the 1992 Eurobarometer survey (INRA, 1993) as being based on a 'culturally determined idealisation' of what should constitute scientific knowledge. As a result, he argues, the measures present a biased indication of the relative levels of relevant scientific understanding that is dependent on respondents' national and cultural locations.

Whilst all these criticisms may be valid to some degree or other, there does not appear to be any a priori reason for assuming that knowledge and information would not play a role in determining people's attitudes towards science and technology. Quite to the contrary, it has been convincingly shown in other fields that these factors are highly relevant, for instance in social psychological theories of attitude change (Petty & Cacciopo, 1981) and of political behaviour (Converse, 1964, 2000; Delli Carpini & Keeter, 1996). As in the case of any other political or social attitudes, in the case of science and risky technologies, there appears ample reason to consider it quite implausible that the well-informed and poorly informed citizen go about the business of making up their minds in the same way (Sniderman, Glaser, & Griffin, 1990).

A more trenchant critique is one which suggests the existence of other knowledge domains that influence attitudes towards science and technology in opposite or conflicting ways to factual scientific knowledge. Jasanoff, for example, suggests that what is important for people's understanding of science is not so much the ability to recall large numbers of miscellaneous facts but rather 'a keen appreciation of the places where science and technology articulate smoothly with one's experience of life…and of the trustworthiness of expert claims and institutions' (Jasanoff, 2000 p.55). Brian Wynne, an incisive critic of the deficit model, delineates this position further. Criticising survey-based PUS research's over-reliance on simple 'textbook' knowledge scales, he suggests that in order to properly capture the range of knowledge domains relevant to lay attitudes towards scientific research programmes 'three elements of public understanding have to be expressly related: the formal contents of scientific knowledge; the methods and processes of science; and its forms of institutional embedding, patronage, organisation and control' (Wynne, 1992 p.42)

The implication of this position is that the deficit model considers only the first two of these elements and that, in neglecting the different forms of engagement that individuals and groups might have with science in a variety of contexts, PUS research has overstated the importance of the simple linear deficit model. Other knowledges - be it intimate knowledge of working procedures at a nuclear power plant or awareness of the practical political interdependencies between government, industry and scientific institutions - will always be moderating factors on the way people perceive the attendant risks. Here there are connections with the risk perception literature. For example, Steven Yearley highlights public trust in scientific expertise as a key factor in the contextualisation of knowledge of science (Yearley, 2000). Trust in expert claims, he argues, is always mediated by knowledge of the institutional arrangements under which expertise is authorised. Claims to expert knowledge are always contestable depending on what one knows of the relevant institutions. For instance, claims made by government experts may be evaluated differently to those made by scientists employed by non-governmental organisations.

The general thrust of the critique from Wynne and others, then, is that other forms of knowledge are important for people's relationship with science. The deficit model's focus only on knowledge of scientific facts is at best incomplete and at worst misleading. Knowledge of the way scientific, political and industrial actors interrelate is also thought to be a relevant consideration in understanding attitudes to science and, by extension, understanding perceptions of risk from specific technologies.

2.6 Re-reading risk: from perceptions to attitudes

As is probably clear from the foregoing review of the literature, one of the difficulties with studying risk from a social scientific point of view is the problem of conceptual clarity. This difficulty, which afflicts much of the work in the field, may go some way towards explaining the divergent theoretical viewpoints brought to bear on the empirical research. Clearly, there is far from complete agreement amongst researchers as to what constitutes 'risk' as a concept or as phenomenon to be investigated. From the review of the literature, it is obvious that there are differences of interpretation of the risk concept. On the one hand, for Kahneman and Tversky, risk is something 'out there' to be perceived by the senses. Given that all human beings possess the same set of sense organs, ways of perceiving risk are assumed to be common to all people across all cultures. On the other hand, cultural theory seems to imply that risk is a socially constructed, culturally specific concept that has a specific function within any given cultural milieu. There is an obvious need clarify what is meant by 'risk' or 'risk perception'

Surveying the development of risk perception research, from cognitive heuristics to cultural theory, it is obvious that more inclusive and varied conceptions of risk have evolved over time. This in turn has led to a situation where debates about risk often concern definitional issues as much as anything else. This, in my view, turns on the particular way in which risk research began. The work on heuristics and biases was very much based on a highly cognitive, information processing approach with a strong normative background in regard to rational decision-making. However, before long, research questions about political issues like civil nuclear power, hazardous waste disposal and, recently, gene technology, began to be tackled using an analogous theoretical and operational framework. When some people's perceptions of risk in these areas were found not to accord with those of experts and, indeed, with other individuals and social groups, this was seen as a problem of distorted perceptions, or biased processing of risk information.

However, it seems obvious that there is a qualitative difference between, on the one hand, the heuristics and cognitive biases that people bring to the processing of numerical, probabilistic information and, on the other, the factors that contribute to the formation of people's social and political attitudes towards new technologies. In the first case, probabilities are known and the respondent experimental tasks are rather anodyne and apolitical. In the second case, there are all kinds of political and scientific uncertainties and, in any case, numerical probabilities based on empirical frequency distributions are often simply not available. Clearly the investigation of people's 'perceptions' of the risks associated with gene technology falls much more comfortably into the latter type than into the former. If one accepts this line of argument, research on risk 'perception' would perhaps be better conceptualised as a particular area of research on political and social attitudes. Risk 'perceptions' become simply attitudes and beliefs about controversial social and political issues. In this view, societal decisions about new technology are political decisions like any other and have costs and benefits for different stakeholders.

Taking this line of thinking further, there are several social psychological frameworks for understanding and explaining attitudes that are consistent with risk perception research. For instance, Fishbein's expectancy-value model of attitudes. This is the basis of the theories of reasoned action and planned behaviour (Ajzen & Fishbein, 1980), although these theories also extend to the prediction of behaviour from attitudes and beliefs. Fishbein's original expectancy-value (EV) model distinguishes between attitudes and beliefs in relation to concepts or objects (Fishbein & Raven, 1967). Attitudes are the evaluative dimension of a concept: is it good or bad? Beliefs are the probability dimension of a concept: is it existent or non-existent? Fishbein introduced this distinction in research on people's attitudes to extra-sensory perception (ESP) where there was a great deal of variation in the extent to which people believed in the existence of the concept at all. Not all beliefs about concepts call into question their existence, but, according to Fishbein and Raven, all beliefs remain probabilistic but can be distinguished into to types: belief *in* a concept and belief *about* a concept. Belief about a concept refers to belief in the existence of a relation between concepts. These may be, for example, 'is part of', 'leads to' 'is opposed to' and so on (Fishbein & Raven, 1967 p.187). As all objects or concepts can be evaluated (placed on an attitudinal dimension), belief in the existence of a relation between concepts allows the inference of attitude from belief. This is always assuming that one knows how the related concepts are evaluated by the individual. The EV model suggests that intentions or exhortations to behave in certain ways are determined, amongst other things, by a weighted combination of salient beliefs and attitudes with respect to the concept, object or behaviour in question (Ajzen & Fishbein, 1980). Viewed in this light, one could see people's risk 'perceptions' as attitudes towards hazards that are based on some number of salient beliefs about and evaluations of such hazards.

Applying an EV framework to risky decision-taking is not a new idea (Maiman & Becker, 1974), and in fact EV principles underpin most rationalist 'goal-oriented' psychological theories. But seeing risk perceptions simply as particular types of attitudes may be more helpful in understanding the existing research than treating 'risk' itself as a psychological concept *sui generis*. The risk concept becomes particularly difficult when one tries to link the idea of 'real' risk and 'perceived' risk in relation to the radical uncertainty surrounding developments in gene technology, from scientific and political perspectives.

In fact, this approach to risk perception was explored quite some time ago by Otway and colleagues in relation to attitudes to nuclear power (Otway & Fishbein, 1977; Otway, Maurer, & Thomas, 1978). More recently, Otway (1992 p.217) describes the origin of this work thus:

> *In searching through the psychology literature I was struck by the similarity between attitudes toward risk and what was beginning to be called "risk perception." After much thought it seemed that the relevant issue was not risk per se, but attitudes toward the technology associated with the risk. Obviously it is the technology as a whole that is ultimately accepted, not its risks in abstract isolation.*

Several empirical studies were carried out that used the Fishbein EV model to study attitudes toward nuclear power. For example, Otway and colleagues found that attitudes to nuclear power risks were affected by clusters of beliefs concerning socio-political issues, environmental risks, economic benefits and personal or psychological risks. They also found that for people who were broadly 'for' nuclear power, belief in economic benefits were important, while for those who were 'anti', it was beliefs about personal susceptibility to risk that were important (Otway, Maurer, & Thomas, 1978).

It is unclear from these studies whether or not beliefs and evaluations were combined as a cross-product term, as in the formal EV model, but the general thrust of Otway and colleagues' conclusions support the idea that technologies are evaluated according to a range of salient beliefs that vary across individuals and groups. It is the resulting overall attitude that leads people to consider a particular technology more or less risky.

Another general social psychological model of risk perception has been suggested recently by Eiser (2001). Eiser points to the need for such a model because, in his view, the 'perceptual space' in which risks are evaluated is not invariant across persons. Individuals who take opposing stances on risk issues will tend to judge some aspects of the problem as more or less salient. Therefore, any theory of risk perception 'demands an understanding of how we form preferences and evaluative judgments' (Eiser, 2001 p.113). Rather than the particularly rationalistic EV model, Eiser proposes that a better framework for understanding attitude formation is one based on learnt associations. In this view, attitudes are 'attractors' that are recalled as attitudes according to how easily accessible they are and how consistent they are with the information that activates them. The point is that evaluation of a risk is not a rationally weighted combination of salient belief and attitude but a purely associative process. Eiser does not present empirical research in support of this general model but it is proposed as a useful reconceptualisation of risk perception as a special case of social attitudes.

Some type of framework that that posits a holistically-based judgment underlying risk perception would certainly clarify and account for many of the findings in the literature. For instance, one interpretation of the common finding in risk research that the perceived risks and benefits of a technology tend to be negatively correlated, is that benefits are one of the salient beliefs that contribute to the formation of risk attitudes. From a rational perspective, risk (as probability x negative consequences) and benefit (utility) should be independent of each other. The widely observed fact that, psychologically, they are not, lends support to the idea that asking people about risk is a way of eliciting general attitudes towards an object which will depend on different sets of beliefs for different people. Expert/lay differences can be explained by a different set of salient beliefs, different evaluations and strength of beliefs, or any combination of these. For experts, risk managers, scientists, salient beliefs about risk might mainly concern risk assessments in terms of formal probabilities. That is the focus of their professional interest (Thompson, 1999). For lay persons, on considering a possible new technological risk like environmental release of GMOs, a much wider range of salient beliefs will be elicited, not only concerning probabilities but political beliefs about control and exploitation, values and beliefs about the environment and so forth.

Recently, Slovic and colleagues have pointed to the existence of what they call the 'affect heuristic' in risk perception (Slovic, Finucane, Peters, & MacGregor, 2002). This framework takes affect, that is to say emotion, as the orienting mechanism for risk judgments instead of attitudes. Nevertheless, a similar principle applies. More specifically, they suggest that risk in the modern world is confronted in two ways. Risk as 'feeling' refers to the fast, intuitive way in which we react to dangers. Risk as 'analysis' describes logical, scientific and more cognitively demanding ways of making risk assessments. They refer to a kind of dual processing psychological model where 'experiential' thinking is holistic and 'encodes reality in concrete images, metaphors, and narratives'. Analytic thinking, by contrast, is 'reason oriented' and encodes reality in abstract symbols, words and numbers. They point to several studies that demonstrate that in some situations, people rely on affective or experiential cues to come to risk judgments. For example, Finucane et al designed an experiment in which information about risks and benefits of nuclear power were manipulated across four treatment groups (Finucane, Alhakami, Slovic, & Johnson, 2000). They showed that those people who were given information that made the benefits of nuclear power salient judged it to be less risky than those who were not given the information, and vice versa. Finucane et al conclude that people are drawing an inference about risk based on how much they 'like' nuclear power (that is to say, according to its putative benefit) rather than an analytic judgment. After all, there is no particular reason why perceptions of risks and benefits should be negatively correlated on any formally rational criteria. The extent to which affect is linked to risk judgments can vary from one person to the next according to the degree of involvement, length of deliberation and other factors. Interestingly, Eiser makes the very plausible suggestion that Slovic's 'affect heuristic' is really nothing more than a restatement of an associative theory of attitudes (Eiser, 2001). That it is not couched in the social psychological language of attitude theory is simply because this tends to be linked with the rationalistic EV model, even though it need not be.

Seen in a similar light, Earle and Cvetkovitch's SVS theory of trust, discussed earlier, looks like something similar. Trust is accorded to risk assessment and management authorities according to a quick, non-cognitive, appraisal of the extent to which they seem to share similar goals and values. Rather than a cognitively demanding analytic judgment, people simply decide whether or not, in essence, they like the institution or person responsible for managing the risk. And this evaluation derives from easily accessible, pre-existent associations or attractors. People's eventual evaluation of the risk will be, so the argument goes, strongly influenced by the degree to which this trust is forthcoming.

Similarly, cultural theory suggests that people focus on particular risks according to the relevance they have to their social group. Hence hierarchists will be concerned with social risks, crime and deviance, because these threaten what for them are important aspects of social structures. Egalitarians are more concerned, so the argument goes, with environmental risks according to the particular view of nature that they tend to hold. What this suggests is that people's existing beliefs, values and associations partially determine how they perceive risks. Cultural theory stripped of its grid-group typology, which has never really received much empirical support (a typology is usually more accurately described as extreme points on one or more continua in social psychological analysis), fits quite comfortably into some type of attitude theory framework.

It is not my intention to formally test this 'holistic' perspective on risk perception, were that even possible. However, I consider it to be the most promising perspective for risk research currently on offer. I aim to cast more light on it by assessing its usefulness as a framework for interpreting the results of the empirical studies that I present later in the thesis.

2.7 Concluding remarks

This chapter has provided an introduction to the concept of risk in modern societies and a review of the social scientific literature on what has come to be known as risk perception. I have shown that although the beginning of this research programme was concerned with explaining differences between lay and expert estimates of numerical probabilities, the focus quickly shifted to studying the psychological, or perceptual, dimensions of risks themselves. A further development took place when it became clear that other social and psychological factors linked to group memberships, cultural stereotypes and differing worldviews exert an influence on the way people perceive risks. More recently, the effect on risk perception of the extent and type of knowledge and information – scientific or otherwise – that people possess has once again become a contested issue. At the same time, the role of social trust, in governments, scientists and regulators responsible for managing technological risks, has come to be seen as crucial for the public acceptance of controversial technologies. Finally, I suggested that many, if not all, of these piecemeal approaches to risk perception conceal the wider picture. Reconsidering risk 'perception' as simply one component of people's attitudes to a technology as a whole may offer a more parsimonious and realistic framework for studying risk and society.

The focus of risk perception research has generally been on technologies that have the potential to create both societal risks and benefits, such as nuclear power. In order to address some of the interesting theoretical questions in relation to risk in this thesis, in particular those that relate to trust and the knowledge that publics possess, I focus on a similar case, and one that has recently courted controversy in Britain: gene technology. In the next chapter I provide a brief history of gene technology and its economic and social significance before presenting a review of recent empirical research on attitudes to gene technology in Britain with a particular focus on work that has investigated the role of trust and of knowledge in relation to people's attitudes and beliefs .

3 GENE TECHNOLOGY AND THE BRITISH PUBLIC

3.1 Introduction

In this chapter I briefly describe gene technology and its development since the discovery by Crick and Watson of the 'double helix' structure of DNA in the early 1950s. I then move on to a selective review of the literature on public perceptions of gene technology in the UK in which I focus on the types of questions that are relevant to the theoretical concerns of this thesis – risk perceptions, trust and knowledge. This is both to set a context for the empirical findings presented later in the thesis and to bring together the theoretical and substantive components of the research that have guided its subsequent design and analysis. My focus in this review is on UK-based empirical research as this thesis confines its empirical analysis to UK data sources. In adopting this focus, I have necessarily omitted a fair amount of empirical work in other European countries, especially Germany (e.g. Gorke & Ruhrmann, 2003; Hampel, Pfenning, & Peters, 2000), the US (Hallman, Hebden, Aquino, Cuite, & Lang, 2003; Jasanoff, 1995, 2001; Priest, 2001; Priest, 2001; Priest, Bonfadelli, & Rusanen, 2003) and Canada (e.g. Einsiedel, 2002; Krewski, Slovic, Bartlett, Flynn, & Mertz, 1995; Leiss & Chociolko, 1994; West, Gendron, Larue, & Lambert, 2002) The interested reader should refer to this work for views of the situation outside of the UK.

3.2 A strategic technology

> *Biotechnology is, perhaps, going to be, for the first half of the 21st century what information technology was to the last half of the 20th century…*
>
> (Blair, 2000)

This remark by British Prime Minister Tony Blair is indicative of the widespread belief that gene technology (also referred to as biotechnology or life sciences) is the third 'strategic technology' of the post-war period (Gaskell, Durant, & Bauer, 1998). Like the first strategic technology of the period, nuclear power, its arrival was, and continues to be, mired in public controversy. In Britain especially, the pitch of political debate accompanying developments in agri-food gene technologies as well as, to a lesser extent, biomedical innovations, has risen sharply during the past five years. The controversy in the US over nuclear power during the 1970s was instrumental in the development of the psychometric approach to risk perception, not least because a great deal of public money was spent in trying to find out why people were so concerned about the supposedly remote dangers. In Britain today, a somewhat analogous situation pertains with respect to gene technology, and in particular genetically modified food and crops. There are significant resources being channelled into social scientific research into understanding public perceptions of GM food and crops as well as a recent official public consultation exercise the scope of which had not seen before in Britain (Agriculture and Environment Biotechnology Commission, 2003). These, it seems, are ideal conditions which afford the opportunity to study the public's perception of risks from a new technology as it emerges into the public consciousness.

Looking back at the development of gene technology, it has, from its inception, offered enormous potential benefits: new therapies to cure diseases, new strains of pest-resistant crops to alleviate third world hunger and new technologies for environmental remediation. But by the 1970s, soon after important breakthroughs were made, genetic scientists themselves were counselling caution. Crick and Watson's Nobel Prize-winning discovery of the double helix structure of DNA took place at Cambridge in 1953 but it wasn't until 1973 that what became known as recombinant DNA technology (rDNA) was successfully realised. For the first time it was now possible for the genetic material from one organism to be combined with another, paving the way for the kinds of developments seen today in many different fields of application.

A group of genetic scientists called for a moratorium on rDNA experimentation soon after the first successful experiment had been announced, fearing that research guidelines were not sufficient to prevent possible environmental damage by escaping recombinant micro-organisms. This proposal was heatedly discussed at the Asilomar conference in February 1975, which was widely covered in the press and on television in the US. This had the effect of creating a controversial social issue out of a scientific or technological one and also meant that, for the first time, the state became actively involved (Liakopoulos, 2000).

Following the establishment, in 1976, of the Recombinant DNA Advisory Committee, the moratorium on rDNA research was lifted and the technology developed apace as it became clear what the economic benefits might be. The UK and Europe too have, since the late 1980s, sought to catch up with the US in realising the economic potential of biotechnological processes in pharmaceuticals, agri-food and a host of other areas, identifying gene technology as crucial to a competitive industrial and economic strategy for the 21st century. However, in the early 1980s, while gene technology was not seen by industrialists and scientists as 'one thing', but simply a collection of techniques to be adapted to the needs of existing industrial sectors, there were signs that public perceptions were developing in a quite different direction.

3.3 Public perception of gene technology

Gene technology, in the shape of genetically modified food and crops, has been particularly newsworthy over the past few years. Following the explosion of media coverage on GM food and its possible risks in February 1999, controversy has simmered on. This led ultimately to the British Government implementing a major public consultation exercise, GM Nation?, in 2003 (Agriculture and Environment Biotechnology Commission, 2003). The results of this rather bold experiment in public participation have been the subject of some controversy since their release in early 2004, mainly on account of the over-interpretation of the negative views of unrepresentative samples of the public that took part in what was intended as a deliberative exercise rather than a scientific survey (Horlick-Jones, Walls *et al.*, 2004). Whatever the methodological shortcomings of the exercise, the episode serves to illustrate the contentious nature of agri-biotechnology in contemporary Britain.

One should not, however, make the mistake of thinking that public disquiet about gene technology is a new phenomenon. In a review of European Community biotechnology policy, Cantley (1992 p.21) suggests that during the late 1980s

> *[leaders of European industry] failed to address an intangible but important reality: that public and political opinion was learning to see gene technology, genetic engineering, biotechnology and so on as a single vague and disquieting phenomenon.*

In fact, a survey carried out as far back as 1979 indicated that over one third of Britons thought that 'genetic research' and 'the development of research on synthetic food' were both an 'unacceptable risk' (Cantley, 1992). At around the same time, in the US, Slovic and colleagues, working within the nascent 'psychometric paradigm', found that 'DNA research' was a highly 'dreaded' and 'unknown' risk (Slovic, Lichtenstein, & Fischoff, 1980). There had been a series of surveys on the public's opinion about science and scientists carried out in the US, beginning in 1958 (Withey, 1959) and regularly from 1979 onwards (National Science Board, 2002). In Europe, the first major survey on public attitudes to science was carried out in 1988 as part of the Eurobarometer series (Durant, Evans, & Thomas, 1989). However, there was little or no attention paid to gene technology in particular in these surveys.

The first major survey in the UK that did focus on attitudes towards gene technology was the 1991 Eurobarometer on Biotechnology (INRA, 1991). This was followed by similar surveys in 1993, 1996, 1999 and 2002 (Gaskell, Allum, & Stares, 2003; INRA, 1993, 1997, 2000). There was also another Eurobarometer survey, fielded in 2001, that examined general attitudes to science and technology but also included a section on attitudes to genetically modified food and crops (European Commission, 2001).

Alongside the major governmental surveys there have been a number of smaller scale quantitative, social psychological, studies of gene technology (mainly in the agri-food area) and risk perception in the UK from the mid-1990s onwards. Most of these were carried out by Shepherd, Frewer and colleagues in various combinations (Frewer, 1997; Frewer, Howard, & Shepherd, 1998; Frewer & Shepherd, 1994, 1995; Frewer, Shepherd, & Sparks, 1994; Frewer, Howard, Hedderley, & Shepherd, 1996; Frewer, Howard, & Shepherd, 1997; Sparks, Shepherd, & Frewer, 1994). In addition to these quantitative studies, a smaller number of qualitative studies of people's attitudes and beliefs about various aspects of gene technology have recently appeared. These include those by Grove White et al (Grove-White, Macnaghten, Mayer, & Wynne, 1997), Marris et al (Marris, Wynne, Simmons, & Weldon, 2001) and Shaw (Shaw, 2002). All of these studies used focus groups. Very recently, the Food Standards Agency (FSA) has also commissioned focus group research on attitudes to GM food and labelling as part of its public consultative function (Food Standards Agency (UK), 2003). In the next part of this chapter I review first some of this quantitative research on public perceptions of gene technology in Britain. After that I consider some of the relevant findings from recent qualitative studies.

3.3.1 Quantitative research

In 1991, the Eurobarometer survey on biotechnology asked people about whether or not research into six applications of biotechnology or genetic engineering[1] was worthwhile, was risky and whether it needed to be controlled by government (Marlier, 1992). The biotechnological applications included treatments for cancer, changing an organism's characteristics, creating new organisms by combining hereditary information from other organisms, food

[1] A split ballot design was used with one half of the sample being asked about biotechnology, the other about genetic engineering. In general, genetic engineering had a more negative connotation than biotechnology.

processing and modifying human cells to treat hereditary diseases. The phrases that are in use today – 'GM food', 'genetic modification', 'DNA' - were not used. Medical applications were widely viewed as worthwhile and a small majority in the UK thought the same about GM food. All the applications were viewed as somewhat risky, with GM food and modification of farm animals seen as most risky. Whilst there was variation in the extent to which people considered different applications to be risky and worthwhile, there was essentially no difference between the applications as far as the perceived need for control and regulation. A large majority thought that all forms of genetic research should be controlled by government. Notable is the fact that perceptions of 'worthwhileness' and riskiness were negatively correlated. The more worthwhile an application was believed to be, the less risky it was thought to be. This corresponds to the general finding in risk perception research that perceptions of risk and benefit tend to be inversely related (Slovic, Finucane, Peters, & MacGregor, 2002).

The survey also included questions to tap factual knowledge of gene technology where people were first asked which of the seven topics under consideration (mentioned above) actually concerned biotechnology. There was also a subjective knowledge indicator ('how capable of answering the questions I asked you about biotechnology/genetic engineering?'). These two correlated positively at the European level. Marlier does not report the country level correlations but it is reasonable to assume a similar pattern in the UK. A global measure of risk perception across all applications, at the European level, was associated only slightly with objective knowledge, where more knowledge tended to be associated with slightly higher perception of risk. The same measure of knowledge was correlated positively with a global measure of 'worthwhileness'. The weakness of this approach was that it only considered the bivariate relationship between knowledge and risk perception without controlling for other background variables.

Trust in various sources information was measured by asking people 'which of the following sources of information have you confidence in to tell you the truth about biotechnology/genetic engineering?'. The most trusted in the UK (and across Europe) were consumer organisations, environmental groups and schools or universities. All three of these were selected by around 20% of respondents. This question has been asked in one form or another in all the succeeding Eurobarometers on biotechnology with approximately the same result on each occasion (Gaskell, Allum, & Stares, 2003). It appears that trust is accorded mostly to those groups perceived as having a critical or independent role in relation to biotechnology.

In 1993 another Eurobarometer survey was fielded. Many of the questions were the same as those asked in 1991 and, in general, the results were extremely similar in the UK as they were two years previously (INRA, 1993). GM food remained near the bottom of the list of 'worthwhile' applications. It also remained, along with modifying farm animals, the application for which most risks were perceived. The perceived need for government control of all of the applications remained at a similar high level to that observed in 1991.

In the 1993 survey a new battery of 'objective' knowledge questions, tapping people's knowledge about biology and genetics, was introduced. This represents a convergence with the format used in public understanding of science surveys (Durant, Evans, & Thomas, 1989). Twelve quiz type statements were presented to respondents who were invited to say if they thought each of them were true, false or that they didn't know. Examples of these items include 'yeast for brewing beer consists of living organisms' and 'the cloning of living things produces exactly identical offspring'. In the UK, the mean number of correct responses out of the twelve possible was just under seven. This index correlated positively with the other measure of objective knowledge (mentioned above in relation to the 1991 survey) and with a subjective measure that asked the respondent to say how complex or simple he or she thought the topics were that were discussed in the survey. From this point on, each Eurobarometer on biotechnology has used the quiz format for tapping respondent knowledge. In fact, knowledge levels have remained rather stable in the UK between 1993 and 2002 on this measure (Gaskell, Allum, & Stares, 2003).

New questions about the various applications of biotechnology were introduced into the 1996 Eurobarometer. On the whole the same picture emerges. Agri-food products of gene technology are seen as more risky and less useful than medical applications. Notwithstanding the perception of these risks, 40% thought that 'we have to accept some degree of risk from biotechnology if it enhances economic competitiveness in Europe'.

In 1996, the Government was still not trusted to tell the truth about gene technology but less than one third wanted industry to be mainly responsible for regulation. This typifies the impression from the research that while the government is not trusted much in Britain, it is still seen as the legitimate regulatory authority.

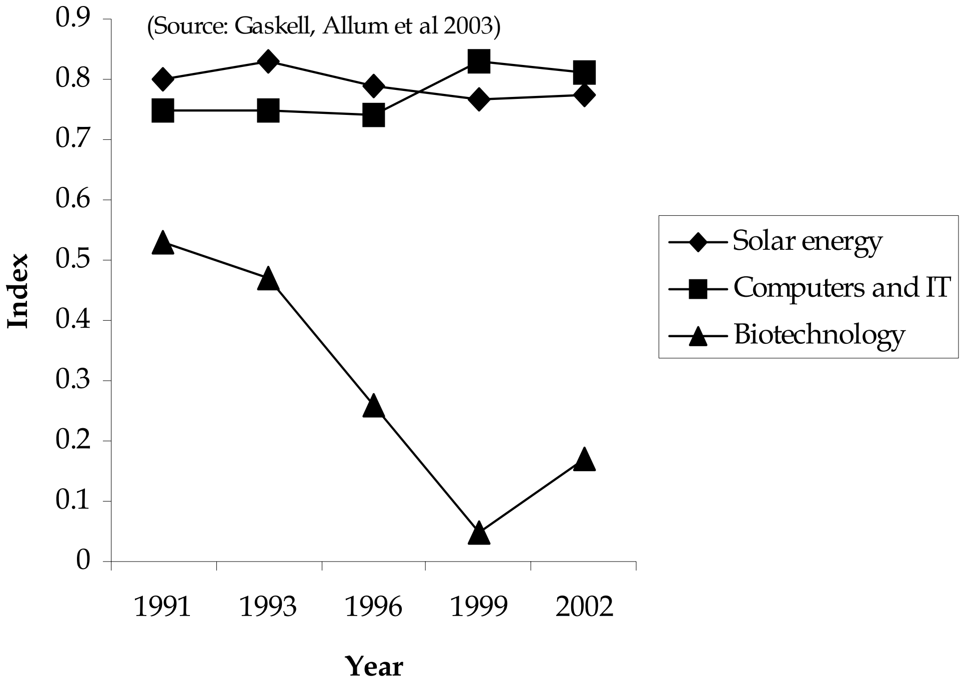
For the first time, an open ended question was asked near the beginning of the survey: 'what comes to mind when you think of modern biotechnology (or genetic engineering)?'. I have reported elsewhere on some results from this question (Allum, 1998). Seven dominant themes, derived by word co-occurrence analysis (see Kronberger & Wagner, 2000 for an explanation of this method) were apparent in people's responses. As well as positive connotations about curing diseases and developing more effective reproductive technologies, there was a strong current of rather unspecific worries about gene technology as well as specific concerns about GM food. There was also a significant proportion of respondents for whom nothing came to mind at all. This underlines a recurrent feature of research into gene technology. Many people do not appear to hold very strong or well-formed opinions on it. In all the Eurobarometer surveys on biotechnology, there are many more 'don't know' responses to closed ended attitudinal questions about gene technology than would be expected for a topic in which people were actively engaged (Gaskell, Allum *et al.*, 2001). In 1996, only 64% of respondents said they had 'ever talked about biotechnology before', which is further evidence of the relatively low salience of gene technology.

In the 1999 survey, many questions were retained from previous surveys with the addition of some new ones (Gaskell, Bauer, Allum, Lindsey, & Durant, 2001; INRA, 2000). A set of items that were designed to tap Slovic's 'dread risk' characteristic in relation to GM food were included for the first time. Responses to these showed that even people who were supporters of GM food were quite likely to agree that genetic modification of food and crops 'threatens the natural order', that they 'dread the idea of GM food' and that 'if anything went wrong with GM food it would be a worldwide catastrophe'. The vast majority of opponents of GM food and crops, not surprisingly, agreed with these statements. There were further declines in support for GM food but no real change for medical applications, compared to 1996.

Trust was measured in a different way in this survey. People were asked whether or not they thought various actors - the government, industry, farmers, environmental groups, medical doctors, newspapers and others - were 'doing a good job for society' in relation to biotechnology. Surprisingly, all the actors except industry were thought to be doing a good job in relation to biotechnology by at least 50% of respondents, in many cases a far greater proportion than that. An interpretation of this is that while people do not expect the Government or media, for instance, to tell the truth about gene technology, this does not mean that they are not fulfilling a useful and legitimate role.

The final survey in the Eurobarometer series was fielded in 2002 (Gaskell, Allum, & Stares, 2003). Many time series questions were retained. Interestingly, results from these showed that support for GM food and crops levelled off in the UK, after falling since the beginning of the 1990s.

Figure 3.1 Optimism about biotechnology/genetic engineering 1991 - 2002



Another question, asked in 2002 and in all previous surveys, concerned people's optimism (whether or not they thought that biotechnology/genetic engineering would 'make our lives better over the next twenty years') about gene technology. Figure 3.1 shows the long term trend in an index derived from answers to this question compared to the same question in respect of 'computers and information technology' and 'solar energy' (Gaskell, Allum *et al.*, 2003). This shows very clearly the volatility of public opinion about gene technology compared to the stability of attitudes to other new technologies. It also shows the recent interruption in the trend of opinion about gene technology over the past ten years, with the most recent survey, in 2002, showing a small rise in optimism after nearly a decade of decline.

Alongside the small increase in optimism in 2002, there were accompanying increases in the belief that the Government and industry are 'doing a good job' in relation to gene technology. All of these indicators point to the period between 1999 and 2002 as being a 'watershed' in the evolution of public opinion, in the sense that a long secular decline in the public's favourability towards gene technology, at least in the agri-food area, may have ended. This coincided with the highly charged period in early 1999 when the 'great GM debate' took place in the UK press and, for the first time, became a party political issue at Westminster (see Durant & Lindsey, 1999 for a detailed decription of these events).

As a final note on the Eurobarometer on biotechnology survey series, it must be borne in mind that whilst public opinion on gene technology has been labile during the past decade, this by no means implies that it has been a topic of great importance or salience amongst the public at large. In each of the three surveys since 1996, respondents were asked whether or not they had ever talked about biotechnology before the interview took place. The percentages of people who said that they had *never* spoken about gene technology before were, in 1996, 1999 and 2002 respectively, 52%, 59% and 64% (Gaskell, Allum *et al.*, 2003). Whilst the exact estimates of these proportions are no doubt subject to some recall error, the trend shows that gene technology is probably not one of the more salient issues for the majority of the British public and, if anything, is becoming less so as time passes.

One other recent Eurobarometer survey included questions about Europeans' attitudes towards GM food. In 2001, the Eurobarometer survey 55.2 (Science, Technology and Europeans) found that 44% of the British public thought that 'the dangers have been exaggerated by the media' , 15% that 'there is no particular danger from this kind of food' and 54% that 'it may have negative effects on the environment'. 'Don't know' responses were quite high for all three questions - at 24%, 39% and 31% respectively (European Commission, 2001). These results contribute to a picture of concern mixed with ambivalence, judging by the number of 'don't know' responses. That nearly half of the public thinks that the media exaggerate the dangers from GMOs is interesting and counterbalances the often heard complaint from the science community that the public overestimates scientific and technological risks because of media scare stories.

In 1999 the Government's Office of Science and Technology commissioned a survey on public attitudes to the biosciences (Office of Science and Technology and the Wellcome Trust, 2001). Results concurred with the Eurobarometer research that showed the public largely in favour of advances in medical science through genetics but more sceptical about GM foods and animal cloning. The survey also underlined the public's desire for strong regulation in the biosciences although, in common with other findings on trust, the Government is not seen to be as trustworthy as doctors, expert advisory committees, scientists and environmental groups. Interestingly, in this survey, spontaneous answers were requested before closed-ended questions. Environmental groups, widely trusted to take decisions about gene technology according to most other research, were only mentioned by 2% of respondents spontaneously. This is in contrast to the 33% that subsequently chose when offered a list. Perhaps this is because these groups, such as Greenpeace, are not thought to be involved in decision making at the moment, although the public would like them to be.

The most recent major scientific survey of the British public's attitudes to gene technology was carried out by Poortinga and Pidgeon (Poortinga & Pidgeon, 2003). This was an interesting study as it compared perceptions of GM food and crops with four other risk cases, namely climate change, radiation from mobile phones, radioactive waste and genetic testing. It also placed these risk cases in context with a number of other personal and social concerns such as health and family concerns, world poverty and human rights. All five of Poortinga and Pidgeon's risk cases were rated as less important than all of the personal and social concerns. GM food was very close to the bottom of the list of concerns. Of the five risk cases surveyed, GM food was amongst the most positively evaluated, although a substantial minority thought that GM food is 'a bad thing'. The most common response was that GM food is 'neither good nor bad'. People appeared to be less concerned with GM food risks than with most of the other risk cases, although a majority still felt that the risks outweighed the benefits.

Poortinga and Pidgeon report that the most trusted groups in relation to GM food are doctors, consumer organisations, environmental organisations and friends and family. This largely corresponds to the Eurobarometer findings on trust. People were also asked to evaluate the Government's policies on the five risk cases. Poortinga and Pidgeon (reported in more detail in Poortinga & Pidgeon, *2003*) use questionnaire items designed to tap the dimensions of 'competence and care' suggested by Johnson (1999). However, in an exploratory factor analysis, they do not find that these dimensions are independent but rather that two dimensions, 'general trust' and 'scepticism' account for most of the variation in people's responses. Interestingly, the results for all five risk cases are very similar. The implication is that people evaluated government policy as a whole, and did not differentiate between policy issues in relation to the different risk cases. As for the actual level of trust and favourability towards the government, general trust was quite low and scepticism high. Little confidence was expressed by respondents about the rules and regulations governing GM food (and all other risk cases except genetic testing). Finally, Poortinga and Pidgeon found that scientists were not evaluated differently across the five risk cases, but instead were evaluated more with reference to the type of organisation they work for. Scientists working for universities, government and industry were, respectively, the most to least trusted.

On the whole, the Poortinga and Pidgeon study adds a great deal to the picture built up by the Eurobarometer survey series, chiefly by putting GM food and genetic testing into context alongside other scientific risk issues and more personal and social concerns. Gene technology, although of passing interest to many British people, is not a 'hot issue', but nevertheless one that elicits concerns that go beyond science and technology issues and towards more general issues of governance, trust and accountability.

In addition to the large scale survey research described so far, several, generally smaller scale, sometimes experimental, quantitative studies were carried out in the early to mid 1990s in Britain that explored some particular theoretical issues in relation to risk perception, trust and familiarity with gene technology.

Looking at knowledgeability and involvement with gene technology, Martin and Tait (1992), in a survey of several distinct social groups with varying involvement, found that the most involved groups (e.g. members of Friends of the Earth, biotechnology research scientists) had more stable and resistant attitudes compared to members of the lay public. Martin and Tate also found that the two groups most knowledgeable about gene technology were at the opposite ends of the spectrum of positive and negative attitudes about the technology. They conclude that correlating knowledge and attitudes would give uninterpretable results unless group memberships or social milieux are taken into account. Sparks, Shepherd and Frewer (1994), using a mail survey found that perceptions of risks and benefits were predictors of overall attitudes to genetically modifying food in order to make it less fatty, to confer resistance to diseases and various other aims. Most people surveyed thought that GM food has few benefits and carries considerable risks. However, most people were quite unfamiliar with gene technology, echoing Martin and Tait's earlier results.

Much of the research arising from the Eurobarometer surveys suggests that medical gene technologies are seen as more beneficial and less risky than agri-food applications. Frewer and Shepherd tested this proposition in an experimental survey study (Frewer & Shepherd, 1995). They found, as expected, that agri-food applications were perceived to be more risky and less beneficial than medical applications. The demand for regulation was found to be linked with the degree of risks perceived. Frewer and Shepherd also suggest that gene technologies are evaluated according to the nature of the application, not as gene technology *per se*. Frewer, Howard and Shepherd (1997) report similar findings from another study that involved a qualitative pre-test phase and a quantitative survey using 'repertory grid' techniques. Once again, attitudes to a range of applications were strongly influenced by perceptions of risk and benefit, and varied according to the nature of the application (e.g. whether human or plant DNA was transferred). They found that general attitudes were not predictors of specific attitudes for most people. This finding is only partially consistent with other recent survey studies based on Eurobarometer data (e.g. Gaskell, Allum, & Stares, 2003; Gaskell, Allum *et al.*, 2001; e.g. Midden, Boy *et al.*, 2002). These latter studies indicate that although mean levels of support and opposition to gene technology vary with the application in question, attitudes to all applications tend to be moderately or strongly correlated with each other. This would tend to suggest that they are all evaluated with reference to an underlying attitude towards gene technology as a whole.

Several studies looking specifically at trust and information were carried out by Frewer and colleagues. Frewer and Shepherd (1994) conducted an experimental study that varied the attribution of source of an information pamphlet about GM food across five conditions. They found that the provision of information actually increased the perception of risk and that knowing the source of information as against anonymous sources was linked to higher perceived informational quality. Frewer and Shepherd conclude that although trust in sources of information may be associated in some instances with lower risk perceptions (e.g. government, regulatory bodies, scientists), people's reaction to being given information may serve to increase risk perception, and so work in the opposite direction to that expected. In another study, Frewer, Howard, Hedderley and Shepherd (1996) found that sources that are trusted are also seen as knowledgeable, and distrust is associated with inaccuracy of information. They also found indications that trust tends to be placed in sources that are accountable. A further study on trust in information sources, using experimental methods, investigated the effect of prior attitudes and of admissions of uncertainty on the effects of persuasive communications about GM food risks (Frewer, Howard, & Shepherd, 1998). Sources of information that admitted to some uncertainty were seen as more trustworthy than those that claimed certainty over risk estimates. Prior attitudes to GM food were strong predictors of post-message attitudes but also of the perceived credibility of the source and of the quality of the information presented. This suggests that people's existing orientations towards the technology may act as moderators of the effect of communications from risk managers, scientists and the like and it cannot be assumed that the provision of accurate information will have a consistent effect across all members of the public.

The main findings from quantitative research on attitudes and perceptions of risk in relation to gene technology in Britain seem to suggest that the favour or disfavour with which people view applications of the technology are strongly linked to the potential benefits of each one. Over the past ten years, attitudes towards agri-food gene technologies have been becoming less favourable, while medical gene technologies have remained relatively well regarded. GM food is seen as more risky, while gene therapy, seen to carry great potential for benefits tend, to be seen as relatively safe. Although people clearly differentiate between different uses to which gene technology can be put, there is also evidence that those people who have more positive attitudes towards any particular application will tend to be more positive about others too. This suggests that people to some extent make a holistic judgment about gene technology *in toto*. This resonates with recent developments in risk research that see affect, worldviews and values as important organising frames out of which particular risk perceptions emerge.

People's evaluation of the trustworthiness of gene technology actors - scientists, regulators, government and industry – is consistently found to be linked with risk attitudes. The more trusted are those responsible for gene technology developments, the lower are people's perceptions of risk. Frewer *et al*'s work on trust also shows that prior attitudes are important moderators of the effect of risk communications. Poortinga and Pidgeon's work adds credence to this notion that people's overarching values and systems of beliefs are the mechanisms through which trust judgments are made. They show that the evaluation of Government trustworthiness, across a number of dimensions, hardly differs between widely varying risk cases. This suggests that public controversy over gene technology where it exists might not necessarily be due to its unique scientific character but as an expression of generally held values and beliefs relevant to a whole range of political issues.

Balanced against these findings must be the acknowledgment that gene technology is not a salient issue for most members of the British public. Nearly all the studies reviewed here allude to the lack of familiarity and knowledge about gene technology. If one concludes that, for most people, gene technology is not, even in 2002, something about which many people have elaborated views, it would not be surprising if, when asked questions about it in a survey, people attempt to situate it with more general beliefs and values and respond according to those.

3.3.2 Qualitative research

There have been a number of studies in recent years that have used qualitative methods to explore the public's attitudes and beliefs about gene technology. Just as within the area of public understanding of science more generally there has been something of a bifurcation between survey research and research based on qualitative methods of inquiry, so the same division is visible in relation to social scientific research on gene technology. It would probably be true to say of both fields that researchers working with qualitative methods like focus groups and in-depth interviews tend to be more explicit in drawing normative implications from their work. This is partly, one suspects, because the dynamics of a focus group interview are quite close to the kind of deliberative democratic consultation that is often called for on the basis of the results. In this paradigm, quantitative survey research is often implicitly or explicitly criticised for being at best procrustean and at worst misleading and inaccurate and for often casting the public as foolish and irrational (see Wynne, 2001 for a comprehensive statement of this position). However, on closer inspection of findings from quantitative surveys and experiments and from qualitative or ethnographic approaches, a picture emerges that is quite consistent in most respects.

In the most comprehensive qualitative investigation so far on perceptions of gene technology, Marris *et al* have presented the findings from their study, Public Perceptions of Agricultural Biotechnology in Europe (PABE) in terms of typical 'myths' about public perceptions of GMOs. These myths are, according to Marris *et al*, often promulgated by policymakers but are unsubstantiated by the PABE focus group research (Marris, 2001; Marris, Wynne, Simmons, & Weldon, 2001). I now briefly consider of some of these myths along with empirical evidence, not only from the PABE research but from other qualitative research and the quantitative research reviewed earlier, as a useful way to bring together the findings from several qualitative studies of public perceptions of gene technology. It will also be possible to see where the quantitative research reviewed thus far is consistent or inconsistent with accounts drawn from the qualitative work.

The first myth that Marris *et al* consider is that "the primordial cause of the problem is that lay people are ignorant about scientific facts". This position is often the one implicitly adopted by scientists and policymakers. It corresponds to what has been referred to in the previous chapter as the 'deficit model' of public understanding of science. As such, it is also associated with the social scientific knowledge deficit models of, for example, Durant and Miller (Durant, Evans, & Thomas, 1989; Miller, 1998). Marris *et al* perhaps overstate this myth, at least in respect of social scientific work that adopts a knowledge deficit model, by characterising ignorance as 'the primordial cause' when usually it is seen as simply one of several factors affecting attitudes to science and technology (Sturgis & Allum, 2004).

The findings from the PABE focus groups apparently show little support for this myth. Marris *et al* claim that although people do mobilise empirical knowledge in support of their arguments about GMOs, it is not of the kind that is 'assumed to be relevant by scientists and promoters of GMOs' (Marris, Wynne, Simmons, & Weldon, 2001 p.5). They observe three different types of knowledge – non-specialist knowledge (e.g. 'bees fly from field to field'), knowledge about human fallibility (rules and regulations are not, in the real world fully applied as they should be) and knowledge about the past behaviour of institutions responsible for the regulation of risk. All of these knowledge domains are used in people's deliberations about GMOs. Grove-White et al (under the ESRC Global Environmental Change Programme) found that characterising public concerns as being based on scientific ignorance is misleading because while people may not know the scientific detail, they have a 'sharp awareness of the broad issues involved' (ESRC Global Environmental Change Programme, 1999). Grove-White et al also suggest that focussing on the public's lack of scientific knowledge ignores the central role of trust in the formation of attitudes. In another recent study it is suggested that more knowledge leads to more scepticism about GMOs. Shaw found that most participants in her focus group study had little detailed knowledge of gene technology but that those that did were drawn from a local organic food group and vegetarian society. These people tended to be more critical of GM food and drew on quite detailed scientific information to support their arguments (Shaw, 2002 p.277-8).

These results can be compared to quantitative research, which has suggested a variety of effects of scientific knowledge on attitudes to gene technology. Gaskell et al have found positive correlations between textbook knowledge of biology and genetics and attitudes towards a number of different medical and agri-food applications (Gaskell, Allum, & Stares, 2003; Gaskell, Allum *et al.*, 2001). In the USA, Priest has found the same relationship (Priest, 2001). A similar finding, but at the level of European regions, is reported elsewhere by Allum, Boy and Bauer (2002). By contrast, as discussed earlier, Martin and Tait find greater polarisation in attitudes with higher knowledge while Frewer and Shepherd found the provision of more information to the public increased perception of risk in one case (Frewer & Shepherd, 1994) and had no effect in another (Frewer, Shepherd, & Sparks, 1994).

Most quantitative studies, then, show some link between risk perception, attitudes and knowledge, although the nature of the relationship varies between studies. The qualitative studies by and large indicate there is a relationship but that the forms of relevant knowledge are different to the scientific knowledge assumed to be important by policymakers and scientists. However, a problem with Marris et al's 'non-specialist' knowledge is that it could equally well be interpreted as simply inaccurate or crude scientific knowledge, invalidating their claim that the latter type of knowledge is not relevant to the way people form judgments about GMOs. Knowledge about the past behaviour of institutions in managing risks is seen as the most important knowledge domain but one that is hard to separate from the general issue of trust in scientific and regulatory institutions in most of the literature to date. In sum, the questions surrounding knowledge, risk perception and attitudes to gene technology have not yet been fully answered, with a gamut of different studies and methodological approaches generating mixed results.

"The public is 'irrational and unscientific'" is another myth that follows directly from the previous one about the public's putative ignorance of scientific facts. According to the myth's adherents, there are 'facts on one side of the debate and emotions on the other. Rational facts are founded on scientific evidence and demonstrate…that GMOs are safe. Thus people that oppose GMOs are irrational' (Marris, 2001 p.546). The PABE findings, according to the authors, suggest that although most people are indeed quite ignorant of the scientific details, the principal concerns that they express are not based on erroneous scientific information but are linked instead to issues of trust, accountability and choice. This means that 'even if we could wave a magic wand and create a world tomorrow where all citizens knew that all tomatoes contain genes[2]…the controversy would be unlikely to abate' (Marris, 2001 p.546). This corresponds to Grove-White et al's suggestion that focussing on whether or not the public is ignorant of the science is to miss the point – it is matters of trust that are the important drivers of controversy over biotechnology. Shaw also emphasises the role of trust and suggests that while knowledge is also important, highlights that 'lay expertise' within parts of the public is an important factor in the way people arrive at their judgments about GMOs.

The question of the public's 'rationality' in relation to gene technology is a vexed question. Findings from the qualitative research reported here tend to recast the public as rational in terms of an alternative set of beliefs and knowledges that have traditionally been seen as irrelevant according to the narrow remit of 'sound science'. This knowledge predominantly concerns the behavioural record of institutions in relation to crises such as that surrounding BSE and the fallibility of expertise. The problem in this type of interpretative framework is that 'rationality' is not really defined, much less operationalised in the research. This leads to analytic anomalies. For instance, Marris claims that many people use their knowledge about past institutional behaviour to 'rationally' form (mainly critical) views about the development of GMOs. The implicit assumption here is that there must be a real danger of harm from GMOs, otherwise mismanagement would not in any case lead to any negative consequences. However, in spite of a broad scientific consensus that GM food carries no special health risks (Food Standards Agency (UK), 2003), the failure of some of the public to take this type of information into account is not cited as evidence of 'irrationality' but is at best under-emphasised and at worst ignored. Indeed, the denial that the public's opinions are, or could be, irrational or emotional in relation to risks from gene technology is often presented as an assumption, not a hypothesis. For instance, Shaw prefaces her analysis by

[2] A reference to oft-cited Eurobarometer surveys that suggest that around 70% of the UK population think that 'ordinary tomatoes do not contain genes, whereas genetically modified ones do.

indicating that a core strand of her analytic framework 'is to move away from a "deficit model" of public understanding…to focus on the diverse, intuitive knowledge about science as applied to food among different publics' (Shaw, 2002 p.275). This is a perfectly reasonable strategy, but, alas, one that does not provide much leverage on the question of how people with varying degrees of scientific understanding use that particular kind of knowledge in forming judgments about gene technology compared to other relevant factors such as trust, political values, emotions and so forth.

The next myth that Marris et al aim to debunk is that "the public is 'for' or 'against' GMOs". They find that overall, most people interviewed were rather ambivalent about GM food, seeing both positive and negative attributes and discriminating between different types of GMOs (Marris, 2001). In fact there is broad agreement between these findings and nearly all other studies of gene technology reviewed here. The qualitative studies of Shaw and Grove-White et al produce similar findings. The recent focus group study commissioned by the Food Standards Agency also came to a similar conclusion – that ambivalence and suspended judgments are the most common starting points in discussions (Food Standards Agency (UK), 2003). In the quantitative literature too, there is general agreement that ambivalence is a striking feature of the public's views about gene technology, with low prior awareness and many 'don't know' responses in surveys (e.g. Gaskell et al's article in *Nature* in 1997 was entitled 'Europe ambivalent on biotechnology') . Added to evidence about ambivalence is the insight from Poortinga and Pidgeon's study of five risk cases that shows that GM foods are some way down the list of risk issues and, *a fortiori*, societal concerns that people in Britain have (Poortinga & Pidgeon, 2003). The latter finding is also supported by the FSA study, in which focus group participants hardly ever spontaneously mentioned genetic modification in relation to their general interests and concerns about food. Whilst the notion that people are either 'for or against GMOs' may possibly be a myth that has some credence within policy, industry and natural scientific circles, practically all the social scientific research - quantitative and qualitative alike - demonstrates that it is a false assumption.

The final myth relevant to present concerns is that “the public demands zero risk”. If we had applied a ‘zero risk’ policy in the past, so the argument goes, we would not have developed technologies like the motor car or electricity. Marris et al find that far from demanding that the development of GM food and crops should only go ahead if there are proved to be no risks attached, the public is very well aware of the risk and uncertainty inherent in all human activity, including science. The scepticism of the public is directed towards expert statements that asserted zero risk. These are thought to be untrustworthy. People feel that inherent uncertainties should be acknowledged by expert institutions and taken into account in decision making (Marris, Wynne, Simmons, & Weldon, 2001 p.6). Shaw’s findings do not contradict those of Marris et al but provide an indication that although people acknowledge uncertainty, many of them think that the focus of GM scientists and regulators is too much on the short-term and that there is not yet enough evidence against long term harm from GMOs. BSE is the typical example that comes to participants’ minds of a food production technology that had unanticipated long term harmful effects (Shaw, 2002 p.279). The implication here is that even if scientists acknowledge this uncertainty, moving ahead with the commercialisation of GM crops and food may still be unacceptable to many people at present.

The findings from quantitative research also tend to indicate that the public does not, in fact, require zero risk in order to be convinced that an application of gene technology is worthwhile. Practically all work on risk perception concerning gene technology, or anything else for that matter, shows that perceptions of risks and benefits are negatively correlated. However, although it seems clear that those people who are favourable towards gene technology, or think it is useful, will also tend to see it as less of a risk, there are many people who perceive risks but nevertheless retain a positive attitude towards applications of gene technology. Gaskell et al refer to these people as 'risk-tolerant supporters' of biotechnology (Gaskell, Allum *et al.*, 2000; Gaskell, Allum, & Stares, 2003; Gaskell, Allum *et al.*, 2001). A similar concept is found in more recent work by some of these authors. In the Eurobarometer surveys, there is a sizeable group that perceive both some risk and some benefit in relation to GM food and crops. Gaskell et al refer to them as the 'trade-off' group, in contrast to those that are 'relaxed' – seeing benefit and no risk, and the 'sceptics' who see no risk and no benefit (Gaskell, Allum *et al.*, 2004; Gaskell, Allum *et al.*, 2003). However, just as Shaw's work shows that there are probably a range of thresholds of what constitutes acceptable risk in any given context, there is evidence of this from a recent cross-national study (Gaskell, Einsiedel *et al.*, 2001). In this study of differences in risk attitudes between Europe, America and Canada in relation to biotechnology, they showed that whatever the level of risk perceived by Americans, the level of risk they felt was acceptable while still judging applications of biotechnology worthy of encouraging was greater than it was for Europeans. Hence it seems likely that people within different cultural and social milieux will vary in what for them constitutes 'acceptable risk'.

3.4 Concluding remarks

Comparing recent qualitative and quantitative research on gene technology in Britain produces, perhaps surprisingly, a quite consistent picture of public opinion. In both research paradigms, the public is revealed as rather ambivalent towards GM food and crops, prepared to see both risks and benefits. There is clear concern in the case of agri-food gene technology over potential long term health and environmental risks and, from the quantitative time series data, it looks as if these concerns have been on the increase during the 1990s. People do not seem to require zero risk as a precondition of their being favourable towards applications of gene technology and although there is some variation in findings, it appears that people are aware of the inherent uncertainty that accompanies scientific and technological innovation.

Some quantitative research shows that, along with ambivalence towards gene technology, there is a lack of awareness and involvement in the issue. The recent study by Poortinga and Pidgeon makes this clear, as does the time series data on awareness and engagement with gene technology provided by the Eurobarometer surveys. Perhaps linked to this lack of engagement are the inconclusive results that suggest that although people do differentiate between different uses and applications of gene technology, there is evidence of a superordinate orientation towards the technology as a whole. This could be taken, on the one hand, as an indication that many people have a coherent belief system about gene technology that structures their attitudes to specific applications or, on the other, that they respond to cues provided by the interviewers and use only a vague and undifferentiated schema or representation of what gene technologies are to fashion their responses. These findings are also consistent with the recent research in risk perception that suggests that worldviews and affect influence the way in which unfamiliar risks are evaluated.

Nearly all studies, qualitative and quantitative, reveal trust and confidence in scientists, government and industry as key drivers of attitudes towards risks from gene technology. The work of Frewer and colleagues shows that the effect of trust is moderated by prior attitudes and that the confidence that people have in actors is linked to the accuracy of their information and how accountable they are. These results sit well with the findings on trust from the qualitative studies reviewed that show trust and accountability as key factors. Recently, quantitative studies have begun to explore the dimensionality of trust, as well as its effect on risk perception. This issue is one of those addressed in the empirical part of this thesis.

The principal area of divergence seems to be in relation to the role that scientific and other forms of knowledge play in the formation of attitudes to gene technology risks. Broadly speaking, quantitative studies have thus far mainly addressed the effects of scientific, 'textbook', knowledge about biology and genetics on risk perception. Qualitative approaches have emphasised instead people's knowledge about the past behaviour of scientific and regulatory institutions and so-called 'lay expertise'. This cleavage is reproduced in the public understanding of science literature in relation to generalised attitudes to science and, as such, appears to be an area where more research is needed. This thesis attempts to contribute to empirical research in this area.

In relation to the psychometric approach to risk perception, reviewed in Chapter Two, gene technology appears on the face of it to be high on both of its main dimensions: 'dread' and 'unknown' risk. As is clear from the foregoing review, there has been relatively little research on gene technology in the UK that has explicitly used the psychometric approach (but see Fife-Schaw & Rowe, 1996). However, several questions in Eurobarometer surveys since 1999 tap some of the perceptual dimensions suggested by the approach. More research exploring the validity of the psychometric paradigm in relation to gene technology in the UK would be interesting. Again, this is an area in which the present investigation aims to contribute.

This chapter introduced gene technology as an important strategic technology for the 21st century. A review of recent research on the British public's attitudes towards gene technology suggested that many people are ambivalent about applications of the technology, particularly in the agri-food area. Both qualitative and quantitative research identify trust as an important factor underlying risk perception. Results relating to the effect of scientific and other knowledges on risk perception are less conclusive. Ambivalence, lack of engagement and the structure of people's beliefs about gene technology are clearly areas where more detailed investigation seems to be indicated. Equally, the roles of trust and knowledge in explaining such attitudes and beliefs also appear as key topics for more study. The remainder of this thesis is devoted to addressing these issues through a series of empirical investigations. The next chapter briefly outlines the research designs and methodologies used for these investigations.

4 RESEARCH DESIGN AND METHODOLOGY

4.1 Introduction

The two previous chapters have provided a theoretical and empirical background to the research presented in this thesis. The remainder of the thesis consists of four separate, but theoretically linked, empirical investigations and some conclusions and implications that can be drawn from them. Each study addresses different questions and hypotheses that appear important in light of the reviews of the risk literature and of the related research on public opinion about gene technology in the UK. Both qualitative and quantitative methods are used. In this short chapter, I describe the data sources and research designs used in the empirical chapters that follow. More detailed explanations of the rationale for the research questions, hypotheses and analyses are contained in the introductory sections of each of the empirical chapters. The purpose of this chapter is primarily to introduce the relevant methodological considerations and details so that the flow of the text in later chapters can be focussed more on substantive issues.

4.2 Study A: Analysis of focus groups

The first investigation is mainly exploratory in nature and aims to discern some of the ways (if any) in which the dimensions of risk perception identified within the psychometric paradigm are manifested in lay discourses about gene technology. A qualitative, thematic analysis of four focus groups is carried out using a formal coding scheme. There were 26 participants in total, with 6-8 in each group. The results of this study feed into the subsequent design of a questionnaire that is used in other parts of the research.

Focus group techniques, along with other qualitative forms of data collection and analysis are not, in general, well suited to formal hypothesis testing but are well suited to more exploratory approaches. The analysis of qualitative interview data can be suggestive of what might be the more promising theoretical directions in which to take a study. It can aid in the formulation and development of hypotheses; it can suggest interpretations and contextualise survey findings (Bauer & Gaskell, 2000). There are other significant advantages conferred by utilising focus groups as a data gathering strategy. It is possible to generate rich 'emic' data that are the result of processes of interaction between participants rather than via individual responses to questionnaire items (Silverman, 1993). Related to this is the difference in the role of the moderator in a focus group compared to the interviewer in a structured or semi-structured interview setting. In the latter two research contexts, the interviewer provides all or most of the direction to the discussion that takes place. In focus group settings, a good moderator need only 'set the ball rolling' after which time it is hoped that the participants themselves provide much of the direction to the discussion. In a sense, the participants become simultaneously interviewers and interviewees, while the moderator's role is reduced to the periodic guidance of discussion into domains relevant to the research aims. This is particularly pertinent for discussions about topics that are rather far removed from the everyday experiences of participants.

In addition to these general points about the use of focus groups as a methodology, there are a particular reasons why it is an appropriate approach to use in the case of gene technology. Many studies of attitudes towards gene technology have pointed to the low salience that it has for the lay public (Gaskell, Allum *et al.*, 2001; Midden, Boy *et al.*, 2002; Miller, Pardo, & Niwa, 1997). Consequently, one might expect that participants will not bring to the discussion a coherent set of beliefs and strongly held attitudes towards gene technology (Converse, 1964). This expectation acts as an 'indication' for the chosen research method (Bauer, Allum, & Gaskell, 2000). Focus groups allow the researcher the possibility to observe the formation of attitudes 'on the fly' and to gain understanding into the ways in which new and unfamiliar concepts are integrated into existing constellations of beliefs, attitudes and perceptions. The exploration of concepts of gene technology in a collective discussion would seem to offer a useful way of gaining insights into the likely ways in which these concepts are assimilated into the public sphere outside of a controlled research setting. In other words, the methodology can reasonably be expected to have good external validity. This is obviously not to say that results can be quantitatively generalised to a population. It simply means in this context that the types of communicative processes observed in the groups are not far from what could be observed in informal discussions outside of the 'laboratory'. As such, what is interesting is the range and variety of views as well as what appear to be the 'centres of gravity' and the salience of the topics for the participants. This is the broad purpose of this first empirical investigation in the thesis.

4.3 Study B: Secondary analysis of longitudinal survey data

The second study is a secondary analysis of a longitudinal survey dataset on perceptions of GM food risk. Having longitudinal data opens the possibility of introducing a time dimension into the research. Access to a resource of this kind permits me to analyse stability and change in people's views about gene technology over a period of more than a year. The focus group analysis, as well as the previous literature in the area, suggests a deep ambivalence or uncertainty about the risks from gene technology and in particular from GM food. Therefore, the important questions asked in this chapter of secondary data analysis are: how stable are people's views about risk from GMOs?; do people really hold enduring attitudes about gene technology?; do the dimensions of people's attitudes to GM food risk correspond to those suggested by the psychometric paradigm?

The data come from a study on food-related risks carried out during 1995 and 1996 by Chris Fife-Schaw and Gene Rowe at the Social Psychology European Research Institute (SPERI), University of Surrey, on behalf of the Ministry of Agriculture, Fishery and Foods (MAFF) (Fife-Schaw & Rowe, 1996a; 1996b)[3]. After a pilot study comprising nine focus groups and a postal questionnaire (N=293), Fife-Schaw and Rowe designed and administered a postal panel

[3] I am very grateful to Chris Fife-Schaw for making the data available to me.

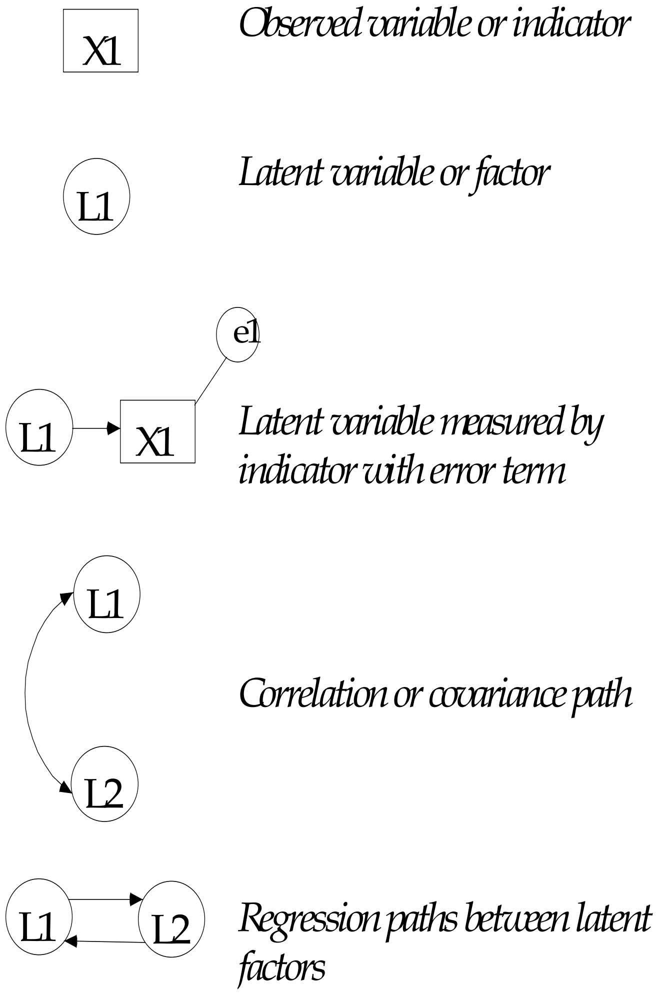
survey, at three separate occasions, that contained questions about ten food risks. One of the food-related risks they asked about concerned health risks from eating GM food. I analyse the survey using a psychological model based on the state-trait distinction (Kenny & Zautra, 2001), using structural equation modelling. I introduce the basic concepts involved in this form of statistical modelling in the following section.

4.4 Statistical analysis: structural equation modelling

The principal method used for statistical analysis in this and subsequent chapters is structural equation modelling (SEM). SEM is based conceptually on path analysis (Wright, 1921). Both path analysis and SEM use graphical symbols to represent statistical models. The innovation in recent years is that modern software allows these models to be specified using a graphical interface, obviating the former need for a great deal of command line input. The strength of SEM is that it allows the researcher to specify complex theoretical models and to test them explicitly. SEM can be thought of as incorporating factor analysis and regression under one general framework. It is, in common with these two techniques, primarily a linear method, although recent theoretical and computational advances are making it possible to use non-linear models in SEM. It is sometimes known as covariance structure analysis because of the basic principles that underpin it.

It differs from regression and factor analysis in several ways. Firstly, models are fitted in SEM by estimating the unknown parameters given the restrictions specified by the researcher (i.e. the model structure) such that the discrepancy between the observed covariance matrix and that implied by the model (estimated parameters + restrictions) is minimised. This is in contrast to Ordinary Least Squares (OLS) regression where parameters are estimated with respect to minimising the observed and predicted differences at the individual level. The second major difference, which follows from the first, is that in SEM factor analysis is confirmatory, in the sense that a latent factor structure is hypothesised a-priori to explain the observed covariances of a set of manifest variables. This is then tested against the data. In conventional exploratory factor analysis (EFA), the factor model is unrestricted in that all manifest variables are allowed to load on all factors, but the result is necessarily indeterminate and arbitrary rotations are used to find the most interpretable solution. In some instances, with little prior knowledge of the field of study, this may be a useful strategy. In many cases, though, the researcher has more than a little idea of what the likely set of latent factors is that underlies responses to a set of observed variables. In these cases, the researcher can move directly to testing hypotheses.

Figure 4.1 Symbols used in SEM (from Bollen, 1989 p.33)



In most situations where multiple manifest variables are used as indicators of a single latent construct, models will be 'overidentified'. That is to say that there are more pieces of information available than are minimally required to estimate all the required parameters. Because of this, it is possible to assess a model for its overall fit with the data. This is different to most conventional regression models that are 'just identified' - having as many data moments as unknown parameters (saturated models). In the latter case, there is only one unique set of parameters possible for any combination of model and sample data and these reproduce the observations perfectly. The upshot is that, in SEM, a single model, or several alternative explanatory models, can be proposed and evaluated empirically for their fit to the observed data.

The graphical symbols used in SEM to represent the various elements of the model are shown in figure 4.1. Observed variables are represented by square or rectangular boxes. Unobserved or latent variables are shown as circles or ellipses. Regression paths between variables are shown as single headed arrows. Covariance or correlation paths are represented as double-headed arrows. A great advantage of SEM is that theoretical relationships between variables can be modelled at the latent level by using multiple indicators of the relevant constructs. Indicators are assumed to be composed of true score on the construct and residual 'error' variance. Each indicator variable has an error term, usually estimated within the model or sometimes fixed or constrained by the researcher to some a-priori value. Latent variables are assumed to cause the observed scores on the indicators. By using multiple indicators, one can obtain a much purer measure of the construct which is embodied in the latent variable, while an estimate of error variance is produced that corresponds to the variance left unexplained in each manifest variable by its latent variable(s).

The process of testing and developing models in SEM is often conceptualised as a two-step process. The first step is to test a measurement model. This is the stage at which one evaluates how well the indicators together measure the constructs that they are supposed to. This is also known as confirmatory factor analysis (CFA). In the second stage, theoretical relationships between latent constructs are modelled and can be tested. While there has recently been some debate around the usefulness of this step by step approach (Hayduk & Glaser, 2000; Mulaik & Millsap, 2000), it is widely recommended.

Because simultaneous equations are estimated, the distinction between independent and dependent variables is not so clear cut as it is in simple regression models. 'Endogenous' variables in SEM are those that have a regression path leading towards them. They are acting as dependent variables in this part of the model. Endogenous variables can also act as causal indicators of other endogenous variables. In this sense they are not pure dependent variables. 'Exogenous' variables are those whose causes are left unmodelled. Graphically speaking, they have no regression path leading towards them, though they can, and usually are, allowed to covary with other variables. The assumption here is that any correlation between exogenous variables could be spurious and that they more than likely share common, but unmodelled, causal antecedents.

Models are usually fitted using specialist SEM software. The software I use is AMOS 5.0 (Arbuckle & Wothke, 1999). AMOS has the advantage of a user-friendly graphical interface that handles the user's model specification. It also produces good quality path diagrams. Several algorithms are implemented for fitting models. The one used throughout the analyses in the thesis, in common with most applications of SEM, is maximum likelihood (ML) estimation. This is an iterative procedure that estimates parameters for the model, subject to the imposed constraints, that maximise the likelihood that the observed variances and covariances are drawn from a population assumed to be the same as that implied by the model-produced variance/covariance matrix. Additionally, in AMOS, a full information ML procedure for dealing with missing data is implemented (see Wothke, 1998). Although ML estimation assumes that data are multivariate normal, there is considerable evidence that the method is quite robust to moderate departures from non-normality (Hoogland & Boomsma, 1998).

The discrepancy between observed and implied covariance matrices is distributed as Chi Square. This provides the basis for overall tests of model fit such that Chi Square is higher relative to its degrees of freedom as a function of increasing discrepancy. This means that a non-significant Chi Square (i.e. a low value, relative to degrees of freedom) is indicative of good fit. In addition to testing the fit of a single model, the Chi Square test can be used to evaluate a series of nested models. This is often used to test the assumption of equal factor loadings, error variances, or testing whether a particular parameter estimate is significantly different from another. In fact, it is important at the outset to realise that the goodness of fit of a model is formally a test only of the overidentifying restrictions and not of the freely estimated parameters. Hence, it should be clear that the strongest (most falsifiable) theoretical propositions are those contained in the restrictions on the model (the 'zero' paths) and not in the free parameters, although these may also be of considerable interest, depending on the particular analysis in question.

The greater the power of a test, the more sensitive it is to model misspecification. The Chi Square test becomes more sensitive as a function of sample size, to the effect that with large samples, even despite the observed data being reproduced closely by the model, a significant lack of fit will be reported according to the Chi Square statistic. If one shares Box's view that 'all models are wrong but some are more useful than others' (Box, 1979) one needs some supplementary ways of deciding on the fit of models that takes into account closeness of approximation, parsimony and so forth. Accordingly, various additional indices of approximate fit have been developed. I follow Hu and Bentler's recommendation (Hu & Bentler, 1999) in reporting two or three of these in addition to Chi Square.

The Comparative Fit Index (CFI) assesses the fit of the model relative to another model - usually the null model or independence model where the implied covariance matrix is made up of 0s. The idea is to compare the fit of the proposed model to another baseline model and see how much better the hypothesised model fits in comparison. Better fit is indicated by higher values tending to a maximum of 1.

The Standardised Root Mean Residual (SRMR) is the mean of the absolute discrepancies between the observed and implied correlation matrices. Better fit is associated with smaller values of SRMR. A perfect fitting model would have an SRMR of zero as there would be no residual after subtracting observed and implied matrices.

The Root Mean Square Error of Approximation (RMSEA) gives a measure of error per degree of freedom of the fit of the population covariance matrix implied by the model to the population covariance matrix itself (Steiger, 1990). It has a known distribution and an associated confidence interval. It will favour models with more overidentifying restrictions, independent of sample size. The argument for its use rests on the presumption that models with many restrictions constitute stronger theoretical models in the sense that they are more easily falsified (they have more degrees of freedom). The temptation when faced with a poorly fitting model and a large sample size is over-fitting - freeing many parameters that were originally fixed. This runs the risk of capitalising on chance sampling variability and results in models that are unlikely to be replicated. A measure of misfit per degree of freedom is therefore useful as a heuristic for assessing closeness of fit. Mathematical derivations of these fit statistics can be found in Arbuckle & Wothke (1999).

The use of approximate fit statistics and the assessment of model fit in general are two of the most hotly debated areas of SEM. The latest Monte Carlo studies, widely considered as useful, have been carried out by Hu and Bentler (1999). They recommend reporting pairs of fit indices including RMSEA, SRMR and CFI. A value at or below .08 for RMSEA or SRMR and at or above .95 for CFI gave acceptable Type I and II error rates in their simulation study. This is the strategy that I employ here, in combination with reporting the Chi Square statistic. Keep in mind that, for the reasons discussed, amongst others, assessing model fit, here as everywhere, is a matter requiring the sensible use of heuristics and informed judgment and not simply the implementation of rigid decision rules (Cohen, 1994).

4.5 Studies C and D: Design and analysis of an Internet survey

The third and fourth empirical studies in the thesis are carried out using a new survey that was designed by me especially for the purpose. A questionnaire was fielded as an Internet survey, by political research company YouGov (YouGov, 2003). The first of these investigations focuses on the dimensionality of trust and the relation of trust in science and in government to perceptions of GM food risk. The study examines levels of public trust in genetic scientists and in the Government among the UK public and tests several hypotheses arising from recent literature on the structure and function of trust in relation to technological risk. The final empirical study concerns the role of the public's scientific and other, less formal, types of knowledge in relation to gene technology risk. The aim is to integrate several disparate strands of research within public understanding of science concerning knowledge and attitudes to gene technology risks as well as to science in general . A structural model is developed and tested using data from the same Internet survey.

Details of the survey design, sampling and weighting procedures are presented in the next section. The survey items themselves are described as they arise in subsequent chapters.

4.5.1 Why an Internet survey?

The decision to use an online survey methodology was mainly motivated by cost and value for money considerations. With a small fixed research budget, getting access to a reasonably representative sample of the UK population was only really possible via a self-completion postal survey or Internet survey. The cost of buying space in regular omnibus surveys, fielded by the Office of National Statistics for instance, is too high to be able to include more than three or four questions in total. The decision between postal or Internet survey rested on trade-offs between costs, labour intensiveness and data quality. The main advantage of a postal survey would be the opportunity to use a properly drawn random sample of respondents. However, for a survey of this type, the likely response rate, assuming one contact with each member of the sample, would be between 15% and 30%. Given postage, printing and administration costs applied to a fixed budget, the maximum achieved sample size would probably only have been in the range of about 400. This is not, of course, to say that postal surveys are in all circumstances an inferior alternative to web surveys. Dilman suggests that a response rate of 70-80% should be attainable using his 'Tailored Design Method' (Dillman, 2000). However, in its full form, this requires five contacts with respondents and would involve a large investment of time in administrative tasks. Particularly for this latter reason, the web-based alternative, for me, was considered a superior option despite it being a non-probability sample.

A web survey is something akin to a quota sampling strategy, always in theory a worse option than a probability sample but with the advantage in this case of delivering a much higher final sample size for the same fixed cost. Given the low expected response rate of 15-30% for a postal survey the bias of estimates due to non-response would be unknown but possibly substantial. With an appropriate weighting scheme, both mail and Internet options could well offer comparable accuracy of estimates but the web survey option looked like the optimal solution for this study, as it offered lower costs in terms of time and money for a given achieved sample size.

The company chosen to field the survey was YouGov (YouGov, 2003). Over the past two years, this company has carried out polls for the Daily Telegraph, Observer, Sunday Times and other national newspapers in addition to other commercial, Governmental and academic contracts. There is considerable debate at present about the efficacy of Internet polling as compared to state of the art face-to-face probability sample surveys (Couper, 2000). There is evidence to suggest that surveys such as those carried out by YouGov can produce seemingly representative results, at least for certain topics. In 2001, an experiment was carried out by Sanders et al (Sanders, Clarke, Stewart, Whitely, & Twyman, 2001). One module of the British Election Study was replicated by YouGov online and the results derived from Internet and probability samples compared. Sanders and colleagues found that there were large differences in the demographic profiles of the two samples. The Internet sample was skewed towards professional, better educated men. There was also a higher proportion of Liberal Democrat and Conservative supporters, as well as more people professing interest in politics. However, when models predicting intention to vote Labour were fitted, only three regression coefficients out of twenty were significantly different in the two survey modes. Sanders et al conclude that while weighting can help to reduce bias in the marginal distributions of variables resulting from the difference in demographic profiles, relationships between variables were very similar across the two survey modes and, in their experiment, no major differences in causal inferences about voting intentions would be made using either mode. I came to the same type of conclusion in a recent study comparing Internet and probability surveys. Causal inferences from multiple regression analysis were broadly similar across survey modes. Weighting helped reduce bias in the Internet survey, although this advantage was offset to some degree by a loss of precision (Allum & Sturgis, 2003).

In a more recent report, Baker, Curtice and Sparrow (2002) are more critical. They demonstrate that although YouGov has produced good predictions of electoral outcomes, the reasons for this, given the substantial non-coverage of the 'non-wired' UK population, (according to Baker et al, around 45% of people have Internet access at home) are unclear. More importantly, they find that while obtaining the correct demographic profile in an Internet sample by a combination of weighting and recruitment strategies, there remain differences in some social attitudes between 'wired' and 'non wired' people that are uncorrelated with demographics. Baker et al cite attitudes towards Europe and towards capital punishment as two issues on which YouGov surveys consistently overestimate the proportion of Euro-enthusiasts and opponents of capital punishment compared to non Internet surveys. They suggest that Internet users may be slightly more open to new ideas and more likely to have socially liberal attitudes.

In light of these investigations it was decided to devise an appropriate weighting scheme and report marginal distributions using these weights. Multivariate analyses are conducted using unweighted data. It is not clear what the likely difference in general attitudes towards gene technology might be between the 'wired' and 'non-wired' populations. If the wired population is more open to new ideas, then the present survey may overestimate the true number of people generally supportive of the development of GM food and crops. Therefore, where possible, comparisons will be made with other surveys, such as the 2002 Eurobarometer on Biotechnology (Gaskell, Allum, & Stares, 2003), in order to contextualise results from this survey.

4.5.2 Sampling

YouGov maintains a panel of about 80,000 Internet users for which it holds demographic information. Panel members register with YouGov and submit details relating to age, income, education, occupation, media consumption, car ownership and several other variables. Respondents are paid 50p for each separate survey that they complete and receive a payment by cheque when their credit reaches £50. A minimum sample size of 1000 was the objective. This would provide enough statistical power to detect small to moderate correlations between variables and allow for the stratification of the sample into subgroups of reasonable size that could be analysed separately where desired.

A sample of 2710 panel members were sent an email inviting them to participate in the survey of which about 40% were expected to respond. No mention in the emailed invitation was made of the topic. Only panel members were allowed to take part, in contrast to some 'open' polls that YouGov runs on its website in which anyone may participate. It was expected that people who were uninterested in science and technology would be less likely to complete the survey. It is known that interest in science and in biotechnology is correlated with level of education, in that people with more years of schooling and university study tend to be more interested (Gaskell, Allum, & Stares, 2003; Gaskell, Allum *et al.*, 2001). Interest in science has been shown to be correlated with attitudes towards science. It was therefore important to obtain a range of respondents having all levels of interest in science so that interest could be used as a variable for analysis later on. It was therefore decided to 'over-sample' people who are less likely to be interested in biotechnology and science in general. This could not be achieved in a direct manner as there were no direct measures of panel members' interest in science but there were other measures available for some of the YouGov panel that could be expected to correlate with interest in science and technology. Analyses from the 2002 Eurobarometer on Biotechnology suggest fairly strong correlations between interest in politics and interest in science and biotechnology. YouGov had available data on interest in politics from panel members who had taken part in a previous survey on which we were able to base the over-sampling. Specifically, people who had previously indicated a very strong interest in politics were omitted from the issued sample. In other words these people were omitted from the random sample of 2710, drawn from the YouGov standing panel, that were originally invited to participate in the survey. This was the best way available of minimising the likely bias towards respondents who were very interested in science and technology in the achieved sample.

4.5.3 Weighting

The final achieved sample size was 1273. The marginal distributions of four key variables are shown in table 4.1. It was decided to create a weight variable based on age, education and interest in politics, as these are all factors known to correlate to some degree with attitudes towards biotechnology and for which reliable data are available. The British Social Attitudes Survey (BSA) of 2000 contained the necessary data for matching on the first three variables shown in the table. It is a high quality survey based on probability sampling methods and is therefore used as the basis for extrapolation to population estimates. It was decided not to weight for gender as more recent census estimates put the proportions of adult women and men at 52.6 and 47.4 respectively (Office of National Statistics, 2003). This is very close to the proportions in the YouGov sample.

Looking at table 4.1, it is clear that those educated up to the age of 16 are severely under-represented in the YouGov sample, while those who completed their continuous fulltime education aged 19 or above are over-represented. Those who are interested in politics are also over-represented. Insofar as respondents' age is concerned, the YouGov sample over-represents people between the ages of 60 and 69 and under-represents the 70+ age group. Other age groups are quite closely matched in the two samples.

Table 4.1 Comparison of marginals - YouGov and BSA 2000

		BSA 2000 (%)	YouGov (%)
Age completed full time education	15 or younger	31	13
	16	30	25
	17/18	18	27
	19+	18	30
	Still studying	3	5
How much interest in politics?	A great deal of interest	10	24
	Quite a lot of interest	23	29
	Some interest	33	35
	Not very much interest	24	11
	No interest at all	11	1
Age	18-24	11	9
	25-29	9	9
	30-39	20	20
	40-49	18	17
	50-59	15	18
	60-69	14	23
	70+	13	4
Gender	Male	45	49
	Female	55	51

Weighting to the proportions shown in table 4.1 was carried out using the method of 'raking ratio estimation', sometimes known as 'iterative proportional fitting'. Raking allows one to poststratify to marginal population totals of several variables simultaneously. Typically, raking is used in situations where the interior cells of a crosstabulation are either unknown or sample sizes in some cells are too small for efficient estimation (Elliot, 1991; Westat, 2002). The latter case applies here. Inspection of the full cross-classified tabulation of the three weighting variables in the YouGov and BSA samples revealed many cells with fewer than five cases.

Estimation of weights was carried out using the software program WESVAR 4.2. Despite the raked weights being smoothed as far as possible by the iterative fitting algorithm, there remained some cases with weight values of 20 or higher. When some cases are weighted up by this magnitude, standard errors of estimates can be shrunken substantially, meaning that the precision of estimators like means and percentages is over exaggerated. In view of this, the final weights were truncated so that the highest value was 3.5. This strategy sacrifices some potential gain in bias reduction but means that the precision of estimates (in the absence of more complex methods for deriving standard errors) is less distorted (Elliot, 1991). The final weight factor was scaled so that the weighted total sample size is exactly equivalent to the unweighted sample: 1273. This weight factor is used all parts of the thesis where descriptive statistics, cross tabulations and correlation coefficients are presented, unless otherwise specified. Where inferential tests were carried out on these statistics, I also carried out the same tests on the unweighted data as a form of sensitivity analysis. In no case was there a difference in the result depending on whether weighted or unweighted data were used. Structural equation models are all estimated using unweighted data, due to restrictions on the use of weights in the AMOS 5 software. Unweighted frequencies for all variables are reported in the codebook, in Appendix A.

4.6 Concluding remarks

In this brief chapter I have given an overview of the methods used in the empirical research presented in the thesis. In doing this I have also indicated, very approximately, the kinds of questions that are to be addressed in each of the following four chapters. The first two of these are concerned broadly with the structure and form of beliefs, attitudes and opinions about gene technology risk. The final two are directed at elaborating some of the factors hypothesised to contribute to the formation of public perceptions of gene technology risk, using the example of GM food. It is to the empirical part of the research that I now turn, beginning with a qualitative analysis of lay discourses on gene technology.

5 LAY DISCOURSES OF GENE TECHNOLOGY

The purpose of this chapter is to provide an exploratory analysis of people's beliefs about, attitudes towards and representations of various applications of gene technology. Within this general objective, a more specific focus is on how people talk about uncertainty and possible dangers from gene technology and how this relates to the perspectives on risk and gene technology that were discussed in Chapters Two and Three. As well as adding breadth and depth to how lay perceptions can be understood, the results also help to generate further hypotheses and research questions to be addressed in later chapters.

I begin with a brief discussion of some of the theoretical perspectives reviewed in chapters two and three and I link these to some possible expectations about the kind of discourse, on this basis, that one might expect to see in the data. Some methodological details are presented in the next section, followed by the results. A discussion focussing on the interpretation of the results in the light of theoretical perspectives on risk perception closes the chapter.

5.1 Introduction

One of the previously discussed perspectives on risk that offers an integrated explanation for people's perceptions of new technologies is that it is not so much the 'perception' of the risk that is important, but rather it is people's attitudes and beliefs about the technology as a whole that counts (Eiser, 2001; Otway, 1992). I drew parallels between this perspective and that of Finucane, Slovic and colleagues who have developed what they term the 'affect heuristic' in relation to risk perception (Finucane, Alhakami, Slovic, & Johnson, 2000; Slovic, Finucane, Peters, & MacGregor, 2002). Here the idea is that people's beliefs about risks, benefits and acceptability of new technologies is shaped by their unconscious, emotional and intuitive reactions to unfamiliar new hazards. This is particularly likely where little prior cognitive deliberation has taken place. If these complementary perspectives have any validity, one might expect that focus group discussions with people previously unfamiliar with gene technology would not focus so much on specific risks but on a much broader range of general issues to do with science and technology. Although affective processes can underlie any behaviour unconsciously, one might expect emotive discourses to play a major part in the discussions of lay people in relation to gene technology.

Tversky and Kahneman showed that people tend to estimate the probability of events of a type that come easily to mind systematically differently to those that are harder to recall. There are two main reasons for this. Firstly, events that resemble others with a known probability of occurrence are likely to be judged as similarly likely. This is so even when the attributes that are similar are unconnected to what lies behind the propensity of the event to occur. This is known as the representativeness bias (Kahneman, Slovic, & Tversky, 1982). The second reason is known as the availability bias (Tversky & Kahneman, 1973). Events of a type that are more readily imaginable, perhaps because they are vivid, or very recently experienced are systematically biased upwards in their estimated probability. In the case of people's perceptions of gene technology, one might expect to see people being more concerned about attendant risks if the type of danger posed resembles another similar and/or easily recallable negative event. This process, where new risks are grounded in understandings of more familiar ones may be visible in the types of past event that people refer to when talking about the risks of gene technology (Moscovici, 1984; Wagner, Elejabarrieta, & Lahnsteiner, 1995; Wagner, Kronberger, & Seifert, 2002). It is therefore of considerable interest to know what are people's existing representations of gene technology because of the way these may affect the reception of incoming new information and the subsequent formation of attitudes.

Tversky and Kahneman's Prospect theory suggests that, compared to a strictly rational approach to decision-making, people tend to weight the possibility of a loss more strongly than the possibility of an equivalent gain (Kahneman & Tversky, 1979). In other words, people will tend towards risk aversion when faced with potential gains, but will be risk-seeking when it comes to losses. In terms of the way people think about gene technology, it follows from Prospect theory that the potential harm caused by genetic modification of crop plants might loom larger for the public even if weighed against 'equivalent' (in terms of its formal expected value) gains in efficiency, reduction in price, or whatever. That is to say, the benefits need to be great in order to justify taking any risks (Gaskell & Allum, 2001). An exploration of the types of benefits that people consider are likely to flow from gene technology is therefore warranted.

From the perspective of the psychometric paradigm, there are several hypotheses that are relevant. Gene or DNA technology has been included in some recent studies (Fife-Schaw & Rowe, 1996; Siegrist, Cvetkovich, & Roth, 2000) and even in some of the earliest psychometric studies (e.g. Slovic, Lichtenstein, & Fischoff, 1980). The evidence from this work is that gene technology is rated as highly risky, at a comparable level to people's perception of nuclear power. The psychometric paradigm also suggests that risks that are involuntarily undertaken, those that are posed by new and unfamiliar technologies, and those that have catastrophic potential will all be considered as posing greater risks than hazards that do not possess these attributes. We might expect that applications of gene technology that might be seen as posing unavoidable risks will be viewed with particular concern. The entry of GM crops into the food chain may be just such an example. As a relatively new and unfamiliar technology, one would expect some level of concern across all applications. Of course, in the context of the exploration presented here there is no explicit focus on other technologies so it is not possible to say much about the relative standing of gene technology compared to other fields. Nevertheless, what is interesting here are the particular ways that people choose to articulate these dimensions of concern, if they do at all.

A view commonly held within natural science and industry is that the public misperceives risks because of ignorance. Lay people's worries about genetic modification and other controversial technologies such as civil nuclear power are based on a lack of understanding This hypothesis has received consistent empirical support in surveys of the public that assess knowledge of scientific facts and processes (Durant, Evans, & Thomas, 1989; Miller, 1983; Sturgis & Allum, 2000; Sturgis & Allum, 2001). Others have questioned whether knowing scientific facts in a knowledge quiz is an appropriate operationalisation of scientific knowledge (Peters, 2000). Wynne suggests that in order to properly capture the range of knowledge domains relevant to lay attitudes towards scientific research programmes 'three elements of public understanding have to be expressly related: the formal contents of scientific knowledge; the methods and processes of science; and its forms of institutional embedding, patronage, organisation and control' (Wynne, 1992 p.42). Furthermore, according to Michael (1996), ignorance is sometimes used by lay people to actively construct personal or group identities in relation to science. When exploring discourses about gene technology and uncertainty in the context of the present chapter, it is of particular interest to look at the extent to which people might be using their knowledge of science to actively position themselves in the debate. And while it is not possible to assess people's formal knowledge of scientific 'facts', the extent to which their knowledge of 'institutional embedding, patronage and control' is related to their perception of risk can be explored.

Closely related to questions of knowledge is the phenomenon of trust. Trust is of increasing interest to risk researchers, although explicit social or psychological theories of trust are seldom articulated in relation to risk perception (Freudenberg, 1993; Frewer, Howard, Hedderley, & Shepherd, 1996; Slovic, 1993, 1999). Trust, according to Luhmann (1979) functions as a substitute for knowledge. In this sense, it reduces complexity because, whether trust exists or does not exist, it obviates the need for people to engage in the evaluation of many risky choices themselves. Trust granted to or withheld from other people or institutions provides a manageable basis for individual action in societies with complex interconnections and webs of responsibility. Trust is therefore seen as highly important for explaining people's risk perception. In the absence of expert or scientific knowledge, lay people's perceptions of gene technology risks are likely to relate to the extent and nature of trust in institutional actors such as government, industry and in scientists themselves. It should be expected that notions about the trustworthiness of these actors should be implicated in people's uncertainty about biotechnological risks. Additionally, it may be possible to explore the bases on which trust is granted or withheld. Specifically, is trust granted according to the perceived competence and credibility of the institution (Barber, 1983) or is this trust based less on competence and more on the perception of shared values between perceiver and trustee (Earle & Cvetkovich, 1995; Siegrist, Cvetkovich, & Roth, 2000)?

5.2 Data and methods

Four focus group interviews were carried out in two phases in mid to late 1999. The first phase was in July when two interviews were conducted (groups 1 and 2). The second phase was in November when the final two interviews took place (groups 3 and 4). All interviews were conducted in the outer suburbs of London. There were 26 participants in total, with 6-8 in each group. A research recruitment agency was employed to identify and invite a selection of participants to each session according to the chosen sampling criteria (described later). The same agency also organised the venue for each interview which was, on each occasion, a private residence. All interviews were taped with the permission of the participants and transcribed in full (transcripts are available on request). The interviews were co-moderated by two of the principal investigators in the LSES British team. I attended all of the interviews, observing and taking notes.

5.2.1 Sampling

In qualitative research, the theories and practical application of sampling procedures differ greatly from those associated with quantitative research. In the latter, the population of interest is first identified. In order to make valid inferences from the sample, each member of this population must have a known, non-zero probability of being selected for the sample (Kalton, 1983).

The aim is to be able to make generalisations from sample to population with a known degree of uncertainty. Of course, this is crucial when the aim is to discover the distribution of an attribute of interest in the population. In the present case, however, the concern is not to make formal inferences about the distribution of attitudes within the UK population. The aims, as stated earlier, are (1) to orient both the reader and myself as the researcher to some of the ways that members of the lay public think and talk about gene technology; (2) to establish whether there is any evidence at all that general theories of risk perception are applicable in the case of gene technology; (3) to explore the range of beliefs, attitudes and representations in the sample in order to generate further research questions and hypotheses that can be addressed using quantitative data.

The sampling strategy employed could be described as 'purposive' sampling or 'stratified purposeful' (Patton, 1990). In this view, the purpose of sampling is not to gather a representative sample, but one that will provide interesting and useful data according to the particular hypotheses, hunches or intuitions of the researcher. The selection of groups or individuals is made according to the likelihood of their providing new insights for developing theoretical perspectives (Flick, 1998). In qualitative research, one needs to be modest about the generality of inferences that can be made from the data. At the same time, one needs to be ambitious in the level of detail and understanding that it is possible to achieve.

In the present case, groups were selected on the basis of several factors including theoretical interest, the constraints imposed by international collaboration and, finally, cost and convenience. The specific target composition of all four focus groups is shown in table 5.1.

Several factors were involved in deciding how to select participants for the focus groups. As was pointed out in Chapter Two, it is sometimes assumed that people who are more knowledgeable about science, or more highly educated in general (the two are generally correlated), will be more positively disposed towards new technologies and more relaxed about their risks and uncertainties. Some commentators hold that in publics where there is more widespread scientific literacy, opinions become more polarised and there is greater variation within and between social milieux (Bauer, Durant, & Evans, 1994; Durant, Bauer *et al.*, 2000). Others have presented evidence that with increasing knowledge comes more scepticism and a greater likelihood of negative opinions towards controversial technologies (Martin & Tait, 1992). There may be no single knowledge dimension that is uniquely significant in this regard; as well as knowledge of 'scientific facts' and methods, other types of less formal knowledge may be significant. Local and institutional knowledges have hitherto been largely ignored in the PUS literature, but may be crucially important (Bauer, Petkova, & Boyadjieva, 2000; Wynne, 1991). For these reasons it was important to obtain participants who had received varying levels of formal education: interviewing participants with different educational experiences was expected to uncover a more diverse array of attitudes and representations than would otherwise have been the case.

Table 5.1 Sampling characteristics of four focus groups

	Group 1	**Group 2**	**Group 3**	**Group 4**
Gender	Mixed	Mixed	Mixed	Mixed
Age	20-30	30-45	25-50	25-50
Children	No	Yes	-	-
Education	Further/Higher	High school	-	-
Newspaper	-	-	Mail (tabloid)	Independent (broadsheet)

A more informal method for segmenting participants is based on whether or not they regularly read a newspaper, and, more especially, which one. Between February and April of 1999, there was intense coverage of the GM food controversy. This followed the release of results from Arpad Pusztai's experiments concerning the effects on rats from eating genetically modified potatoes. An energetic campaign, highly critical of the handling of the crisis by government and scientists, was run by a number of UK national newspapers (Durant & Lindsey, 1999). Alongside this, it was noticed during the first phase of focus group interviews conducted that participants seemed relatively uninformed about or, possibly, rather uninterested in, or unable to recall, this apparently high profile public debate. For the second round of interviews, it was decided to target regular readers of two of the papers that had run anti-GM campaigns in order to try to tap into a more attentive segment of the lay public. The Daily Mail and the Independent were chosen as they represented tabloid and broadsheet respectively. To the extent that that readership of these two newspapers is likely to be correlated to some degree with social class and educational background, the segmentation was expected to provide a suitably wide spread of participants across the final two groups.

The psychometric literature identifies 'danger to future generations' as an attribute that is predictive of increased sensitivity to risks. In the case of GM food at least, the possible dangers that the public may perceive are likely to include long-term risks to health and the eco-system. It was thought particularly likely that for people with children this type of gene technology risk would be particularly salient. The inclusion of at least one group of parents in the sample may reveal aspects of long term concerns that may not be so apparent in those without children.

This thesis has been developed and written in the context of an international collaborative research project, as described in Chapter One. The focus groups described here were conducted as part of the data collection activities of this collaboration. The rationale for the sampling segmentations has been described above. However, it is obvious that this particular segmentation, based on education, newspaper readership and parenthood, is not the only one of conceivable interest. In order to gain a more extreme range of views, one might have sampled, say, environmental campaigning groups and genetic scientists.

Given that the aim of the LSES project was to produce a comparative report of lay public opinion across as many as ten countries, it was decided to segment along a minimal set of criteria that were expected to be interesting in each country. Furthermore, it was clear that it was lay publics that were under investigation. Accordingly, it was decided that no elite or special interest groups were to be sampled. Newspaper readership and education were selected, after much discussion within the group, as the basis for sampling segmentations of lay publics in each country. Any additional criteria beyond this minimum protocol were added at the discretion of national teams. For the UK focus groups presented here, the parenthood segmentation was added, for the reasons described earlier.

In any research project, there are limited resources. The costs of recruiting participants, hosting and conducting focus groups are quite considerable. Equally important, although sometimes ignored are the costs, in terms of either time or money (or both), of accurate transcription and thorough analysis. In an ideal research situation for a qualitative and exploratory investigation such as presented here, it would perhaps have been desirable to establish a lengthy cycle of sampling, interviewing, analysis, further sampling and so forth. Given that this analysis forms only one part of the empirical part of the thesis, I decided that the fairly small number of focus group sessions scheduled within the LSES project was more than sufficient. In fact, in the context of its place in the overall structure of the thesis, I am confident that the particularly rich material that was finally collected is more than adequate for its purpose.

5.2.2 The interview schedule

In some respects it is more appropriate to refer to the interview schedule as a ‘topic guide’. This more accurately reflects the semi-structured nature of the focussed interview, where, as mentioned earlier, the moderator guides the discussion towards relevant areas where necessary. Much of the conversation, though, is freely generated by the interaction of participants. With this in mind, a topic guide was designed to cover three main conceptual areas and three principal thematic domains. Reviewing the social scientific literature on risk, it seems apparent that the term 'risk' is freely used by social scientists (and, for that matter, natural scientists, engineers, financial economists and other experts) to denote somewhat different concepts.

Table 5.2 Summary of interview schedule

1. Open with elicitation and discussion of what comes to participants' minds when biotechnology and genetic engineering are mentioned.
2. Evaluation and discussion of specific applications of biotechnology using a card-sort procedure.
3. Focused and more extended discussion on two applications of biotechnology: GM foods and cloning animals (using example of Dolly the sheep).
4. Discussion of biotechnology regulation and attitudes towards some of the key actors (government, advisory committees, environmental organisations and others), using a card-sort procedure.

In much of the work in the psychometric paradigm, and within the cultural theory tradition, risk is operationalised in a variety of ways, for example 'how much risk to you personally do you think is posed by…? how much risk to you and your family…?', but not explicitly defined. In this way, although the stimulus often (but not always) includes the word 'risk', it is left to each respondent to mentally construct his or her own semantic representation of the word. Building on this general principle, and in recognition that what is at stake here is the elaboration of lay discourses, the topic guide is practically oriented to the structuring of discussion around quite concrete themes. It is in the analytic stage that the conceptual interpretation of rather general discourse around specific topics – GM food, cloning, politicians responsible for regulation

– can begin to be fleshed out in more detail. Therefore, although the guide was focussed on these more concrete themes, these were intended to serve as vehicles for the exploration of more abstract concepts. A brief synopsis of the topic guide is shown in table 5.2 (the full schedule can be found in Appendix B).

5.2.3 Coding and analysis

In order to be able to code text into identifiable categories it is necessary to have operationalisations of the concepts in which one is interested. In the case of risk, as we have seen, this may not be a straightforward task. One of the main purposes of carrying out this analysis is to map the ways in which respondents talk about gene technology, the type of language used, and to assess the correspondence between the theorising of risk and its empirical manifestation in ordinary talk. The strategy employed, therefore, was to use the simplest, most all encompassing working definition of risk. For the purposes of coding, risk was defined as *talk concerning some negative outcome in the future that has some degree of uncertainty attached*. The coding scheme was intended to have heuristic value in interpreting the data, rather than its codes 'becoming' the data to be analysed. With this in mind, no codings are dependent on the presence of specific keywords or phrases. This is necessary in order to enable the analysis of discourse that not only explicitly denotes a particular theme or concept of interest but also discourse that may only implicitly connote it.

The interview transcripts were coded using the Atlas/ti software package (Scientific Software, 2000). This package is able to perform 'code and retrieve' type operations, as well as cross-referencing via hyperlinks, text searches and the creation of visual code networks (Kelle, 2000). In the present case, the interview transcripts were coded iteratively using a hierarchical structure where superordinate themes (e.g. 'trust') were coded with sub-themes at a greater level of specificity (e.g. 'trust granted' 'trust not granted'). The basic unit of analysis used was a single 'turn' of a participant speaking. However, Atlas/ti does not require the user to pre-specify any particular length of analytic unit and at times, several short 'turns' were coded as one. An unlimited number of codes could be attached simultaneously to any fragment of text.

The initial coding frame was developed by me, along with other members of the LSES team, for a cross-national comparison on general attitudes towards biotechnology (this work is presented in Wagner, Kronberger *et al.*, 2001). For the analysis presented in this chapter I augmented the original coding frame with a new and much more fine-grained set of thematic codes specifically focussing on risk discourse. The initial, basic coding of the interview transcripts was carried out by me and a colleague on the LSES team. Following this, I developed the new codes germane to the present analysis.

Although it is not a common practice in this type of qualitative analysis to evaluate the reliability of the coding, I did carry out some basic analysis of this kind. I and my colleague both coded a sample of the transcript for Group 1 independently of each other, just coding the relevant top level codes. Cohen's Kappa (Cohen, 1960) was then estimated for each of the six binary codings that arose. Kappa is a statistic that evaluates the agreement between two raters, correcting for chance concordances. It ranges from 0-1, where 0 indicates no more than chance agreement and 1 represents perfect agreement. Average Kappa for the six codes was 0.6. Only one value was below 0.5, at .23. Landis and Koch characterise a Kappa of >0.2 as indicating a 'fair' level of agreement, values over 0.5 as 'moderate' and values between 0.6 and 0.8 as 'substantial' agreement (Landis & Koch, 1977). These guidelines perhaps appear somewhat generous at the lower end of the scale, where 0.2 could reasonably be seen as rather less than 'fair' agreement. However, as only one of the present codes has a Kappa falling within the range 0.2-0.5, these results give some indication that the coding is, on the whole, adequately reliable.

The analytic procedure that I followed was to repeatedly read all the transcripts in full until I became very familiar with them. Next I compiled subsections of text that all shared the same basic code (e.g. 'risk' or 'GM food'). Within these subsections I developed new codes at a 'higher resolution'. The final stage was to retrieve all the text for all the codes and become familiar with these. Finally, the interesting questions that arose as part of this process were addressed by defining searches based on cross-classifications of relevant codes (e.g. 'risk-unknown' and 'Actor_biased'). This allowed me to see commonly occurring relations between themes in the discourse.

It must of course be borne in mind that I am only analysing text relating to discourse specifically focused on risk. Therefore, even though other discourses of benefits, progress, optimism and so forth were present to varying degrees in the original transcripts, my analytic attention here is solely on risk discourses.

The final interpretation is presented holistically and discursively rather than strictly according to the coding categories. This is, in my opinion, the best way to convey the sense of the findings in a coherent narrative. The entire coding frame with code frequencies per focus group is presented in Appendix B. The full interview transcripts are available on request.

5.3 Results

5.3.1 The central concept: risk

How do respondents talk about risk and gene technology? The first and most striking feature of all the groups is that the word risk is seldom employed by anybody. When it is, it is usually in direct response to the moderator's questioning. From the transcripts, certain common themes and ways of talking about risk, as I have defined it above, emerge quite strongly. They can be placed in two dimensions. The first consists of the common ways in which risks manifest themselves, the process and mechanism of how they come to be known, or remain unknown. One might call them 'risk schemes' in that they consist of a collection of beliefs about familiar cause and effect patterns or relations that are seemingly shared by many of the respondents interviewed. The second consists of the specific kinds of dangers that are perceived in relation to gene technology. One might call these domains of risk. Domains encompass the types of application of gene technology seen as dangerous, and the specific nature of the threat.

The most ubiquitous way of talking about gene technology risk is its potential long term harmful effects. Respondents are concerned about what may turn out to be harmful in ten or twenty year's time. This is most often heard in relation to GM food. The prototype for this type of belief is firmly linked to well known events surrounding the emergence of BSE and CJD.

> *It's not until years to come, like with BSE, when everybody's dropping down dead, or minds melting or whatever.* (Female, Group 1)

There is something particularly worrying about something entering the body - a virus, radiation or poison - and lying dormant for years. One of the most fearful aspects of HIV, as it entered public consciousness during the 1980s, was (and still is) the uncertainty about when and if the potential for full-blown AIDS would be realised (Joffe, 1999). Although AIDS is seldom mentioned by respondents, the parallels are evident. The concept of a virus or infection remaining unseen and undetected in the body over a long period, before striking the victim down, "…and we've been eating them for years - it's too late…" is one that is familiar to everyone. That this extant causal scheme is widespread is made clear by the uncontroversial assent that respondents tend to give whenever it is given voice in the discussions.

Some respondents also allude to the particular unease generated by the idea of eating something that has been altered in ways that are invisible. The belief that genetic modification is invisible or only visible 'under a microscope' is not a reassuring thought in a time when healthy food is increasingly being equated with 'natural' food. That supermarket shelves are stocked with more organic produce than ever before also indicates that this belief is probably shared by a growing section of the British public. It is hardly surprising, therefore, that, for many people, GM food, perceived as both as unnatural and with hidden, manufactured attributes, engenders the feeling that it is quite the opposite of 'healthy' food.

Evidence on why the invisible genetic modification of foods may be seen as dangerous or frightening also comes from the latest Eurobarometer survey on Biotechnology. About one third of the UK public think that 'ordinary tomatoes do not contain genes while genetically modified ones do' while 22% think that 'by eating a genetically modified fruit, a person's genes could also become modified' (Gaskell, Allum *et al.*, 2000). If some people perceive genes as microscopic unnatural 'additives' that contaminate natural foodstuffs, it is understandable that they might think twice before eating genetically modified food.

Coupled with beliefs about dormant infection and invisible contamination are beliefs about human tendencies and motivations. There is the idea that people in general often do not consider the long run consequences of their actions. Or, at any rate, they place much more value on the short term outcomes. Of course in many instances, this represents quite rational behaviour. If one is uncertain about the long term future then it makes sense to confine one's attention to what is known with more certainty in the present or near future. However, when this belief is projected onto the public domain, to public policy and the production of foods or medicines, or in relation to the stewardship of the environment, it is an understandable cause for concern. The future consequences here are seen as potentially catastrophic, affecting millions of people, so the long term future is not so easily ignored. Nevertheless, it is recognised as an everyday 'matter of fact' that, very often, those who make decisions on behalf of others do not look as far ahead as they should:

> *It's like with anything, when you come to work, with changes in work, they all offer you money so that you take these changes but nobody ever looks at the long term effects, whether it be working conditions or your lifestyle, or the effects of things like that.* (Female, Group 1)

There are well-known examples of where long term risks have not been correctly anticipated by public authorities, science or industry and where there has been high profile regulatory failure. BSE is the clearest parallel that respondents cite in relation to possible dangers from GM food. The case of the morning sickness drug Thalidomide was also mentioned in one group as an example of where regulations designed to protect the public had not worked. The crisis over salmonella in eggs was another mentioned by some respondents. All of these seem to provide the background against which people try to evaluate the possible risk posed by GM food. And, for many people, it appears that there is a quite fundamental and rather pessimistic imprint left - expressed by one respondent as a 'gut reaction':

> *The gut reaction is because of what's happened in the past; I mean, there's so many things that you find out later on…* (Male, Group 2)

In the case of cloning, different types of dangers are perceived, although they are still framed as unanticipated long term effects of present actions. A notable feature of the discussions is that they move quickly from the notion of cloning an animal ('Dolly' the sheep, prompted by the moderator with a showcard) to what is seen as the inevitable cloning of a human being (adult nucleic transfer). It is mainly in this domain that long term dangers are considered likely. A parallel is drawn with what is commonly believed about animal breeding:

> Female: *Look at the problems with pedigree animals…where they interbreed and interbreed so much.*
>
> Female: *Yes, Persian cats that can't breath properly because their noses are so flat from all the interbreeding and they can't groom themselves.*
> (Group 2)

The prospect of people being 'bred' like pedigree animals is quite repugnant to all respondents. Other images seem to be universally recognised too. The possibility of a 'cloned army' is widely seen as, if not a concrete possibility, then a scenario that people are familiar with and see as a dangerous - if far fetched - notion. The psychometric paradigm might predict that gene technology, along with other relatively new technologies, for example nuclear power or microwave ovens, is threatening because it is unfamiliar. In the case of adult nucleic transfer technology, it is precisely because the idea of it is all too familiar, and has a very strong cultural resonance, that it is seen as dangerous. One respondent articulates this feeling in a way that garnered agreement from all the other participants:

> *it's a bit science fiction isn't it?…it goes back, I suppose, to, almost, Hitler's sort of super-race. Those of us who were born after the war, but you still revert back to it because it was part of history* (Male, Group 3)

The notions of the 'mad scientist' and 'wicked dictator' (Hitler or Saddam Hussein) are central to these respondents' worries about cloning. And these are linked to underlying schemes, types of belief about risk mechanisms, about the ways in which potential dangers might be realised. One of these distinct schemes concerns the misuse to which cloning technology could be put. Although any scientific knowledge or technological expertise could, in principle be 'misused', cloning in particular and, arguably, gene technology in all its manifestations, is seen as uniquely powerful - and therefore dangerous. The danger comes from, at best, people's fallibility and imperfect understandings: 'that's why to produce something with such an impact, it can't be right because it's too dangerous a power to have' (Female, Group 2); or, worse still, some people's malign intentions:

> *I don't think [we should allow] cloning, full stop, because it will fall into the wrong hands. I mean, imagine if there was cloning around when Hitler was in power.* (Female, Group 2)

Here the salient element of concern is not so much related to the way people perceive the process of cloning, but on the social consequences of its misuse or the unintended social fallout from ill-thought out experimentation. On reflection, it would have been interesting to probe people a little more on this. How believable is this scenario of cloned armies, of super-races and eugenics? The imagery clearly resonates with people, and its cultural ancestry is quite apparent, from myths of the Golem and Shelley's 'Frankenstein' to Nazi eugenics. In respondents' imagination, the cloned child always has blonde hair and blue eyes. And the combination seemingly brings to mind both the notion of perfection and accompanying feelings of disquiet. But it is difficult to assess the extent to which these are strongly felt beliefs about the likelihood of malign influence on how gene technology is to be used, or simply associations that are readily accessible. One should bear in mind that many respondents said that they had never previously talked about the topic before and seemed to be constructing new discursive ground for themselves during the interviews.

There is another way in which possible dangers from cloning animals, raised by discussion of Dolly the sheep, are thought likely to occur. It is assumed without question by all the groups that cloning a sheep is just the first step towards cloning human beings. This mirrors the trajectory of press coverage of Dolly when the story first broke in 1998 (Einsiedel, Allansdottir *et al.*, 2002). It is this 'signal' function of the Dolly story that is, again, evident here. The scientists, are working to their own agenda - one that will eventually lead to the cloning of a human being: 'with anything they do to animals is always geared up, isn't it, to what they might do with us?'(Female, Group 2). One of the ways in which unanticipated harm might occur in relation to gene technology in general is the idea that a chain reaction of technological innovation could be dangerous in itself. One respondent, on being shown a list of applications (see Appendix B) had the following comment to make:

> *You see the danger is you can look at one card and say well, yes actually it would be a good idea for that, and it would be started with that but then it would snowball and then it would go into the fields that you don't want it to be going into. Once it's started, it's started, hasn't it?* (Female, Group 2)

In this view, it makes no sense to try to evaluate the risk from one particular application of genetic science in isolation. The danger is synergistic and uncertain; it appears as a 'Pandora's Box' of possibilities. These concerns, like the others described so far, are, to a great extent, amplified by the lack of knowledge or relevant information that people possess: 'Where do we go from there [cloning Dolly]? It's the next stage that concerns me: I don't know the next stage…' (Male, Group 3). Although none of the respondents seemed to have much detailed knowledge about any of the gene technologies discussed, the general assumption was that scientists, if given free rein, would make rapid advances into areas that would be viewed with concern and that go beyond what is seen as acceptable now. In the absence of detailed knowledge, the pace of change is something that is sometimes seen as threatening:

> *Some technology can be quicker and some technology … can [be] safe and not as quick, so sometime it's worth waiting a bit more to go for something safer.* (Male, Group 2)

Yet, an alternative interpretation of the concern about genetic science moving too quickly is that it is no more than a rational desire to see that a proper balance is sustained between managing risks and making scientific and technological progress. In fact, despite the concerns raised about things moving quickly, respondents are quite sanguine about risks being linked to progress, and consider that what is needed is a sensible balance:

> *So it's trying to get that happy balance between moving forward - because we got to move forward, that's obvious - but doing it safely and try to minimise the risks.* (Male, Group 3)

5.3.2 Risk and knowledge

Respondents were not asked any questions to test their factual knowledge of gene technology. It seems safe to assume that while there is variance, none of the groups had any specialist or expert knowledge in any of the fields of gene technology discussed (although one person worked in the National Health Service and was familiar with some medical practice). Not surprisingly, a recurrent theme was people's perception of their own ignorance of genetic science. Mike Michael (1996) argued, in his study of beliefs about Radon gas, that this ignorance is not simply to be understood as a deficit of relevant scientific factual information. Rather it is actively constructed by laypersons in relation to any given technological or scientific domain in order to create or reinforce a social relationship with science. Across varying contexts, people actively reflect on their (self-ascribed) ignorance and use it to delineate their own self, or group's, identity in relation to expert knowledges and to science and its institutions. Furthermore, the interview situation sets up conditions whereby, in positioning themselves in relation to 'science', interviewees treat the interviewer as a proxy for science, scientists of various sorts, institutions and so on (Michael, 1996 p.114). This is a useful assumption to make here for understanding the way in which participants talk about their own lack of knowledge. In some senses, the interviewer or moderator is seen as a 'generic' scientist who is assumed to have some expertise in the area of genetic science (which, in the present case, is not true). Despite introducing ourselves at the start of each interview as researchers interested only in what the public thinks about gene technology, the topic of discussion tends to encourage an expert-lay distinction within the groups. Michaels's observation about participants positioning themselves in relation to science, as an implicit interlocutor in the interview situation, seems pertinent here.

None of the respondents in any group gave the impression of being satisfied with the state of their knowledge. At the beginning of each session, the moderator asked each person what came to mind when thinking about biotechnology and genetic engineering. The following answer is a good example of how some respondents positioned themselves in relation to self-ascribed 'ignorance':

> *I haven't really got a vast knowledge of biotechnology so it's good to learn as you go along - the information, or something that's been given out.*
> (Male, Group 1)

In this instance, the respondent appears to have some enthusiasm for new information if it comes along, but I would argue that there is an implicit justification of why she does not know more already: it is not a matter of great importance in daily life. To learn 'as you go along' is to only make an effort to find out as much as you need to know at any particular time. Gene technology, for most people, is not something with which there is conscious involvement in everyday life. It is quite rational not to spend too much effort in becoming informed about something that may be of only tangential importance. Another respondent makes the point more explicitly:

> *I mean we're so busy, aren't we? You pick up the paper, you look at something that comes up, you go off and you don't come back.*
> (Male, Group 3)

Here, the message is clearly articulated: 'we're so busy, aren't we?'. This is seen as sufficient justification for not knowing more about biotechnology (in this case GM food). No doubt where gene technologies impinge on people's lives very directly, such as in relation to medical therapeutic genetics, or genetic testing for inheritable disease, a whole different range of responses to ignorance would be observed (see for example Richards, 1996). But in the present case, where discussion centres around cloning and GM food, the connections to people's normal life do not appear to be all that strong or, at least, have not been considered as such by many participants. Some people had talked about gene technology before, but the tendency is to circumscribe what they know or think as not constituting 'scientific knowledge':

> *I've had the discussions, yeah. Whether they were the right discussions or not you don't know because it's scientific and we are not scientists; we don't know the full ins and outs of anything…* (Male, Group 3)

These participants, then, position themselves very much outside of science, and do not make strong claims about gene technology on what they consider to be 'scientific' premises. Nor do they consider (at least some of them) that it should even be necessary to have this type of specialised knowledge. This is not to say, though, that having no access to scientific information is unproblematic.

5.3.3 Trust, knowledge and risk

Much stronger claims relating to knowledge and access to information are made about the actors and institutions that are formally responsible to the public. Participants' concerns about possible dangers from gene technology appear to be more strongly related to the way they perceive the knowledge, credibility and integrity of scientists themselves, as well as government and industry. Quite clearly many people do not expect to be able to make sound judgments about these dangers themselves, but they expect others to do so. Where they perceive that authorities are lacking the knowledge necessary to make the right decisions, or failing to convey reliable information properly to the public, warning bells sound. Risks may be perceived not only because the unknown is somehow inherently threatening. For example, air travel may in general be perceived as more dangerous than it really is, perhaps because many people do not understand aerodynamics and probability, but if one suspected that the pilot was inexperienced or drunk, one would probably be right to construe the situation as rather dangerous! There are a number of themes that emerge in the discussions that seem to be important. Some relate to the reliability of actors' knowledge while others relate to actors' motivations.

There is not much sense that participants expect scientists to have certain knowledge. There is a feeling that scientific knowledge develops over time and that what was thought by scientists to be true 20 years ago may not be seen in the same way now. From a pragmatic point of view, though, this makes decisions about what to eat or judgments about the safety of genetic manipulation uncomfortable to make. One participant (in Group 2) said that the advice she was given during pregnancy ten years earlier about eating liver was completely at odds with the kind of advice being given today. There was not a strong sense of scientist's ignorance being to blame but that it nevertheless made decision-making difficult.

A stronger feeling that seemed to emerge in all the sessions was that in relation to potential risks, it was the motivations of scientists, not the uncertainty inherent in scientific research, that is the greater cause of worry. Participants' knowledge of scientists' motivations, biases and sponsorship is not very secure and this leads to fears that, notwithstanding the provisional nature of scientific knowledge, the best knowledge about risks may be distorted or only selectively presented to the public.

> *you never really know, you read a paper or you watch something on TV, what's been suppressed, what haven't they been told? We don't really know, you know, people say you can't believe everything you read, which is true, and it's what's not there. So it's very, very difficult to decide anything. I think you just have to have as much information as you can possibly gather.* (Female, Group 2)

While this expression of concern may be attributed just as much to a mistrust of government as of scientists, there is another factor in some participants' view of the motives of scientists. Even if scientists working on gene technology are not in the pay of national governments (one person referred to arguments between British and French scientists that he felt were probably the result of opposing political patronage rather than science), pharmaceutical or life-science companies, they might be motivated to misinform because of their own personal ambitions. Scientists and other people involved in developing gene technologies are sometimes seen as zealots following a rather blinkered path of 'discovery for its own sake'. As a result, they may plough on with dangerous research, unaware of the wider social or environmental contexts in which it will come to fruition. There maybe other reasons why people believe that pressing on with this type of research is the right thing to do. As mentioned earlier, the spectre of ill-advised experiments with eugenics is something that comes to mind when cloning is discussed. Even if the scientists are not fundamentally irresponsible or have disreputable aims, the power that they might have through genetic manipulation is one that is sometimes seen as too much to handle. The following extract illustrates this point.

Male: If that technology were to fall into-
Female: The wrong hands.
Male: The wrong hands.
Female: That's right.
Male: Think of the consequences.
Male: Is it not possible that they're not irresponsible but they just have too much responsibility, and sometimes-
Male: They're blinded, they're blinded by whatever way they're turned to, whatever their beliefs, they believe-
Female: What they're doing is right.
Male: They hold the power, and what they do is right.
(Group 1)

There are many expressions of distrust in government and politicians. Sometimes this is because of the perception of industry bias in elected politicians or, worse still, undeclared private interests in biotech companies. Where participants do not have much relevant knowledge or information about this, the default position is often one of scepticism. It is often simply assumed that politicians are not telling the whole truth and are not to be trusted. This was most evident in the group of younger people interviewed (Group 1). The idea that parliament could allay public fears about gene technology fails to impress on two grounds for some participants. Firstly, where politicians are seen to be self-serving and 'biased', the idea that they can adequately represent the public's concerns about dangers of gene technology is barely credible. When one person was asked whether parliament could represent the public's point of view, the reply was succinct:

> *Isn't it well known that they're the most corrupt set of people?*
> (Male, Group 1)

Here, the assertion of corruption is warranted by an appeal to its being a 'well known' fact, shared by many people. This view is not shared by all participants, though. Some people are inclined to a more favourable view of parliamentarians, arguing that misdemeanours committed in particular areas of life do not bar them from acting responsibly concerning biotechnology policy. Even holding a more positive view about the integrity of politicians and officials does not necessarily mean that people are confident that any risks will be adequately dealt with. That confidence is sometimes undermined by the perception that politicians lack adequate knowledge to make the right decisions. Discussing a recent announcement on GM food by Prime Minister Tony Blair, someone encapsulated this point dismissively:

> *Moderator: Did you know that Tony Blair…seems to think that most of these things are safe?*
>
> *Female: Yes. What does he really know about it? He's probably been told that by someone else, and he's now passing on the message.*
> (Group 1)

Lack of knowledge and information is seen as problematic in relation to the extent to which confidence in government is justified. In some ways this appeared to be a more important point than people's own self-ascribed ignorance. In the latter case, people do not expect to be able to answer complex scientific questions themselves, nor do they regard it as their role. In the former case, where people are sceptical of the trustworthiness or knowledgeability of those responsible for decision-making, their concerns about future dangers from new gene technologies are accentuated.

5.3.4 Styles of deliberation: risk and moral judgment

When speaking of uncertainty and the possible implications of developments in gene technology, participants employ a variety of forms of reasoning or deliberative styles. The strength of the focus group situation is that people tend to 'think aloud', almost trying out ideas on other group members. For this reason, even if some people do not appear to have strong views to begin with (and this is almost certainly the case here), the type of deliberation that they bring to the issues is exposed as a series of hypothetical arguments addressed to the rest of the group.

Despite not being one of the focal issues of the thesis, the way in which people develop their thoughts about gene technology discursively, and according to certain characteristic criteria is of interest for the way in which this unfamiliar technology is anchored in more familiar ideas contained in people's existing belief systems. Following a long philosophical tradition, it may be useful to attempt to divide these argumentative styles into what can be termed 'deontological' and 'consequentialist' forms of reasoning. These distinctions are not merely academic, but seem to correspond to people's common experiences of trying to make sense of complex and emotive problems. Here they are particularly useful for clarifying different ways in which people try to make judgments about 'means' and 'ends'.

Deontological ethics are based on the notion that actions should or should not be carried out regardless to some degree of the consequences that follow. Consequentialism, by contrast, judges the rightness of actions according to the value of what follows from their performance. Utilitarianism is the best-known form of consequentialism. Deontological arguments at their most extreme take the form of absolutism. In this view, some actions are always wrong, regardless of whatever consequences arise. The tension between these two types of consideration was very often apparent in people's mulling over of the pros and cons of applications of gene technology.

Table 5.3 shows a crosstabulation of deliberative themes and styles observed in the groups' consideration of uncertainties about gene technologies. Specifically, they relate mainly to discussions of GM food and human and animal cloning. The deliberative styles, or ethical considerations, are divided into deontological and consequentialist, as described above. There are five main themes, one having two sub-themes. Elements of most of them have been discussed earlier, in other contexts.

Table 5.3 Deliberation about gene technology risks: themes and styles

		Deontological	Consequentialist
Nature as a complex system			✓
Playing God		✓	
Is it necessary?			✓
Taboos		✓	
Trust	**Rights and responsibilities**	✓	
	Competence		✓

The table shows each theme with its typical associated deliberative style. While the classification is, in fact, much fuzzier than this implies, I have placed each theme in one or other category to show the basic distinctions clearly.

5.3.5 Nature as a complex system; Playing God

There is a great similarity between these two themes. In many ways, they represent two different styles of arguing the same basic point: that it is wrong to tamper with nature. Elsewhere, I and others have reported that this dual pattern of argumentation is visible across Europe, not only in Britain (Wagner, Kronberger *et al.*, 2001). One style is couched in quasi-scientific terms. The claim is that genetic manipulation is wrong because it disturbs the equilibrium of the natural world. We should not do this because it is dangerous to meddle in the complex system that is nature (or 'life'), when the consequences are impossible to predict. The other way of expressing a similar view is to talk about 'playing God'. This was described by one participant (Male, Group 1) as 'not quite megalomania but we're becoming God-like creatures who can control everything around us…'. There is an uneasiness with this notion that seems partly to do with the dangers of intervening in nature's complex system and partly out of a respect for nature, the idea that nature should be venerated as a beautiful creation in itself. These arguments are found in connection more often with GM food but also sometimes to cloning. In both cases, caution is urged either through appeal to a sense of duty, of stewardship of nature, or in recognition of the danger of disturbing poorly understood natural equilibria.

5.3.6 Is it necessary?

This is a consequentialist style of reasoning based on the possible benefits of gene technologies. Nearly all participants question the usefulness of GM foods. The feeling, dominant in all the groups, is that there is no need for genetically modified food because people are happy with the food they already have. The argument that there are other alternatives that achieve the same end is also heard in relation to the possibility of genetically modifying pigs so that their organs can be used for transplant into humans (xenotransplantation). One participant, who worked in the National Health Service, said that if more people donated organs and carried donor cards, there would not be any need for questionable techniques like xenotransplantation. On the reverse side of the argument, many people expressed positive attitudes towards the possible medical benefits of GM medicines, pre-natal testing and even reproductive cloning. The difficulty comes in reconciling this with fundamental, deontological concerns which seem to loom larger in the abstract than in relation to particular individual circumstances. For instance, the conflict between believing human reproductive cloning to be wrong but trying to balance this against the good that could come of allowing a person who is infertile to have a chance of having children.

5.3.7 Taboos

Some participants talk of taboos in discussions about human and animal cloning. To some degree, these appear to reflect traditional beliefs about incest as something wrong and morally indefensible. Participants are uncomfortable with the blurring of the normal distinctions constituting family relationships that are implied by the possibility of reproductive cloning. They also hold beliefs about the danger of inter-family sexual relationships that act as anchors for fears about human cloning:

> *I think it's virtually taboo, not only in humans but in animal life as well - insofar as you get deformities and all sorts of problems. And if you had cells from cloned animals and it's modified then surely you get to a point when you don't know what's part of what family, and how close they are.*
> (Male, Group 2)

Interestingly, even where it seems that people have a dislike, even revulsion for aspects of cloning, and think it is wrong, justifications are very often made on consequentialist grounds. The taboo is justified because of the deformities that would be brought about if it were ignored. Even here, religious arguments are not directly referred to. This is a difference between the groups analysed here and some of those from other countries such as Austria, analysed as part of the wider European study (Wagner, Kronberger *et al.*, 2001). People were not probed about religious beliefs so it is difficult to say what kinds of religious arguments might have been advanced had this been the line of questioning.

Still, the fact that religious arguments were almost never spontaneously forthcoming in the British groups could be interpreted as evidence that religious beliefs for these participants do not play an enormously important part in reasoning about gene technology. Another theme that might have been expected to appear is one concerning human dignity and the sanctity of human identity. In some other countries we found that one of the arguments against cloning human beings rested not only on particular dangers to health that might be realised but also because cloning threatened the very notion of what it means to be an individual person (Wagner, Kronberger *et al.*, 2001 p.87). In this view, a person conceived via cloning is a copy of another person with no unique identity. There was little direct evidence for this in the British groups. Nevertheless, it is possible that this idea lies beneath the less-well articulated expressions of concern.

5.3.8 Trust: rights, responsibilities and competence

Common arguments concerning risk and uncertainty are those that explicitly or implicitly employ the concept of trust. Genetic science and applications of gene technology are not under the control of the public. Furthermore, members of the lay public do not typically have access or interest in the expert knowledge that would allow them to evaluate risks for themselves. Under these conditions, trust in scientists, government and industry becomes a key issue. This is clearly the case for participants in the present study. Trust is a key theme and one of those that we deliberately explored when moderating the groups.

The discourse about risk and trust took on a relatively small variety of forms, most of which were evident in all four groups. As table 5.2 shows, these can be broken down into two styles: the first tending towards deontological argument, the second towards more consequentialist forms. The former consists of discourses about responsibility, motivations, values, public accountability and the 'public interest'. The latter concerns the technical competence and capabilities of relevant authorities such as scientists and politicians.

Interestingly, these two broad themes resemble part of Barber's tripartite conception of trust: fiduciary responsibility and technical competence (Barber, 1983). On the basis of the evidence of these group discussions, both aspects are important for the ways in which people evaluate gene technology risks. Participants have concerns about the effectiveness of scientific procedures and the capacity of government and officials to competently oversee developments. Concern is also shown for the extent to which the same actors can be expected to act in the public interest rather than to advance their own particular ambitions.

As far as responsibility is concerned, participants talk about whether politicians can be trusted to do the 'right thing'. The issue here is the motivation of politicians. Are they motivated mainly by the desire to enhance their political careers, in which case they will take the path of least resistance and make decisions based on political expediency, or by a desire to promote the public interest? Ordinary members of parliament are seen as 'political minnows' who just want to 'impress the boss' (Male, Group 3). There is a common perception that the government and big business have 'done deals' and that they cannot be trusted because, no matter what uncertainty about gene technology exists, money will determine the outcome in the end. Not everyone agrees with this pessimistic outlook, though. Some participants profess a 'faith' in scientists and the government to do what is right. Often though, this is expressed as a kind of involuntary viewpoint. People are uncertain whether their faith is justified but feel that without it, they would worry too much. Another theme is that of openness, consultation and accountability. Nearly all participants consider that the public should be told the truth about gene technology as a right. When they suspect the government or scientists of withholding information, this is an additional source of concern about the potential risks that may be involved.

Two forms of argument around the competence or capabilities of actors come to the fore. One concerns politicians and the government. As mentioned earlier on, some people consider government ministers to be poorly informed about gene technology and therefore not capable of making the best decisions that would minimise risks. Others, though, do express some confidence in the regulatory system, particularly with respect to medical applications of gene technology. People are particularly aware of scientific advice turning out to be wrong in the past. This calls into question the capability of scientists to ensure that dangers from gene technology are avoided; hence they are not trusted. BSE is, again, the typical example mentioned. This appears to be an example of trust being much easier to lose than to regain (Slovic, 1993).

In general, it appears that concerns arising from lack of trust are more often, and more forcefully expressed, in relation to the motives of actors rather than their capabilities. Of course, it is difficult for those without expert knowledge to evaluate the capabilities of experts themselves. Thus, it would not be surprising if such concerns were to be expressed with more circumspection. People may find it easier to rely on other more readily accessible types of information about these actors such as impressions about personal character, shared political or other value orientations and past actions in the same context.

5.4 Discussion

People do not use the word risk very much. People do talk about uncertainty, of course, and some did recognise the difference between a known, quantifiable risk and uncertainty. The fact that the word risk was not often employed, indicates that it either does not signify a salient concept in the public mind or that it is so wide that no umbrella term is sufficient to encompass all its connotations. The latter explanation appears most likely. It is consistent with the notion that people use risk as a summary concept, indicative of wider attitudes and beliefs about the hazard in question. It seems very likely that when people are asked about risk in a survey, their answer represents a summation of many different considerations rather than a narrowly defined concept.

People's worries about GM are connected with long term, delayed, unseen effects that would affect many people. They also perceive GM products as having been forced onto them, without permission. This, in accordance with psychometric literature, would go part way to explaining why they might be seen as of particular concern. When discussing medical applications of gene technology, people voice concerns in the abstract, but when related to a hypothesised situation in which they had a particular need of medical treatment themselves, the risks appear more acceptable.

Arguments about gene technology can be loosely broken down as having a deontological or utilitarian basis. Several related clusters of general concerns about gene technology can be classified in this way. The common themes relate to tampering with nature, playing God, transgressing of taboos, trust and responsibility. The last two concern the way gene technology is dealt with by scientific, political and industrial actors while the first three relate to arguments that relate to the nature of the gene technology itself. If anything, the concerns about trust and responsibility are much more clearly articulated than those about the science and technology itself. As far as people's discussion of trust is concerned, the motivations that key actors have, rather than their competence, seem to be the more important factor. The specific issue of perceived similar shared values was not probed specifically with the focus groups. However, it was certainly the case that for some participants, there was a perceived gap between the outlook of 'ordinary people' and scientists and politicians.

The relationship between people's knowledge and the extent of their concern about gene technology appears complex. In the sample of respondents we interviewed, nearly all displayed little knowledge or awareness of the scientific issues involved. On this basis it is unwise to speculate on the effect of differing knowledge levels on attitudes. On the other hand, some people suggested that they really didn't need to know much anyway, as it was others' jobs to make decisions. Many expressions of worry were accompanied by admissions of ignorance, but this is also a natural consequence of an 'expert-lay' interview situation. Essentially, where people are uncertain they begin to hypothesise about what might or might not be the consequences of developing gene technology. Faced with this uncertainty, the issue of trust and mistrust tends often to come to the surface. Hence what already people know, or assume, about scientists, politicians and regulators is likely to influence the extent to which negative perceptions of gene technology might follow from lack of knowledge in general.

Whatever people's differing views about the specific nature of genetically modified organisms, therapeutic cloning or any other application of gene technology, the discussions with these groups suggest that the issues of social and political trust and responsibility are strongly intertwined. Attitudes to gene technology risk are influenced by the extent to which people are confident in those responsible for its deployment. This is something that I explore in more depth later. The findings here accord with other work that suggests that many people have very low levels of interest, knowledge and awareness about gene technology (Gaskell, Allum *et al.*, 2001). One is reminded here of the work of Philip Converse and others who have suggested that, on many political issues of the day, a large proportion of citizens do not hold stable attitudes but merely hold labile opinions or 'non-attitudes' (Converse, 2000). It certainly appeared that people were often considering the ideas we raised in the focus groups for the first time and perhaps held no meaningful or enduring orientation towards the issues at all. Therefore, before moving on, in later chapters, to consider the factors that influence attitudes to gene technology risks, the next chapter explores the extent to which these attitudes may be, in a sense, 'worthy' of exploration in the first place.

6 STRUCTURE AND STABILITY IN THE PERCEPTION OF RISK

6.1 Introduction

In the previous chapter, I explored some of the ways in which people think about and talk about risks associated with gene technology in a focus group setting. One of the key findings that arose from this phase of the research was the rather low salience of the topic for most participants. Despite being regular readers of newspapers known to have run campaigns in early 1999 against government policies on GMOs (Durant & Lindsey, 1999), most people interviewed had little recollection of the events of the period. Another observation of interest was the very infrequent use of the term 'risk'. Participants were more likely to talk about dangers and worries for the future, but the explicit use of the word 'risk' was a rare occurrence. Two possible explanations for this observation were postulated. Firstly, it may be that when people think about applications of gene technology like GMOs or cloning animals, they do not think in terms of risk at all. This seems unlikely, if one considers risk simply as the possibility of some negative outcome in the future. There were many such possibilities discussed in all the focus groups that were conducted. The more plausible explanation is that what social scientists, risk managers and genetic scientists refer to explicitly as risks, benefits, hazards, probabilities and so forth have to be inferred from very different forms of discourse in lay publics. This is the basis of approaches to measuring attitudes with multi-item scales that encompass a wide range of salient beliefs. The psychometric approach to risk perception, although not always conceptualised within an explicitly social psychological attitude theory framework, measures people's views on risky technologies in just this way. The two preliminary aims for this analysis are, firstly, to evaluate how well the psychometric dimensions measure people's attitudes towards GM food risk and, secondly, to evaluate whether people actually hold stable attitudes towards GM food risk over time or whether, as appeared to be possible in light of last chapter's analysis, they generate ill-considered, labile opinions off the top-of-the-head. As will be seen, the first of these questions is answered relatively quickly, so the bulk of this chapter is devoted to exploring the second, using a novel kind of model not used before in risk research.

The evidence from the analysis of the focus groups suggests that some of the typical beliefs usually measured in the psychometric approach ring true in the case of gene technology. Participants, when asked, had rather vaguely articulated worries for the future in respect of GM food. They were concerned that scientific knowledge, as well as their own, was insufficient to assure them of the safety of GM food. People expressed concern that the true effects of consuming GM food and releasing GMOs would not been known until well into the future when it would be too late to do anything about it. Health risks were the dominant concern but the impression gained was that these concerns were being voiced for the first time, in some cases. The suspicion must therefore exist that the actual research interview was in some cases making a strong contribution to the formation of attitudes or opinions rather than eliciting responses indicative of pre-existing ones.

Despite this impression being gained from a small unrepresentative sample, it receives some corroboration from cross-sectional survey results. In the 1999 Eurobarometer on Biotechnology, 59% of respondents said that they had never spoken about it before the survey interview (Gaskell, Allum *et al.*, 2001). Evidence from a previous Eurobarometer survey, in 1996, suggests that many Europeans' attitudes towards applications of biotechnology were, at the time of the survey, not very firm. The fact that many people did not differentiate between six diverse applications of biotechnology with regard to judgments of riskiness, usefulness and moral acceptability is taken by Midden *et al* (2002) to suggest that their responses were not based on well considered beliefs or knowledge.

What this suggests is that, despite great political controversy in Britain and elsewhere in Europe and the apparent public concern about risks from GM food and crops, the real extent to which these issues are important to sections of the general public may have been exaggerated. If it is the case that many people make up opinions 'on-the-spot' when asked questions in surveys or in focus group interviews, this is has considerable significance for public policy over, for example, increasing direct public participation in science policy. Additionally, from the perspective of normative democratic theory, citizens need to have stable and well-informed attitudes towards the political issues of the day in order for them to connect their own best interests with the appropriate policy preferences and vote-choices (Campbell, Converse, Miller, & Stokes, 1960; Converse, 1964; Delli Carpini & Keeter, 1996). The question of whether it is appropriate to speak of stable and meaningful attitudes about GM food risk or only of labile opinions is not merely an academic one. It is this question that informs the empirical analyses of stability and change presented in this chapter.

6.1.1 Assessing the stability of attitudes

The limitations of both cross-sectional surveys and qualitative interviews for the assessment of attitude stability are manifest. In cross-sectional surveys, stability can be inferred from the internal consistency of responses to theoretically related items. For example, one can assess the reliability of an attitude scale using a measure of reliability such as Cronbach's Alpha (Cronbach, 1951). But even in the event that the scale is reliable in the sense that average item-total correlations are high, there is no good method for assessing the likelihood that an individual's position on the measured attitudinal continuum will persist into the future or has been stable in the past. An interesting approach to this problem was adopted by Midden and colleagues, which relies on hypothesised theoretical relationships between different attitudes (Midden, Boy *et al.*, 2002). They assume that holding better-formed, stable attitudes towards different applications of gene technology implies greater differentiation between them. When little differentiation is observed, the conclusion is that attitudes are probably not well considered and are not likely to be very stable. This approach, of course, relies on the veracity of the theoretical assumptions and, in any case, cannot be empirically determined within the context of a single survey.

In the case of qualitative interviews there is practically no way to judge attitude stability, other than by asking participants to describe their past behaviour. In the present case, there was very little reported past behaviour related to, for example, GM food purchasing, avoidance or information seeking. However, notwithstanding variation in the accuracy of accounts of past behaviour, the relation between attitudes and behaviour is moderated by a host of other personal and situational factors that make the inference of attitude from behaviour problematic (Ajzen & Fishbein, 1980). Clearly, what one needs in order to assess stability and change are longitudinal data.

Some data are available and in the public domain. For example, the Eurobarometer survey series has tracked attitudes to GM food risk between 1996 and 1999 with two cross-sectional surveys (see Gaskell, 1997; Gaskell, Allum *et al.*, 2000; Gaskell, Allum *et al.*, 2001; INRA, 1997 for details of these surveys). In the 1996, a stratified random sample of UK respondents were asked the extent to which they thought that GM food was 'risky for society', measured on a 4-point scale labelled from 'strongly agree' to 'strongly disagree'. Mean scores in 1996 and 1999 were approximately 2.9 and the small difference is neither statistically nor substantively significant. However, one cannot conclude from this apparent stability that individuals' attitudes are similarly stable. In fact, in all likelihood, this aggregate stability coexists alongside a great deal of intraindividual change. This phenomenon is an anomaly that has worried political scientists for many years and the approaches to explaining it developed by some of these researchers provide a basis through which the present research questions might be answered. It will be useful, therefore to provide a brief review.

Philip Converse was the first to identify and draw serious attention to this phenomenon with his 'Black and White' model of political attitudes (Converse, 1964). Converse analysed data from panel surveys of the US public. He found that many of the survey items that asked people about their attitudes towards political issues of the day exhibited a good degree of aggregate stability over successive waves of the survey. In contrast to this picture, the change over time in the responses of individuals was startlingly high. For many items, 50 percent of respondents or more gave different responses between waves, with a sizeable minority even reversing their expressed views between successive time points. Converse's conclusion was that much if not most of the American public did not really hold meaningful political attitudes at all but responded to survey questions with what was termed 'non-attitudes'. The very low correlations between people's answers to the same questions at successive points in time led to the conclusion that most people responded almost perfectly randomly to questions about what were presumed to be important political issues of the day. The 'Black and White' model refers to Converse's additional finding that those who had high levels of political sophistication and knowledge showed far greater stability in their attitudes over time and it was this relatively small section of the public that accounted for most of the observed aggregate stability over time.

Converse's thesis has since been challenged from a number of perspectives (Converse, 2000). The critical perspective most informative to the present task of establishing the extent to which people's views about GM food risk are stable attitudes or labile opinions is primarily a methodological one and is worth noting as it may serve as a starting point for the consideration of an appropriate model for assessing stability and change for the present study. Essentially, the contention is that most of the observed temporal response instability in Converse's data was due to errors of attitude measurement rather than to lack of real attitudes or true attitude change. This is the basis of Judd and Milburn's (1980) critique and those of Achen (1975) and Pierce and Rose (1974). Judd and Milburn's model is based on the following features. When comparing people's answers to a set of questions at successive time points, several sources of variation simultaneously explain the observed responses. The first is the underlying attitude, which causes variation in responses to all the items at any single point in time. Secondly, there is variance common to each individual question asked at different time points. This could be thought of as due to the specific meaning of the question, the way it is worded and other elements within the question that are unrelated to either the underlying attitude or to other questions. The third source of variance in each question at each point in time is measurement error. This is made up of random and other time-specific, idiosyncratic components, uncorrelated with any other common source of variance.

By fitting this model to multi-wave panel data, Judd and Milburn showed that once one uses multiple indicators that tap a single attitude (in their case a liberal-conservative ideological dimension) and can decompose variance into three distinct elements, attitude stability appears much greater than was previously assumed. This general approach provides a promising basis for assessing the stability of risk attitudes towards GM food. However, in the present case, the interest is not only in assessing the extent to which one can say that people hold stable risk attitudes but also, the extent to which the time-specific context contributes to the formation of opinions 'on-the-spot'. For this purpose, a slightly more sophisticated model is required. Such a model needs to acknowledge that manifest behaviour (responses to survey or other interview questions) can be influenced by a combination of situation-specific factors, more enduring dispositions possess and other random and systematic measurement error. For instance, it appears from the focus group analysis in Chapter Five that people might be developing opinions on the spot because they have suddenly found themselves in a position where it is socially desirable to 'have an opinion'. Or perhaps they have thought about the risks from GM food before but never articulated them. It may be that after thinking about the issues raised in the group, people's opinions change. In any event, the particular context in which questions are asked influences people's responses. What is not clear is the extent to which people's expressed views might be completely different in another situation, at a different time, or whether they tend to have rather stable attitudes that will lead them to express similar views most of the time. A suitable framework for looking at these phenomena is latent state-trait theory (LST) in combination with longitudinal panel data. Happily, such data are available to me and enable further investigation of these issues in the analysis that follows.

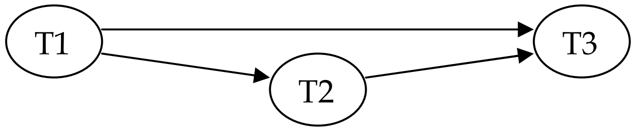
6.1.2 The state-trait distinction

The distinction between states and traits is one that is commonly understood and employed in everyday language to describe people's behaviour or state of mind (Steyer, Schmitt, & Eid, 1999). We all understand the difference between saying that someone is 'acting stupidly' and that someone is 'a stupid person'. The first refers to the person in a situation, the second only to the person. The former is assumed to vary with time and place, the latter is assumed to be unchanging. In reality, although states and traits have often been presented as mutually exclusive entities, for instance mood is characterised as a state, introversion as a trait, most psychological constructs vary along a continuum of stability or what Kenny and Zautra call 'traitness' (Kenny & Zautra, 2001). Thus conceived, a state-trait framework provides a suitable model for examining the stability of risk attitudes and opinions. Here I consider attitudes and opinions to be analogous to traits and states respectively. There is no universally accepted definition of attitudes, although the concept is central to most social psychology. For the present purposes I employ Eagly and Chaiken's definition of an attitude as a 'psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour ' (Eagly & Chaiken, 1993 p.1) with the additional stipulation that it should be relatively stable and enduring too. This distinguishes an attitude from an opinion. I use opinion in this context to mean an expression of a view that is likely to change quite easily, be relatively less well considered, and more likely to vary according to the particular circumstances in which it is expressed. However, using the concept of traitness, it is possible to specify more precisely what these conceptualisations of attitudes and opinions mean in terms of a practical and realistic analytic framework. In LST theory, stability is defined as 'the consistency of interindividual differences in intraindividual change' (Rudinger, Andres, & Rietz, 1991) . That is to say that for a construct to exhibit high traitness, the rank order of individuals on the construct should not vary much, independent of the amount of aggregate change. Conversely, where the rank orderings are unstable, this implies more 'state-ness' (Kenny & Zautra, 2001). This framework allows for a more sophisticated and realistic modelling of the processes that can lead to the apparent discrepancy between aggregate stability and individual variability, recognising the relative contribution of state and trait variance in the observed scores over time. In the following section I describe the LST model in more detail and contrast it with the model of Judd and Milburn (1980). I then move on to a description of the data and methods used for this study on GM food risk before presenting the results.

6.1.3 Models for the decomposition of variance in longitudinal data

There are several types of model for decomposing variance in panel data. One is the LST model proposed by Steyer and colleagues (Steyer & Schmitt, 1990; Steyer, Schmitt, & Eid, 1999). Another is of the autoregressive simplex type, of which Kenny and Zautra's STARTS (stable trait, autoregressive trait and state) model is an example (Kenny & Zautra, 2001) as well as the model employed by Judd and Milburn (1980). This latter model proposes three orthogonal sources of variance in each attitude item: that which is common to all indicators at each time point, that which is common to each indicator at all time points and that which is unique to each indicator at each time point. The measurement portion of the model is an example of an MTMM (multi-trait multi-method) model (Campbell & Fiske, 1959). Attitude stability over time is assessed by estimating the structural coefficient between the common factor at successive time points. The model postulates a Markov or simplex structure whereby the underlying attitude at time 2 is 'caused' by the attitude at time 1, the attitude at time 3 by the attitude at time 2 and so on. These models often do not fit, which is what Judd and Milburn found. They therefore estimated a model for their three wave panel data (shown in figure 6.1) where attitude at T3 is caused by attitude at T2 and directly by attitude at T1, in addition to the indirect effect mediated by attitude at T2. However, there is no real theoretical specification of the interpretation or meaning of 'direct' and 'indirect' effects of earlier attitudes on later ones in Judd and Milburn's presentation.

Figure 6.1 Structural model of political attitudes over time (Judd and Milburn, 1980)



One of the possible causes of lack of fit in Markov models (i.e. without the direct effect from T1 to T3 as above) might be because the real processes generating the data consist of the effects of both underlying, enduring attitudes and of situation-specific opinions. Both the LST and STARTS models incorporate these distinctions. The STARTS model is the more complex as, in addition to trait variance, it includes both occasion specific and autoregressive state variance. However, as it requires at least four measurement occasions for identification and estimation to be carried out, it is not possible to test this model on the data available in this study despite its theoretical attractiveness. The focus in this analysis is on estimating the relative contribution of state and trait variance in responses to questions about GM food risk measured on only three occasions. Happily, this can be achieved using the simpler LST model proposed by Steyer *et al*.

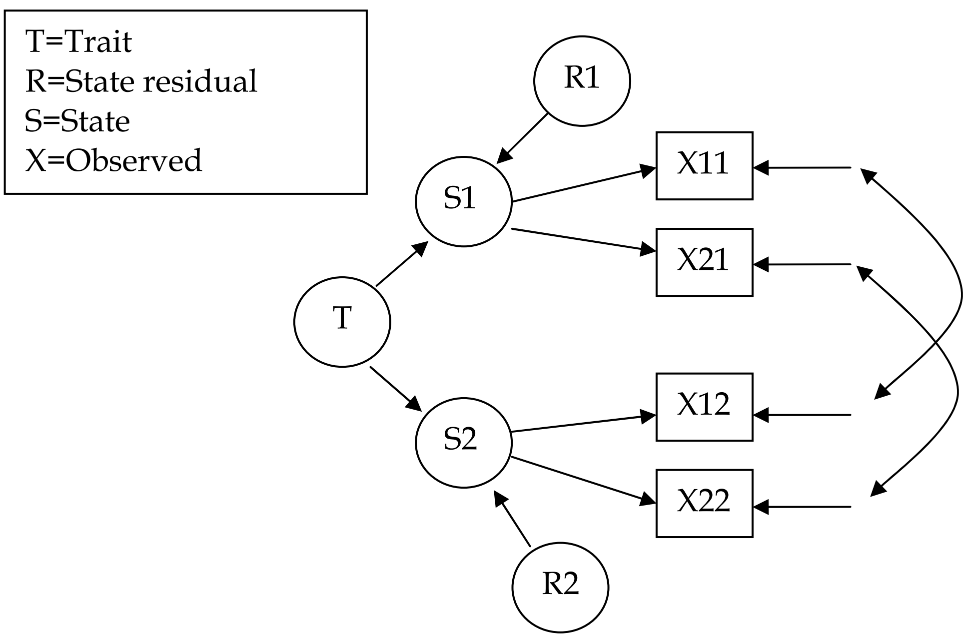
Steyer *et al*'s most general LST model has a single trait and multiple states, according to the number of occasions of measurement. There are four orthogonal sources of variance that account for the observed scores on the indicator variables.

- Trait – common to all indicators at all time points
- State – common to all indicators at each time point
- Unique – common to each indicator at all time points

- Error – unique to each indicator at each time point

As the focus of this investigation is more on the comparison of latent attitudes and opinions and less on the particular characteristics of the items used to measure these constructs, I use a slightly simpler modification of the model. In the model used in this chapter, I do not distinguish between unique variance and error variance. I simply allow for correlations between the same items' error terms between waves. As Kenny and Zautra (2001 p.251) point out, this is the more general model and it is usually subject to fewer difficulties in estimation.

Figure 6.2 LST model with correlated errors



The general form of the model is shown in figure 6.2. Trait variance (T) affects the latent state score (S) at each occasion. Variance unaccounted for by the trait is caused by occasion specific variance - the state residual variance (R). This state residual is the component reflecting occasion specific factors. Variance in the indicators (X) is accounted for directly by latent state variance and unique error, and indirectly by the trait and state residual. All four components account for the total variance in each X variable. The unique error components are assumed to be correlated with each other for the same variables at different time points. This error structure thereby incorporates but does not distinguish between random and unique variance for each question, partitioning only three of the four different sources of variance.

When it comes to estimating the unknown model parameters, there are various possibilities for equality constraints. One can constrain the unstandardised factor loadings (lambdas) for the same items at different time points to be equal (tau-equivalence). The same equality constraints can be tested in respect to the error variances and to the loadings on the latent trait (gammas). The main substantive reason for doing this, aside from the general principle of Occam's razor (favouring more parsimonious models), concerns the item lambdas. In order to be certain that the meaning of the questions in relation to the underlying attitude or opinion is invariant over time, the lambdas should be constrained to be equal at each measurement occasion. If this specification does not fit the data adequately, one would be less sure that the meaning of the concept remains the same through time (Meredith, 1993).

There are two principal objectives for the analysis. One is a test of the plausibility of the state trait distinction for attitudes and opinions about GM food risk. If a good fit to the data is achieved when the restrictions on the covariance structure implied by the LST model are imposed, this would provide some evidence that people's views about GM food risks are partially based on a stable enduring attitude and also on contextually specific factors that are different at each occasion of measurement. The most important model restrictions are firstly that the latent states at each wave are independent when conditioned on the latent trait and secondly that the latent state residuals (situational factors) are uncorrelated. If the model fits, interesting information is contained in particular parameter estimates. An additional constraint can be placed on the state residual variances. By testing a model where they are forced to be equal, it will be possible to see whether all three unique occasions of measurement are equally significant contexts for explaining expressed views.

The aim is to estimate the relative importance of state and trait (attitude and opinion). This can be expressed as the ratio of variance from the state residual and trait factor that accounts for the observed scores. A high ratio of state to trait variance would imply a rather unstable attitudinal base driving responses to the questionnaires. Conversely, a low state to trait variance ratio would imply a more stable and consistent basis for attitudes. Steyer et al refer to the proportion of trait to total variance as the 'consistency' coefficient and the proportion of state residual to total variance as the 'occasion specificity' coefficient (Steyer, Schmitt, & Eid, 1999 p.9). The reliability of each indicator is the sum of these two, in the sense that this is the true score portion of the item variance.

Bearing in mind that it is only the covariance structure of the data that is being examined, the analysis does not speak to mean changes in attitudes and opinions, but only of the sources of variation. Finally, it is important to remember that a stable trait (or attitude) component does not imply an unchanging mean score. What it does indicate is that interindividual differences remain relatively unchanged. That is to say, if the whole population were to become more worried about the risks of GM food over time, the ranking of individuals within the population would remain unchanged insofar as worry about GM food risk has trait-like properties.

6.2 Data and methods

The data for the following analysis come from a study on food-related risks carried out during 1995 and 1996 by Chris Fife-Schaw[4] and Gene Rowe at the Social Psychology European Research Institute (SPERI), University of Surrey, on behalf of the Ministry of Agriculture, Fishery and Foods (MAFF) (Fife-Schaw

[4] I am very grateful to Chris Fife-Schaw for making the data available to me.

& Rowe, 1996, 1996). After a pilot study comprising nine focus groups and a postal questionnaire (N=293), Fife-Schaw and Rowe designed and administered a postal panel survey, at three separate occasions, that contained questions about ten food risks. One of the food-related risks they asked about concerned health risks from eating GM food. Each risk was assessed by asking ten questions similar in nature to those commonly asked in psychometric risk studies - so called 'risk dimensions'. In addition to these items, the survey contained basic demographics (age, marital status, highest educational qualification, ethnicity), ACORN rating (a small-area geo-demographic rating of socio-economic status based on 1991 Census data). A copy of the questionnaire is reproduced in appendix C.

A total of 7500 questionnaires were sent out to a stratified random sample of the UK population in mid-May 1995. The stratification was based on Government region and ACORN rating. Three weeks after the first mailing, reminders were sent out to those who had not returned their questionnaire. 2091 were eventually returned completed (effective response rate 29.4%). There were several versions of the questionnaire fielded that randomly assigned people to experimental conditions based on different question orders, information interventions and the insertion of new hazards. The details of these will not be discussed further here. Several versions of the questionnaire, including these manipulations, were sent out to the same respondents, randomly allocated to different conditions, in October 1995 and again in February 1996. Effective response rates for waves two and three were 67.1% and 88% respectively.

An unfortunate outcome of this, for present purposes is that the usable sample of respondents that completed the same or comparable version of the survey at all three waves, as used in this analysis, was as small as 231. This, along with the low initial response rate means that the results should be treated with appropriate circumspection. That said, the demographic characteristics of the achieved sample are close to that of the full sample with no major over or under representation of the stratified groups. I therefore follow Fife-Schaw and Rowe in not employing sample weights in the analyses that follow.

In section 6.3, I present some basic results that show the stability and change in responses to questions on GM food included in the survey. In section 6.4, I describe the results of the model fitting part of the analysis. I employ structural equations using the Amos 5 software package to fit these models. An introduction to SEM was presented in the discussion of methods in Chapter Four.

6.3 Preliminary results

The ten questions about GM food risk that were asked in the survey are presented in table 6.1 along with mean scores at all three waves of the survey ordered by score at wave 1. In each instance there are approximately 230 cases. As mentioned earlier, this relatively low number is unavoidable because of the differences in alternative versions of the questionnaire sent out. The 231 cases for which comparable data are available are composed of respondents who received two versions of the questionnaire. The first remained the same at each wave. The second introduced a new hazard (campylobacter) at waves 2 and 3. This slight change did not have any significant effect on responses to the GM food questions (Fife-Schaw & Rowe, 2000). Accordingly, responses to the two versions were pooled for the remainder of the analyses in this chapter.

Each question was presented with responses in a 5-point unipolar Likert format (see appendix C for exact wordings and response alternatives) and coded from 1 to 5 (anchors shown in the table) where a higher score is closer to the second anchor. Variables are treated here as continuous.

Inspection of table 6.1 reveals a range of mean scores across the ten items. There is a very high level of agreement that GM food risks are the fault of mankind and that it is the government's job to protect people from any risks (4.6 and 3.9 respectively). Looking to the foot of the table, it is clear that most people consider that it is not easy to tell if food is genetically modified. The average amount of worry expressed about the potential risks is below the scale midpoint (2.5) at 2.2.

Table 6.1 Mean scores for ten risk questions at three waves

	Wave 1	Wave 2	Wave 3
Risks natural or the fault of mankind?	4.61	4.60	4.63
	(0.06)	(0.05)	(0.05)
Your responsibility, or Government to protect you?	3.91	3.81	3.73
	(0.07)	(0.07)	(0.07)
Is harm dependent on how much of it you eat?	3.46	3.63	3.57
	(0.08)	(0.07)	(0.08)
How common in Britain is GM food?	2.88	2.88	2.80
	(0.06)	(0.06)	(0.06)
How much do scientists know about risks?	2.82	2.81	2.76
	(0.06)	(0.06)	(0.07)
How likely is it that your health will be harmed?	2.59	2.47	2.41
	(0.07)	(0.06)	(0.06)
How serious the harm to your health?	2.42	2.43	2.37
	(0.07)	(0.06)	(0.07)
How much control over whether to eat GM food?	2.27	2.35	2.58
	(0.08)	(0.07)	(0.08)
How worried are you?	2.19	2.26	2.20
	(0.07)	(0.07)	(0.07)
How easy is it to tell if food is GM?	1.50	1.63	1.83
	(0.06)	(0.06)	(0.07)

* N=approx 230; SEs in parenthesis

Looking across the columns to compare waves, scores appear to be very stable. The largest difference (.33) is in responses between wave 1 and 3 for 'how easy to tell' where people appear to become more confident at each wave of being able to tell whether food is genetically modified or not. Give that this is the lowest score to begin with, one might suspect regression to the mean is playing a part (Campbell & Kenny, 1999). However, on closer inspection, a more consistent, albeit weak, pattern emerges. The other items where the larger changes take place concern beliefs about control, responsibility and likelihood of harm (.31, -.18, -.18). Although the changes are small, it seems likely that people are becoming slightly more confident in their knowledge about GM food risks, feel they have more control, are prepared to take more responsibility and consider it increasingly unlikely that they will come to any harm. Nevertheless, the overall picture is one of stability. For most questions, scores are not significantly different at successive waves. Standard errors are uniformly rather low, contributing to the picture of consistency.

In reviewing the findings of Converse and others earlier on, I noted that aggregate stability in terms of scale means or percentages can mask a great deal of intraindividual change. The next analysis looks beyond mean summaries and considers the amount of individual switching between response alternatives over successive waves.

Table 6.2 Percentage of 'switchers' and mean correlation of ten risk items over three waves

	% Switching		Mean corr.
	Wave 1 - 2	Wave 2 - 3	
How worried are you?	49	41	.68
How serious the harm to your health?	48	47	.61
How likely is it that your health will be harmed?	55	50	.52
Risks natural or the fault of mankind?	28	28	.52
How much do scientists know about risks?	55	56	.50
How easy it to tell if food is GM?	44	49	.47
Is harm dependent on how much of it you eat?	60	57	.41
Your responsibility, or Government to protect you?	52	51	.41
How common in Britain is GM food?	53	55	.40
How much control over whether to eat GM food?	60	61	.39
(Mean)	(47)	(47)	(.49)

*N=192

Table 6.2 shows the percentage of respondents who choose a different response alternative at wave 2 from that chosen at wave 1 (column 1) and for respondents who make different choices between wave 2 and wave 3 (column 2). The final column presents the mean correlations between responses at wave 1 and 2 and between waves 2 and 3. People who do not make any choice on at least one occasion are excluded from the analysis. The table shows that just under half of all respondents switched response choices at each successive wave. The most consistently answered question is 'natural or mankind?' Between waves 1 and 2 and between 2 and 3 only 28 percent of respondents changed their response. The next most consistent item is 'easy to tell if GM?' where 44 percent and 49 percent switch. It is no coincidence, looking back to table 6.1, that these items also have the most extreme mean scores. There are almost certainly floor and ceiling effects at play here. Additionally, these items did exhibit significant mean shifts over time, albeit small ones. The remainder of the items display quite a high degree of instability. In particular, the two questions about the 'amount of harm' and 'scientists' knowledge' have around 60 percent of respondents switching at successive occasions. In fact, the level of individual 'churn' reported here is very much in line with what is found in other longitudinal attitude surveys on other topics (e.g. Johnson & Pattie, 2000; Sturgis, 2001; Zaller & Feldman, 1992).

By examining the average correlations between wave 1 and 2 and wave 2 and 3 a picture of slightly greater stability comes into view for at least some items. Correlations range between .68 for the question about 'worry' down to .39 for the item about 'control'. Even with the less restrictive view of consistency represented by between wave correlations, there is still seemingly a rather low level of stability in most items. Furthermore, it seems unlikely that this inconsistency results from true change in attitude, as the average correlation between scores on all items between waves 1 and 3 is .48 (not shown in the table). This is of the same magnitude as correlations between successive waves. If true attitude change has taken place over time, one would expect decreasing correlations between more distant occasions of measurement, something that is not the case here.

These results show that there is a rather wide variation in the relatively stability between different questions. It looks as if the more general questions are those that exhibit more stability, judging by the interwave correlations. These are the questions that measure summary beliefs about likelihood of harm, seriousness of harm and the more affective question of how much people worry about GM food risk. Interestingly, they are not predominantly the types of belief associated specifically with the psychometric approach, although the 'natural/mankind' question has the same interwave correlation as the 'likelihood of harm' item.

Of course, one could argue that the 'worry' and 'seriousness' items do in some way reflect the 'dread risk' factor from the psychometric approach. This is true inasmuch as they tap affective and cognitive components in a general sense that resemble part of the dread risk cluster. However, some of the other key components of dread risk – 'controllability' and 'unnaturalness' – are not stable over time. This is, in my view, good reason not to consider 'worry' and 'seriousness' as merely substitute expressions for dread risk.

At all events, to progress further, it is necessary to go beyond looking at individual items. In the following sections I first describe the evaluation of a subset of items as indicators of overall risk perception. This subset is then used in the LST model described earlier.

6.4 Main results

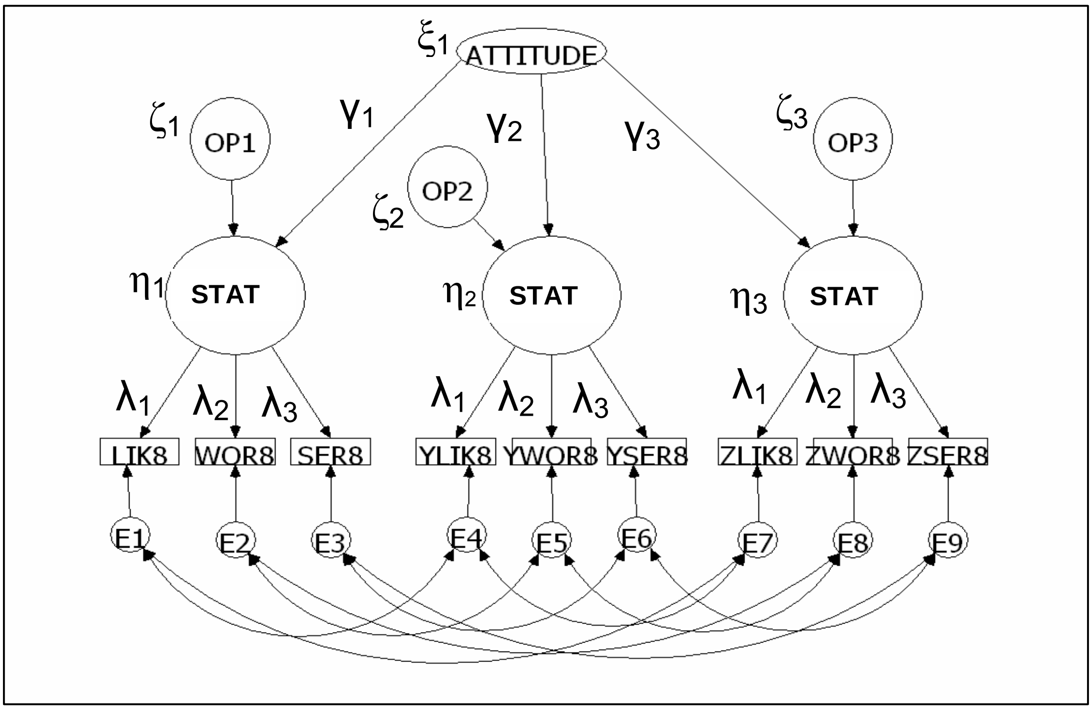
The original idea for this analysis was to extend the single-trait multi-state model to incorporate two traits that correspond to the 'psychometric' risk dimensions found by Fischoff, Slovic and others (Slovic, 1987). Something corresponding to these two factors, 'dread' risk and 'unknown' risk were found in the exploratory factor analysis (EFA) of these data carried out by Fife-Schaw and Rowe. However, they used a method that is unsuited to the examination of interindividual differences, albeit one that is almost always used in risk perception research. The problem comes from the aggregation of respondents' ratings of risk characteristics. While this problem has not gone unnoticed, it still underpins much research in the area even now (but see Arabie & Maschmeyer, 1988; Johnson & Tversky, 1984; Marris, Langford, Saunderson, & O'Riordan, 1997). The basic methodological problem is that the raw data deck is three-dimensional: persons, hazards and characteristics. The problem is to reduce this configuration to two dimensions. This is almost invariably achieved in psychometric studies by calculating mean scores on each characteristic (e.g. familiarity, catastrophic potential) and then re-arranging the data to produce a rectangular file containing hazards in the rows and mean scores for each characteristic in the columns. This dataset is then subjected to a factor analysis or principal components analysis, which generally results in a two or three factor solution that accounts for the covariances in the risk characteristic scores across all the hazards. The problem with this approach is that inter-individual variation is not modelled at all. The use of mean risk characteristic scores for each hazard assumes that each individual's judgments about a hazard are the same. What is represented in the factor analysis is the inter-hazard variation whereas what is really required in order to talk about the structure of attitudes, beliefs or perceptions is an analysis of interindividual variation. From a social psychological perspective it is crucial to be able to achieve this if one wants to say anything about the structure of risk perceptions. In this case, I am only interested in one hazard - GM food. If the dread/unknown dimensions really represent the structure of attitudes, this two-factor structure should be present in the responses to the questions asked about each hazard individually.

Preliminary analysis of these ten risk items at wave 1 using CFA did not support this structure, contrary to expectations from the psychometric approach to risk perception and the original analysis of Fife-Schaw and Rowe (see Fife-Schaw & Rowe, 1996). From the latter analysis, which used all the hazards in the manner described earlier, one would expect to see items 1,2,3,6,9 and 10 load on the first factor (dread risk) and the remaining items load on a second factor (unknown risk). Because this structure did not seem to fit the data at all, an EFA was performed on the same items, which indicated that only items 1,2 and 3 loaded strongly on a single factor. Accordingly, I decided to use these items as indicators of GM risk attitudes in the modelling phase of the analysis. Interestingly, these are the most generally worded questions but also those that contain what could be seen as the basic cognitive (probability and harm) and affective (worry) elements of risk attitudes. I do not present these preliminary results in detail due to space considerations and because they are not crucial to the main questions addressed in this chapter. More details are available from the author upon request.

6.4.1 Model specification

The model to be fitted is shown in figure 6.3. The observed variables, 'likelihood', 'worry' and 'seriousness' are used as indicators of risk attitudes and opinions at each wave. Waves are organised in chronological order from left to right on the diagram. Starting from the top of the figure 6.3, the higher order latent variable is risk attitude (ξ_1), which is hypothesised to account for part of each of the latent state variances ($\eta_{1,2,3}$) at each wave.

Figure 6.3 LST model with correlated errors for GM food risk



The remainder of state variance at each occasion is caused by occasion specific opinions, or state residual factors ($\zeta_{1,2,3}$). Responses on each observed variable are therefore due directly to a state component and indirectly to a state residual (opinions) and trait (attitude). E_1-E_9 are error terms. Each error term covaries with the corresponding item error term at each wave. This reflects the expected random error and systematic error unique to each item.

Constraints in the baseline model were specified such that the unstandardised gamma loadings γ_1, γ_2, γ_3, were fixed at unity to avoid identification problems. Additionally, as is standard practice in SEM, one of the lambda loadings (λ_{11}, λ_{21} λ_{31}) at each wave was fixed to unity in order to set the scale of the latent state variable and allow the model to be identified. The sample means, standard deviations and intercorrelations for the three items at three waves are shown in table 6.3.[5]

Table 6.3 Correlations and descriptive statistics for three risk questions at three waves

	Mean	S.D.	Wave 1			Wave 2			Wave 3	
			Ser1	wor1	lik1	ser2	wor2	lik2	ser3	wor3
ser1	2.41	1.01								
wor1	2.19	1.14	.651							
lik1	2.59	1.06	.620	.704						
ser2	2.43	0.97	.622	.449	.416					
wor2	2.28	1.12	.529	.640	.525	.564				
lik2	2.47	0.88	.427	.453	.437	.457	.600			
ser3	2.34	0.98	.604	.544	.456	.603	.597	.438		
wor3	2.20	1.03	.579	.650	.540	.558	.709	.441	.663	
lik3	2.42	0.88	.443	.546	.511	.458	.554	.579	.577	.650

6.4.2 Model testing and development

A series of nested models was fitted, each adding progressively more restrictions to the baseline model. If the baseline model fits adequately, progressively more constrained models that do not involve significant loss of fit may be preferred as they offer a more parsimonious representation of the data. Model descriptions and goodness of fit measures for the series are shown in

[5] Note that these are not the precise moments used in estimating the model as they are here presented with listwise deletion whereas AMOS uses the FIML method for missing data, which imputes values iteratively during estimation.

table 6.3. Also included are changes in Chi Square and degrees of freedom between each restricted model and the baseline model.

The congeneric baseline model[6] (1) fits the data well. This is apparent from all fit measures. With a sample size of 231, the asymptotic Chi Square statistic is not 'overpowered' and the model can be accepted based on the non-significant Chi-Square, low RMSEA and high CFI.

Table 6.4 Comparison of fit for four alternative nested models

Model	Chi^2	df	p	Δ Chi^2	Δ df	RMSEA	CFI	AIC
1: Congeneric (baseline)	21.7	17	.20	-	-	.04	.99	96.7
2: Equal factor loadings across waves	25.9	21	.21	4.2	4	.03	.99	92.0
3: Equal factor loadings and error variances	32.8	27	.20	11.1	10	.03	.99	86.8
4: Equal factor loadings, error variances and state residuals	46.0	29	.02	24.3	12	.05	.99	96.0

In the next step, the lambdas were forced to be equal across waves. This model does not lead to a significant loss of fit according to the difference in Chi Square. RMSEA decreases a little, probably because the constrained model has more degrees of freedom. That this model fits is important, as it indicates that in some sense the same concept is being measured at each occasion. If the pattern of loadings is markedly different at different waves, one would have reason to suspect that the semantic interpretation of the questions for respondents was changing over time (Meredith, 1993). This would tend to

[6] Congeneric is a term whose origin is in classical test theory. In SEM terms, it has come to denote a measurement model with freely estimated factor loadings.

invalidate or weaken an analysis that postulates an enduring attitude as an explanatory factor.

Model 3 tests a further constraint: that of equal error variances across waves. This model also fits and does not involve any loss of fit compared to the baseline model. It is a more parsimonious representation of the data, with ten more degrees of freedom than model 1. It provides further evidence that the meaning of the questions for respondents is invariant over time and indicates that the measurement model is robust.

In model 4, a restriction is imposed in the structural part of the model, i.e. on the theoretically important latent variables themselves. In this model the hypothesis that the state residuals (zeta variances) are equal at each wave is tested ($\zeta_1=\zeta_2=\zeta_3$). This is of theoretical interest because if it were the case that people are equally likely to respond with labile opinions at each occasion, one might conclude that no further 'learning' or increase in engagement with the issue of GM food risk was taking place. On the other hand, from prior research in longitudinal attitude surveys, there is often observed a so-called 'Socratic effect' (Jagodzinski, Kuhnel, & Schmidt, 1987; McGuire, 1960). This phenomenon has been observed in experimental and non-experimental settings. It refers to the apparent increase in consistency of responses to thematically related items over repeated occasions of measurement. It is plausible that this is due to the measurement process itself and that 'in particular, after the first interview, respondents may continue to process cognitively the topics and issues addressed in the questioning even though they may not be fully aware of doing so' (Jagodzinski, Kuhnel, & Schmidt, 1987 p.263). Looking at the fit statistics for model 4, the imposition of the equality constraint leads to a significant loss of fit. There is an increase in Chi Square of 24.3 for the gain of 12 degrees of freedom. Along with the increase in RMSEA, this suggests that the model does not adequately represent the data when compared either to the baseline model or to the restricted model 3. It therefore seems reasonable to conclude that the relative contribution of labile opinions and attitudes that are more enduring is different at different points in time.

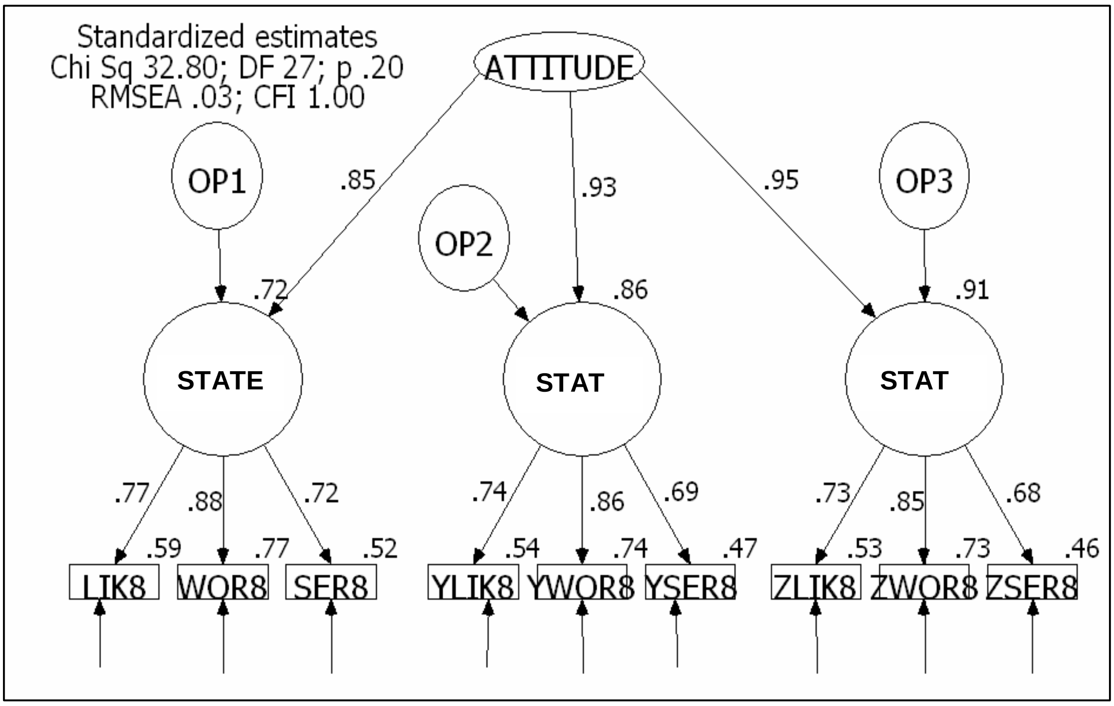
According to the fit of the models described, model 3 is selected as the final one for estimating the relative proportions of trait and state residual variance, as it is the most parsimonious that fits the data. This model, with the relevant standardised parameter estimates, is presented in figure 6.5. Error variances and covariances are omitted from the diagram.

6.4.3 Interpreting the model parameters

Looking first at the items themselves, an interesting pattern emerges. The most reliable item at each wave is the 'worry' question, with squared multiple correlations of between .73 and .77. Next most reliable (.53-.59) is the 'likelihood of risk' question, followed by 'seriousness of risk' (.46-.52). The reliabilities are analogous to what Steyer calls the 'consistency coefficient', that is to say the proportion of item variance due to combined state residual and trait. From these results, it appears that the question that taps the affective part of risk perception - how much someone worries about GM food risks - is a more reliable and discriminating indicator of risk perception than the two more cognitively based questions. The latter two questions tap the more formal beliefs relevant to conventional risk assessment - likelihood of harm and seriousness of harm.

Considering changes across waves, the pattern of standardised factor loadings of the latent state variables (state1,2,3) on the attitude latent (gammas) show an increasing trend over time. Accordingly, the proportion of variance in the latent state variables (which can be thought of as the occasion-specific 'true score') explained by the attitude at each wave also increases from 72 percent at wave 1 to 91 percent at wave 3. The state residuals that I interpret as 'opinion' variances (OP1,2,3) are concomitantly declining over time, being no more than the difference between variance attributable to attitude and total variance.

Figure 6.4 LST model for GM food risk with standardised parameter estimates and fit statistics



Hence we see an increasing influence of the underlying attitude on situational 'true' or state score compared to opinion over time. This is also apparent when one calculates the proportions due to trait, state residual and error in each item. These are shown in table 6.5.

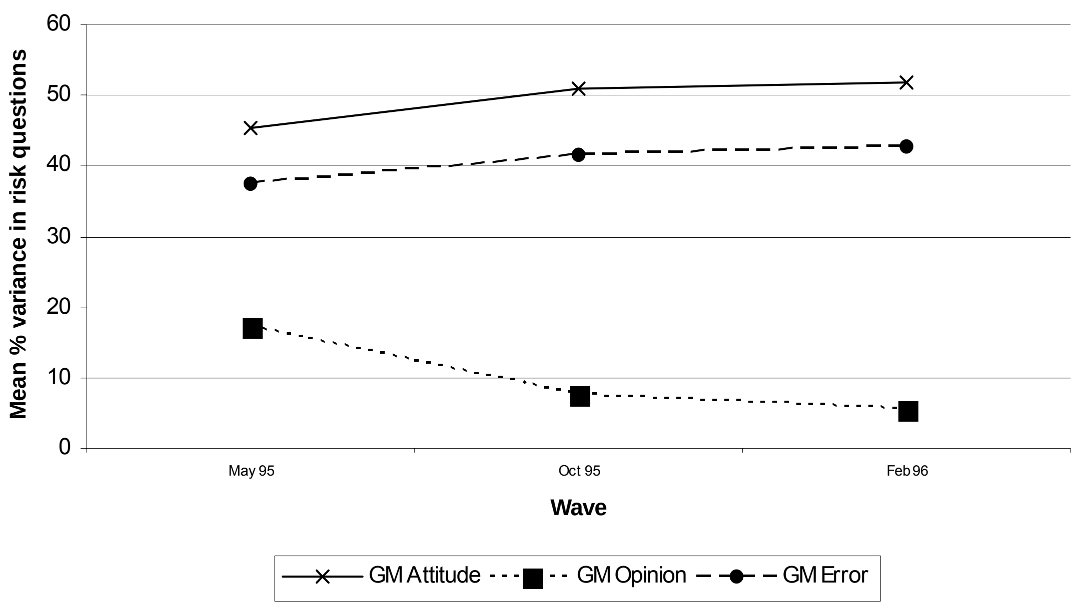
Table 6.5 Decomposition of variance for final LST model

%	Trait (Attitude)			State (Opinion)			Error		
	Wave 1	Wave 2	Wave 3	Wave 1	Wave 2	Wave 3	Wave 1	Wave 2	Wave 3
Worried?	56	64	65	21	10	8	23	26	27
Likely?	43	47	48	16	7	5	41	46	47
Serious?	37	41	42	15	6	4	48	53	54

The percentages are calculated according to the normal method for the decomposition of direct and indirect effects in path modelling. For example, the percentage of variance in the item 'worried?' at wave 1 is calculated by taking the squared multiple correlation of state1 on trait (.72), multiplying this by the standardised factor loading for 'worry' (.88) and then taking the square of this to arrive at .56, or 56 percent. As can be seen, the ratio of trait to state residual for all items at wave 1 is about 2.5:1. At waves 2 and 3 the average ratio for each item increases to more than 6:1. This gives an indication that expressed views become more consistent with an underlying stable attitude over time, but particularly between waves 1 and 2.

A somewhat puzzling feature of the estimated item reliabilities is that they actually decline over time, while the influence of stable attitude at the same time becomes increasingly important. While the model does not allow a firm conclusion to be reached, it is possible that an increasing source of stability is also due to increased unique item variance over time. That is to say that people become progressively more consistent in their responses to the same question at different waves independently of consistency that is reflective of the overall risk attitude.

Figure 6.5 Decomposition of mean variance for three GM risk items



In this model, item specific and random error variance is not distinguishable. To check this, I attempted to fit a model where item specific variance was modelled as three additional latent variables but ran into model identification problems and Heywood cases, possibly due to the relatively small sample size. However, indicative evidence from this exercise (increased factor loadings on item specific latents at later waves) suggests that an increasing influence of time-invariant, item specific characteristics is the most plausible explanation for the small decline in the total contribution of state residual and trait observed at later waves. This observation is captured in figure 6.5 where the average percentages of attitude, opinion and error variances for all three items are plotted over time.

From this depiction, it is amply clear that the biggest change, in line with the Socratic effect alluded to earlier, is between first and second waves. Attitude variance accounts on average for about 50 percent of the variance in the observed responses, while random and systematic error together account for about 40 percent. Opinion variance is the least influential declining from an initial 20 percent to less than 10 percent by the third wave.

6.5 Discussion

In general terms, the analyses presented in this chapter suggest that interindividual differences in expressed views on GM food risks look to be significantly influenced by relatively enduring attitudes. Labile, context specific opinions form another component of the explanation, although not such an important one. It is also a component that, in the present data at least, declines in magnitude over time. Error variance is much greater than opinion variance at all occasions of measurement and is relatively high compared to what is desirable for attitude scales. This suggests that the questions are not interpreted uniformly by all respondents but that each is subject to a fair degree of essentially random response. Another, slightly more speculative view, is that despite many people holding a core attitude towards dangers from GM food, many people interpret and respond to the questions consistently but in ways disconnected with their underlying attitude towards GM food risks. In other words, there may be strong meanings associated with the ideas of likelihood (probability), seriousness of consequences and worry about GM food risk that are not captured in an overall attitude towards GM food risk, or, alternatively, risk perception.

The Socratic effect that apparently takes place is interesting. This corroborates work by Jagodzinski *et al* (Jagodzinski, Kuhnel, & Schmidt, 1987) who were investigating this effect in a completely different attitudinal context (attitudes to guest workers in West Germany). More substantively, as far as this thesis is concerned, it shows how greater cognitive engagement with issues around gene technology can lead to changes in the structure of attitudes and opinions. In this case, of course, the increase in engagement is forced due to the measurement process itself. Nevertheless, it points to possible roles for knowledge acquisition, engagement and information effects in expressed attitudes to gene technology risks. It would have been interesting investigate the extent to which the structure of attitudes and opinions modelled here applies equally to all members of the population. Stratifying the analysis by those who are more or less informed about, or engaged with, gene technology could cast some light on the moderating effect of people's existing state of knowledge on the structure of attitudes and opinions. These are issues that I and others have recently discussed elsewhere (Gaskell, Allum *et al.*, 2001; Sturgis & Allum, 2004); some of them will be taken up in a later chapter of the thesis. Unfortunately, with the dataset used in this chapter's analysis, the sample size is too small to explore the effects of stratification of this kind.

The lack of support for the psychometric dimensions of 'dread' and 'unknown' risk is of some significance and probably warrants further investigation at some stage. As mentioned earlier, it has long been known that the methodology used in support of these two general dimensions of risk perception is of dubious validity for the explanation of interindividual differences. Different analytic strategies, from multi-dimensional scaling (Johnson & Tversky, 1984) to multilevel modelling (Langford, Marris *et al.*, 1999) have been suggested but lack a theoretical framework into which to place risk perception research in general. The psychometric dimensions sound quite plausible as beliefs relevant to attitudes towards gene technology risks from focus group discussions. It appears, though, that the conventionally designed measuring instruments (in relation to the psychometric approach) such as that of Fife-Schaw and Rowe do not confirm this expectation when single hazards like GM food are investigated.

There are some limitations to the analytic approach taken here. I began by noting the seemingly low salience of GM food risk as an issue for the public, with evidence from several sources. It was hypothesised that people's attitudes may more accurately be described in many cases as mere opinions because of the shallow cognitive and affective base from which they appear to emanate. To test this hypothesis, and to assess the relative explanatory power of situation-specific and person-specific factors, a panel survey was analysed using a latent state-trait model. Certainty about the conclusion - that people's expressed views spring in large part from an enduring attitude - should be moderated by realising that the variation in context is not as great as it could in principle be. Three occasions of completing the same survey will inevitably take place in all sorts of situations - enough to make this type of analysis worthwhile. However, an even stronger analysis would take measurements across a wider range of observational settings, and not just the repeated completion of a single questionnaire. Steyer *et al* make this point clearly.

> *The naïve idea that each person has one and only one trait score at a given time, and that this score is independent from the setting considered rests on the assumption that the trait score can be measured without situational effects…the trait score can be defined only by some aggregation procedure such as taking the expectation across different situations in which the individual might be at the occasion of measurement.*
>
> (Steyer, Schmitt, & Eid, 1999 p.21)

It is possible that for this reason, the degree to which the survey responses arise from enduring attitudes is overstated in the LST model results.

Another reason to suspect a possible inflation of trait-like variance in relation to its true value in the population is due to the nature of the sample. One should be mindful that with a 29 percent initial response rate, there must inevitably be a degree of self-selection based on interest in the topic of food risks. It is more than possible, therefore, that people with relatively well-formed attitudes are over-represented in the sample. The same caveat applies to sample attrition. Those who drop out after one or two waves are likely to be amongst the least interested. This may have some effect on the observed trend towards increased trait variance over successive waves.

Notwithstanding these limitations, the results presented here indicate that there is sufficient reason to consider attitudes towards GM food risk as substantial enough to warrant serious investigation of their causes and correlates. It is to some of these that I now turn in the chapter that follow.

7 RISK PERCEPTION AND THE DIMENSIONALITY OF TRUST

7.1 Introduction

In the previous two chapters I have elaborated on the structure and stability of public perceptions of risk in relation to gene technology, and GM food in particular. In the final two empirical chapters, I investigate some of the factors implicated in the formation of these perceptions. The factors on which I choose to focus are suggested partly by the existing literature and partly in light of the empirical findings reported thus far in the thesis. In Chapter Five, one of the striking findings was the way in which people were grappling with what were obviously, to most people, unfamiliar ideas about gene technology. Many people admitted that it was the first time that they had talked about the issue. This did not mean, however, that people had nothing to say about gene technology risks at all, but rather that they seemed to draw on their existing, familiar frames of reference in formulating their opinions, positioning gene technology within these frames. Interestingly, the frame, or schema that was called to mind was not so much about scientfic risk assessment or probabilities but had to do with issues around trust, control and confidence in government and scientists. This points very clearly to the notion that confidence in people responsible for deploying new technologies is a key factor in explaining perceptions of risk. But furthermore, it suggests that even in situations where people have not previously cognised an example of gene technology risk, a schema about the social actors involved is a resource on which people draw as they formulate attitudes and beliefs 'on the fly', so to speak. Hence further analysis of the role of social trust in relation to risk in the case of gene technology would seem to be a potentially fruitful avenue of research. A theory of trust consistent with the notion that people use quick, largely non-cognitive evaluations in assessing actors' trustworthiness seems particularly apposite. The SVS theory of trust, identified in Chapter Two as a promising perspective in the literature, appears equally promising on the basis of the empirical results presented in the thesis so far. These two considerations lead to the work presented in this chapter.

The chapter begins with a brisk revisitation of the literature on trust and the perception of risk, paying particular attention to the contribution of the SVS theory in relation to other perspectives on social trust. From this discussion of what I refer to as the 'dimensionality' of social trust, I then derive several testable hypotheses in relation to perceptions of GM food risk. A new survey instrument was developed for this purpose, which was described in Chapter Four. I present preliminary descriptive results before moving on to address three main hypotheses with several structural equation models. Implications of the results are discussed at the end of the chapter.

7.1.1 Trust and the perception of risk

The theoretical importance of trust in interpersonal and societal relations in the face of uncertainty was outlined in Chapter Two. Trust between individuals can act to lubricate personal relations by reducing complexity and uncertainty. By trusting someone else to make decisions on the basis of relevant information in situations of potential risk, one reduces one's own cognitive load. Social trust, in Niklas Luhmann's perspective, enables societies to tolerate increasing uncertainty due to progressive technological complexification by allowing for the division of labour between trusted expert institutions (Luhmann, 1979). Of course, one can argue that distrust is also 'functional' as a mechanism for calling to account those that do not deliver on their promises and for directing the appropriate amount of vigilance towards those in positions of responsibility. Given this, it should be clear that the empirical investigation of trust as one of the determinants of risk attitudes need not entail any inherent normative assumptions. Trust may be a 'good' thing or a 'bad' thing according to context and one's particular point of view. Having said that, it is clearly a source of concern for governments and scientists wishing to persuade people about the benefits of genetic modification in agriculture and food production if the people do not trust them or treat them as credible sources of information. This is often the way in which the issue of public trust in relation to gene technology is discussed in both political and social scientific contexts (House of Lords Select Committee on Science and Technology, 2000).

Because of its obvious theoretical importance, much work on risk perception has focused on the role of trust in explaining why some people perceive more risk than others in relation to a range of technological hazards. Wynne (1980) was one of the first to make the link between differences in lay and expert perceptions of risk and differences in the extent of trust in regulatory and scientific institutions. Since then, the relationship between trust, confidence and risk perception has been widely investigated (Frewer, 1999; Peters, Covello, & McCallum, 1997; Pijawka & Mushkatel, 1991; Slovic, 1993, 1999; Slovic, Flynn, & Layman, 1991). Most results tend to show, rather unsurprisingly, that people who trust hazard managers tend to estimate the risks from the hazards in question as lower than people who express no trust in these actors.

This view has been called into question only occasionally. Most prominently, Sjoberg (2001) recently suggested that the public believe that there are limits to what experts can know about potential risks from nuclear power and genetically modified food. Accordingly, even if people had complete trust in these actors, potential unknown dangers remain. Sjoberg claims this is a limitation on the whole notion of trust as an important explanatory factor in risk perception, at least as far as new technologies are concerned. However, a closer look at Sjoberg's results reveals that measures of trust do correlate with perceptions of risk from a range of hazards, but less strongly than some other attitudinal factors. Unlike Sjoberg, I do not consider this to be evidence against the importance of trust, only that there are other factors that also play their part in explaining perceptions of risk.

7.1.2 Trust, risk and gene technology

There is an increasing volume of empirical work that relates attitudes to gene technology with trust in governments, regulatory agencies and scientists (most recently Einsiedel, 2002; Finucane, 2002; most recently Frewer, Miles, & Marsh, 2002; Poortinga & Pidgeon, *2003*; Priest, 2001; Siegrist, 2000, 2003). This work finds evidence that trusting regulators, governments and scientists working on gene technology is associated with lower risk perceptions. I, along with colleagues, have described elsewhere how confidence in shops, industry, the government and genetic scientists is one of the factors linked with general attitudes towards GM food and crops (Gaskell, Allum *et al.*, 2004; Gaskell, Allum, & Stares, 2003; Gaskell, Allum *et al.*, 2001; Wagner, Kronberger *et al.*, 2001). These studies utilise data from Eurobarometer surveys and also from focus groups conducted in ten European countries. Another recent study using cross-national comparisons of focus groups in several European countries was carried out by Marris et al. Their results generally accord with the findings of Gaskell et al and Wagner et al in that mistrust in scientists and regulatory authorities is an important source of disquiet about GMOs across Europe (Marris, Wynne, Simmons, & Weldon, 2001).

7.1.3 The dimensionality of hazard-related trust

There is, then, plenty of evidence that trust is important for the perception of many types of risk including those relating to gene technology. Less is known, however, about what 'trust' actually consists of in any given circumstance. There have been a number of studies where theoretical dimensions of trust have been suggested, but not tested empirically. During the late 1980s, Kasperson first suggested three factors underlying trust in risk managers: perceptions of competence, of absence of bias and of caring and commitment to due process (Kasperson, 1986). Later, Kasperson Golding and Tuler (1992) added to this list 'predictability' as a fourth factor. Renn and Levine (1991) proposed five components of trust relevant to risk perception: competence, objectivity, fairness, consistency and faith (defined as 'goodwill'). Covello (1993) proposed four components: caring and empathy, dedication and commitment, competence and expertise, honesty and openness. All of these proposals contain common elements. A factor relating to some form of technical competence or expertise is present in all of them. Commitment to goals, fairness, faith or goodwill, honesty and openness could all be understood as manifestations of care or concern for other people (e.g. the person making the judgment whether to trust or not). For a very good in-depth review of these issues, see Johnson (1999)

7.1.4 Competence and care

In fact, there are any number of particular aspects to trust that could be relevant in any given social context. This does not mean, however, that any aspect, or dimension, in a particular circumstance has any wider, more general applicability as a social psychological construct. Metlay, in a study of trust in the US Department of Energy, is rather critical, on empirical grounds, of the notion that there are a large number of generalisable dimensions of trust in risk management actors (Metlay, 1999). Using exploratory factor analytic techniques, his results indicate that one factor subsumes all of the putative 'caring' factors – an affective dimension of general trustworthiness. One other factor emerges, that of competence or expertise.

Some other factor analytic studies have also yielded two underlying components of trust, but which do not precisely correspond with Metlay's factors. Frewer et al (1995) first asked respondents to generate reasons for trusting or distrusting sources of information about food risks. In a follow up national survey, the generated reasons were used as the basis of attitude statements measuring attitudes towards the same sources of information. Two factors were found. The first combined competence and care aspects of trust, while the second is not easily interpreted. Most recently Poortinga and Pidgeon (*2003*) found two factors common to perceptions of the trustworthiness of the British government across five risk issues – climate change, mobile phones, radioactive waste, GM food and genetic testing. They used eleven attitude statements that tapped most of the dimensions in the literature described here. Their two factor solution resembled that of Frewer et al. The first factor combined subdimensions of both competence and care while the second encompassed credibility, reliability and vested interest.

One possibility that neither Frewer et al nor Poortinga and Pidgeon consider as an explanation for their two factor results is that of acquiescence response bias in the attitudinal data. In the latter study for example, all the items on the first factor are positively worded in regard to evaluation of the Government while all those on the second factor are negatively worded (i.e. agreement indicates a negative evaluation). It is well known that differently valenced attitude statements often produce this factor structure (e.g. Evans & Heath, 1995). This possibility complicates the process of drawing clear inferences from these studies because it may be, for example, that had the valence of all the items been constant, a different structure may have emerged. So while Poortinga and Pidgeon's results provide some evidence against Metlay's, two factor, competence and care dimensions, it is by no means the 'last word' on the matter.

From a theoretical point of view, the most completely elaborated version of this two dimensional concept of trust is by Barber (1983, outlined in Chapter Two). In light of the empirical evidence that has accumulated since the early 1980s when he wrote on this topic, Barber's thesis, which in actual fact was based on broad socio-historical data rather than empirical social psychological investigation, appears to have stood the test of time. The twin dimensions of trust that Barber posited, of technical competence and fiduciary responsibility, thus far at least, seem fairly consistent with the findings of most sociological and psychological research on risk perception and trust.

7.1.5 Consensual values

An intriguing addition to these examinations of the dimensionality of hazard-related trust is the perspective of Earle and Cvetkovitch (1995). They point out that in the twin conception of trust as competence and care, people actually require rather a lot of information about actors and institutions in order to decide whether or not to grant trust. Attending to the behaviours of institutions in order to form reliable judgments of their expertise and responsibility is no easy task for lay people (or indeed anyone). So while the function of such trust may be a reduction of cognitive complexity, the basis on which it would granted would itself require considerable cognitive effort. Earle and Cvetkovitch claim that social trust is based on what they call salient value similarity (SVS). This is a 'groundless' trust, needing no justification. Rather than deducing trustworthiness from direct evidence, people infer it from 'value-bearing narratives'. These could be information shortcuts, available images, schema and the like. Essentially, people trust institutions that tell stories expressing salient values that are similar to their own. Salient values consist of 'the individual's sense of what the important goals (ends) and/or processes (means) that should be followed in a particular situation' (Siegrist, Cvetkovich et al., 2000, p.355). This yields a general basis for trust only to the extent that situations are perceived as being similar. Hence one might think that equal sharing is a salient value in relationships with family members but that competitiveness is important in business situations. Similarity of values between trustor and trustee is inferred from the trustee's words, actions, perceived cultural/social group membership. The key point is that trust is conferred not on the basis of a detailed appraisal of the likely competence and fiduciary responsibility of the actor but on the perception of shared salient values. Evaluations of this kind, so the argument goes, can be quickly generated and require relatively little cognitive effort as they are based on a person's existing attitudes and values and the associations that they hold already in relation to the actor in question. And there is evidence from studies of public participation in science policy that for risk issues such as the ones under investigation in this thesis, the role of values might be expected to be particularly important (Renn, Webler, & Wiedemann, 1995). This is firstly because the development of GMOs for use in the agri-food area has complex and multifaceted environmental implications and secondly because it resonates with a set of values linked to environmentalism. According to Renn et al, as the degree of complexity of the scientific problem increases, so public trust, fundamental values, worldviews and goals become the key variables in public debate and for governments seeking policy legitimation (for a detailed account, see Renn, Webler, & Wiedemann, 1995).

A number of studies by Michael Siegrist and others have operationalised the shared values concept and tested it in relation to the perception of risks (Siegrist, 1999, Siegrist & Cvetkovich, 2000, Siegrist, Cvetkovich & Gutscher, 2001, Siegrist, Cvetkovich et al., 2000). In general, these results suggest that the perception of shared values is indeed strongly related to expressions of social trust and confidence in risk managers or institutions responsible for the deployment of risky technologies. Earle and Cvetkovitch add to this the finding that people who hold different types of worldview are most likely to trust those that express similar worldviews to them in the way they present risk narratives. (Earle & Cvetkovich, 1999).

7.1.6 The present study

What is missing from this work on values similarity is any comparison between values based components of trust as predictors of risk perception with the more traditional competence and care components. The one exception is Poortinga and Pidgeon (*2003*) who do make some comparisons. They find that shared values are weaker predictors of perceptions of risk than any of the other dimensions that they looked at. However, for newer risks (mobile phones, GM food and genetic testing), the effect of shared values was stronger than for older ones.

In the present study, I have carried out a survey of attitudes towards risks from GM food and crops and include measures of competence, care and shared values in relation to two actors: genetic scientists and Government ministers. This will enable me to test some hypotheses that arise from a consideration of the work on the dimensionality of trust, with particular focus on the claims of the SVS theory of trust.

7.1.7 Hypotheses

The conception of trust as based on perceived value similarity departs from the models discussed earlier in that it relates to 'ends' more than 'means' (Johnson, 1999). While competence and care are attributes realised in behaviours independently of any particular goals (means), shared values, or what Johnson terms 'consensual values', imply some correspondence of desired end-states between risk manager and perceiver. A further implication is that whether or not an actor is thought to share some values with the perceiver prefigures and probably frames most judgments of the actor's particular behaviours. Under this assumption, the perception of consensual values could explain the empirical correlation often observed between beliefs about the competence and care of risk managers. To the extent that this is the main cause of such an association, one would expect that after taking shared values into account, the correlation should decline substantially. These expectations are embodied in the first two hypotheses addressed in the analysis:

H1: People who think government ministers or scientists are responsible and honest (i.e. 'care') will also tend to think they are competent

H2: Once consensual values are controlled, the correlation between competence and care disappears or is reduced

The third hypothesis concerns the link between risk perception and trust. SVS theory posits that perceptions of shared values are, at least in part, the common cause of beliefs about both the competence and care of risk managers. Therefore, once differences in perceived value similarity are taken into account, beliefs about competence and care should have little or no effect on risk perception. Accordingly, the third hypothesis becomes:

H3: Once consensual values are controlled, competence and care no longer predict perception of risk from GM food

The analysis is presented in two parts. First, some descriptive results are provided. In the second part, I present several structural equation models to address all three hypotheses. Before that, I describe the questionnaire and measures used in the analyses.

7.2 Data and methods

The data used in this chapter come from a questionnaire survey, fielded as an Internet poll by market research company YouGov. The survey was designed specifically to address the research questions posed in this and subsequent chapters of the thesis. The questionnaire contained 50 items with closed-ended response alternatives of mainly Likert type scales. The full questionnaire is reproduced in Appendix A. An outline of the topics covered is shown below.

1. Attitudes towards science in general
2. Risks and benefits of GM food and crops
3. Trust in scientists and Government
4. Interest in science and politics
5. Knowledge of science and politics
6. General attitudes towards GM food
7. Demographic information (submitted separately when respondents registered with YouGov)

Questions used in the analyses presented in this chapter come from sections 2 and 3 of the survey and are described in the preliminary results section below. Others used in subsequent chapters will be described as they arise. All bar one or two of the questions in the survey had either been piloted by me in a series of preliminary studies or had previously appeared in other surveys.

7.3 Preliminary results

Before going on to address directly the hypotheses set out earlier, it is interesting to look at the univariate distributions of the key variables used in the analyses that follow. Several caveats regarding the representativeness of the data in relation to the UK population have been mentioned earlier. That said, one of the ways in which the likely representativeness of these data can be assessed, at least informally, is by comparing results with other surveys that use conventional face-to-face interviewing with some form of probability sampling. The present survey was run in November 2002, just after the Eurobarometer on Biotechnology 58.0 (henceforth EB580) was fielded in the UK, during September and October, on behalf of the European Commission (Gaskell, Allum, & Stares, 2003). This survey employed a multistage random sample design and some 1000 interviews took place across the UK. For some variables, this provides a useful source of comparison that can provide a context for the interpretation of results presented here.

7.3.1 Perception of risk

Before answering questions on trust and confidence, people were asked how much risk for them 'personally' and for 'people in general' they thought was associated with GM food. The response alternatives were 'No risk', 'Very little risk', 'Some risk', 'A lot of risk', 'Very great risk'. Table 7.1 shows the percentage of responses collapsed into three categories in order to increase the clarity of presentation.

Table 7.1 Perception of GM food risk

%	**'No risk' or 'very little risk'**	**'Some risk'**	**'A lot of risk' or 'very great risk'**
How much risk for you personally do you think is associated with GM food? (RISKPER)	32	42	26
How much risk for people in general do you think is associated with GM food? (RISKGEN)	29	43	28

(Weighted N=1238)

Column one shows the item wordings with variable names in brackets. The distribution of responses is very similar for both measures of risk perception. Around one quarter of respondents consider that GM food is associated with a lot of, or very great risk, to themselves and to people in general.

Around 30% think that there is little or no risk personally or generally. The most popular response, at just over 40% is that there is 'some risk'. There is, then, quite a spread of opinion on the matter, with almost equal proportions of the public perceiving GM food to be very risky as not very risky. In Eurobarometer 58.0, respondents were asked how much they agreed or disagreed that GM food was 'risky for society' (response alternatives were 'definitely agree', 'tend to agree', 'tend to disagree', 'definitely disagree'). 24% definitely agreed and 11% definitely disagreed while 46% tended to agree or disagree. In EB58.0 a 'don't know' alternative was allowed and which was offered by 19% of respondents. These results are reasonably consistent across the two surveys, with a large minority of respondents from both surveys expressing less than extreme beliefs about GM food risk. One might speculate that it is possible that if the 'some risk' option had been available to EB580 respondents, some of the 'don't know's may have chosen this alternative.

Turning to the comparison between the two measures, it looks as if people are slightly more likely than not to believe that the risk to others is greater than the risk to themselves. This would be in line with past research on GM food risk (e.g. Fife-Schaw & Rowe, 1996) and is also linked to work which suggests that hazards activities undertaken voluntarily are seen as less risky than those over which people have no choice (Slovic, 1987). Comparing the distributions for the two measures using either non-parametric or parametric tests[7] shows that the risks to people in general are rated significantly higher (Wilcoxon Signed Rank Test: $Z=-7.46$, $p<.001$; Paired Sample T-Test: $t=-7.2$, $p<.001$; $N=1238$). However, the two measures are also, and unsurprisingly, highly correlated (Pearson's $r = .91$) . In subsequent analyses, I therefore explore the use of these two indicators in combination with each other as separate, but related, aspects of overall risk perception.

[7] With 5-point scales, parametric tests are more powerful if the distribution of the variables is approximately normal. Where there is any doubt, using both types of test is a sensible strategy, with the non-parametric test being more conservative.

7.3.2 Competence, care and consensual values

Trust in gene technology actors was measured by a number of different survey items designed to tap the dimensions summarised by Johnson (1999). Two dimensions, 'care' competence' were measured using 7-point Likert scales ranging from 'strongly agree' to 'strongly agree'. Consensual values were measured using a variant of the semantic differential (Osgood, Suci, & Tannenbaum, 1971) scales used by Earle and Cvetkovich (Cvetkovich & Lofstedt, 1999; Earle & Cvetkovich, 1999). In the latter studies, Earle and Cvetkovich had people rate their beliefs about risk managers on six 7-point semantic differential scales (Osgood, Suci, & Tannenbaum, 1971). These were anchored at either end with descriptors of opposite meaning. For this study, in order to replicate Earle and Cvetkovich's approach, I could select only two of these items because of limitations of space in the survey. The two items were selected on the basis of a pilot study carried out before the main survey was fielded. They were:

> *On a scale of 1 to 7, to what extent do you think that [scientists/government ministers] [working/making policy] on GM food have similar or different values to you? (where 1 is 'very different values to mine' and 7 is 'very similar values to mine')*

> *On a scale of 1 to 7, to what extent do you think that [scientists/government ministers] [working/making policy] on GM food think like you or think differently to you? (where 1 is 'think very differently to me' and 7 is 'think very like me')*

Results for these questions are shown in table 7.2. The first column shows the item wordings with variable names in brackets. In the second and third columns are shown mean scores for each question, with standard deviations in parentheses. The fourth column presents the t-values with associated degrees of freedom from paired sample t-tests of the difference between scores for scientists and government.

Table 7.2 Consensual values shared with Government ministers and scientists

	Scientists working on GM food	Government ministers making policy on GM food	T-value/df for difference
Have similar or different values to me (SCIVAL, GOVVAL)	3.29 (1.76)	2.74 (1.55)	11.6/1207
Think like me or think differently to me (SCITHINK, GOVTHINK)	3.15 (1.73)	2.72 (1.51)	10.7/1210

The first thing one can notice from the table is that, on average, people perceive both actors to have rather different values to them. All scores are below the scale midpoint of 4. There is a clear difference in the way people view the two actors. People tend to see themselves as closer to scientists than to Government ministers. The observed difference in the means for the two actors is statistically significant, as indicated by the high t-values.

According to this measure, then, people do not in general see themselves as sharing the same kinds of values as scientists or Government ministers in relation to the GM food issue. Although scientists are perceived as a little closer, the values of neither actor are perceived as particularly consonant with those of the public.

The next set of statements presented to respondents asked them the extent to which they agreed or disagreed that each of the actors possessed certain attributes or were expected to behave in particular ways in relation to their dealings with the development of GM food. Six items were presented, these having been selected from a larger pool of items piloted before the main survey was fielded. Three statements were designed to elicit beliefs relating to the competence and expertise of both actors. Another three aimed to tap the extent to which people believe actors act in the public interest and would carry out what Barber describes as their 'fiduciary duty' (Barber, 1983). Response alternatives presented were '*Strongly agree, Moderately agree, Slightly agree,* *Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree'*. As with all questions in the survey, an *'Abstain'* button was also present, allowing people to skip individual items. The distributions of responses as percentages, collapsed into three categories for conciseness here, are shown in table 7.3. Items 1,3 and 5 refer to competence while 2,4 and 6 are about care and responsibility.

Table 7.3 Perceptions of actors' competence and care

	Scientists			Government ministers		
(%)	**Agree**	**Neither agree nor disagree**	**Disagree**	**Agree**	**Neither agree nor disagree**	**Disagree**
1. Have the necessary expertise to make the right decisions (SCIEXP, GOVEXP)	48	13	39	10	9	81
2. Don't care about what happens to ordinary people (SCICARE, GOVCARE)	42	14	44	50	15	35
3. Have a good understanding of all the issues relevant to the research (SCIUND, GOVUND)	51	15	34	14	9	77
4. Take their responsibility to society seriously (SCIRESP, GOVRESP)	46	14	39	30	15	55
5. Are good at looking at the evidence about safety and judging what to do (SCIEVDNC, GOVEVDNC)	42	14	44	16	13	71
6. Are usually honest with the public (SCIHON, GOVHON)	32	10	58	10	7	83

Firstly, concerning beliefs about competence, the table shows that nearly half of those surveyed agreed that scientists have the necessary expertise to make the right decisions about GM food while only 10% believe that Government ministers have the necessary expertise. Just over half of respondents think that scientists have a good understanding of all the issues. The comparable figure for Government ministers is 14%. Only just over 40% of people think that genetic scientists are good at looking at the evidence about safety. 16% think that ministers are good in this respect.

These results are not particularly surprising given that the role of scientists is to be experts while the government takes political decisions. Still, it is interesting to note the almost total lack of confidence in Government ministers' expertise when it comes to dealing with GM food issues. Trust here could to some extent be a partisan, party political issue, rather than one concerning perceptions of whomever is in government at the time. This appears, on further investigation, to be only partially true. For example, when broken down according to political party voted for in the previous election, as many as 75% of Labour voters nevertheless disagreed that Government ministers 'have the necessary expertise'. The corresponding figure for both Conservative and LibDem voters is 86%, which is significantly different from that for the Labour voters ($p<.005$).

The picture concerning care and responsibility is a similar one, with scientists being generally more highly regarded than Government ministers. Scarcely anyone thinks that ministers are usually honest with the public; half thinks that ministers don't care about what happens to ordinary people and only about one third thinks that ministers take their responsibility to society seriously. Beliefs about scientists' care and responsibility are roughly evenly split between those who are sceptical and those having confidence although a majority disagrees that scientists don't care about what happens to ordinary people.

For each statement, more favourable responses are generally given in respect of genetic scientists compared to Government ministers. A Wilcoxon Signed Rank test comparing the distributions of responses on each item for both actors confirms that the differences, quite striking in table 7.3, are statistically significant at the .05 level.

Table 7.4 presents the same items, this time summarised as mean scores. This makes the difference between people's assessments of ministers and of scientists somewhat clearer. Mean scores for ministers are always (with the exception of item 2, which is reverse worded) are always lower than those for scientists. Also shown are the correlations between pairs of corresponding items referring to the two actors. All of these correlations are significant at the .05 level. There is, as can be seen, a moderate positive association between people's beliefs about scientists and their beliefs about ministers in their dealings with GM food. That is to say that people who are confident in scientists' competence and responsibility are more likely to be confident about those same attributes in Government ministers.

Table 7.4 Correlations between confidence in scientists and in ministers

	R	Mean	
		Scientists	**Govt ministers**
Have the necessary expertise to make the right decisions	.41	4.04 (1.87)	2.25 (1.49)
Don't care about what happens to ordinary people	.36	3.89 (1.87)	4.37 (1.82)
Have a good understanding of all the issues relevant to the research	.38	4.23 (1.82)	2.44 (1.53)
Take their responsibility to society seriously	.47	4.17 (1.85)	3.33 (1.76)
Are good at looking at the evidence about safety and judging what to do	.49	3.90 (1.83)	2.69 (1.59)
Are usually honest with the public	.41	3.32 (1.93)	2.14 (1.47)

(standard deviations in parentheses)

There are several reasons, none of them mutually exclusive, which could explain this finding. Firstly, it has been shown that individuals differ in the extent to which they tend to trust people in general (Rotter, 1971). In EB580, the average correlation between pairs of dichotomous items that asked whether or not people thought each of twelve biotechnology actors were 'doing a good job for society' was .28 (for more details see Gaskell, Allum, & Stares, 2003). This included pairs of actors seen as oppositional in debates about biotechnology, such as 'industry' and 'environmental organisations'. That beliefs about all of these actors are positively correlated could be explained by a generalised willingness to trust people.

Another explanation might be that both Government and scientists are viewed as 'on the same side' on the GM food issue. If trust and confidence in these actors is linked to the perception of shared values and these actors are presumed by most people to hold similar values to each other, it follows that trusting one will be associated with trusting the other.

Whilst it is interesting to ponder these supplementary questions, the main focus of this chapter is on testing hypotheses about the dimensionality of trust, and the link between trust, confidence and risk perception. Having now described the variables and their distributions, the next section presents some analyses of these variables that address the main questions and hypotheses outlined earlier.

7.4 Main results

In this section I present the analyses designed to address hypotheses 1 to 3, as set out earlier. The analytic method chosen is similar to that used in the previous chapter on the stability of risk perceptions. SEM is a useful technique for assessing the properties of multiple survey items that are intended to measure underlying unobservable constructs. For this purpose, one needs to test a measurement model. This is a model that allows one to evaluate how well the indicators together measure the constructs that they are supposed to. It is also known as confirmatory factor analysis (CFA) and is similar to exploratory factor analysis (EFA) except that in CFA one specifies, a-priori, which items load on which factors. These assumptions can be tested in the usual way, by observing how closely the implied model covariances match the sample covariances (see Chapter Four for more technical details).

In this case, the measurement model to be tested has three latent factors: competence, care and consensual values, with the eight items tapping trust as indicators. A separate model will be fitted for each of the two actors, Government ministers and genetic scientists. As well as assessing the quality of the survey questions as indicators of these dimensions, this model will provide an estimate of the correlation, if any, between the competence and care factors, thus addressing hypothesis 1 (H1).

In the second part of the analysis, hypotheses 2 and 3 (H2 and H3) are evaluated by fitting a series of models that contain the restrictions, in the form of conditional independencies, implied by H2 and H3. Essentially, a multiple regression model with latent variables is fitted, and which predicts risk perception from the three dimensions of trust.

7.4.1 Assessing the survey items

Because the items measuring perceptions of competence and care had never before been fielded to a national sample of respondents, it was far from clear that they would successfully discriminate between the two proposed dimensions of trust. Unless a two-factor model fitted cleanly first time, inevitably there would need to be modifications made based on exploring possible reasons for misfit. In view of this, I decided to carry out an initial model-fitting stage on a randomly chosen 50% of the total sample. Any data-driven changes made to the model at this stage could then be validated on the remaining 50% of the sample, thus reducing the danger of capitalizing on chance variation in the sample when deciding which modifications to make (MacCallum, Roznowski, & Necowitz, 1992).

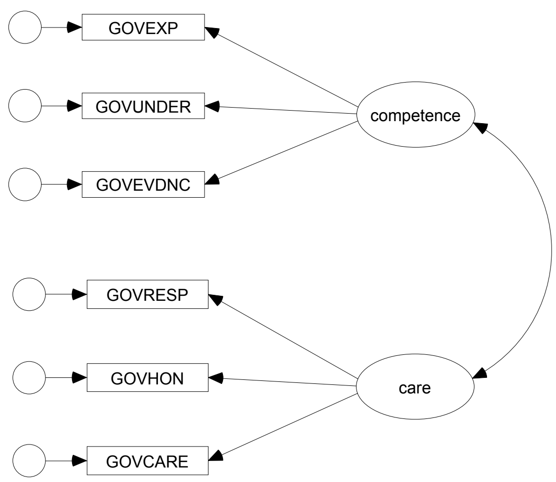
It is worth briefly explaining what information to guide post-hoc model modifications is provided by AMOS 5 and other SEM packages. The main information is provided by what are known as 'modification indices' or 'LaGrange Multiplier tests' (Kaplan, 1989). Modification indices in AMOS are estimated for every model parameter that is either fixed to some constant or constrained to equality with another. The modification index for a parameter is an estimate of the amount by which the discrepancy function (and, therefore, the Chi square fit statistic) would decrease if the analysis were repeated with the constraints on that parameter removed (Arbuckle & Wothke, 1999). Thus in a poorly fitting model, a large modification index for a particular parameter indicates that allowing the value of this parameter to be freely estimated rather than fixed or constrained would increase the goodness of fit of the model.

Of course, the danger is that if one is tempted to make too many of these data-driven modifications, a good fit will, in the end, always be found as the saturated model is approached. However, the value of any 'test' of fit at this stage is greatly reduced and there is little evidence of the model's adequacy until replicated on a fresh sample. It is therefore important that any modification made that is suggested by these indices should have a strongly plausible theoretical justification that is likely to be able to withstand replication.

The specification of the first CFA model fitted at this exploratory stage is shown in figure 7.1. The three items for each of the two concepts competence and care in relation to Government ministers each load on one factor (or latent). The latents are allowed to correlate freely. When this model was fitted to the test sample, a poor fit was found. Modification indices suggested that the residual terms between the two competence items GOVEXP and GOVUNDER were highly correlated and that the item GOVEVDNC was correlated with the latent care. This indicated that the former two items measured something somewhat different to the latter and that this item was being interpreted ambiguously. This is possibly due to the somewhat unclear meaning of 'evidence' in the question wording. It was therefore decided to drop GOVEVDNC. With this change, the model fit improved, and the residual correlation between GOVEXP and GOVUNDER disappeared. With this new model, modifications indices suggested that residual correlations existed between GOVCARE and the competence items. Additionally, its standardised factor loading was much lower than was the case for all other items. It appeared that the negative wording of this question was probably causing a great deal of ambiguity in responding and so a model was fitted dropping this item. This model was a reasonable fit according to approximate fit statistics (Chi Sq 12.6, df 4, RMSEA .043; SRMR .001).

The same procedure was carried out for the items about scientists, with much the same results. Therefore the same two items were dropped as they behaved similarly in respect of scientists as of Government ministers. Finally the two final models were fitted to the validation sample data. Both fitted to approximately the same degree as in the test sample, with similar factor loadings.

Figure 7.1 Initial model for competence and care



It was not important that the estimated parameters should be exactly the same across both samples, only that the structure of the model (in terms of the location and direction of paths) was the same. Because of this, no formal tests of factorial invariance (Meredith, 1993) were carried out.

7.4.2 Development of the full measurement model

The final stage in the measurement part of the analysis was to add the consensual values and risk items to each of the two final models just described, using the full sample. The purpose of this was to ensure that all latent constructs are adequately measured before going on to look at the structure of relationships between them. A series of increasingly constrained nested models was fitted for each of the two actors. The constraints tested were whether all items for each latent have equal factor loadings and whether they also have equal error variances. This is similar to the procedure carried out in Chapter Six. Each latent construct, competence, care, consensual values and risk perception, is measured by two indicators. All latents are allowed to correlate freely. By inspecting the correlation between competence and care for the finally selected model, it will be possible to address H1, which hypothesises an association between competence and care.

Table 7.5 shows the results, for genetic scientists, from fitting three nested CFA models on the whole sample (N = 1238).

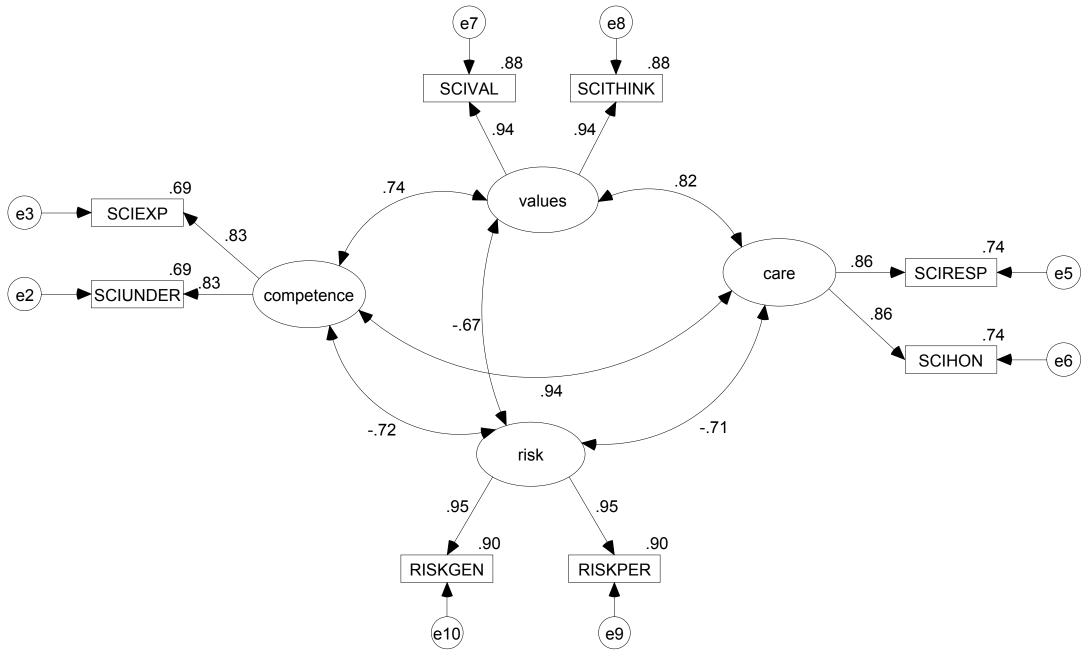
Table 7.5 Nested comparisons of CFA models - genetic scientists

Model	Chi²	Df	p	Δ Chi²	Δ df	RMSEA	CFI	SRMR
1. Unconstrained (baseline)	55	14	<.001	-	-	.051	.99	.015
2. Equal factor loadings	68	18	<.001	13	4	.050	.99	.018
3. Equal factor loadings and error variances	69	22	<.100	14	8	.043	.99	.019

In the previous chapter, the two indices of approximate fit used were CFI and RMSEA. According to Hu and Bentler (Hu & Bentler, 1999), using RMSEA in combination with another index, Standardised Root Mean Square Residual (SRMR), is a slightly better strategy. This was not possible in the previous chapter because of the need to use the FIML method for dealing with missing data, due to the small sample size in that study. Because there is no fixed covariance matrix used as input when using FIML, SRMR cannot be estimated. Here, with a much larger sample, missing values have been deleted listwise, as this results in the loss of only 2.75% of the total sample, and a covariance matrix used as input to AMOS 5. Accordingly, I report RMSEA and SRMR as well as CFI.

None of models 1, 2 or 3 fit on the Chi^2 test of exact fit. However, with a sample size of well over 1000, more attention should be paid to the approximate fit indices, shown in the last three columns of the table. The unconstrained baseline model (1) fits acceptably well on these indices, with very high CFI, an RMSEA of .051 and a low SRMR of .015. The addition of equality constraints on the (within construct) factor loadings produces a small loss of fit.

Figure 7.2 Full measurement model - genetic scientists



The Chi2 difference between the two models is 13 based on 4 degrees of freedom, which is significant ($p<.01$). However, the difference between the baseline model and model 3, the most parsimonious model, with equal factor loadings and error variances, is not significant (Chi2 difference=14, 8 df, $p<.10$). The RMSEA, at .043, is also lower for this model than for either of the other two. Model 3 appears to be the best fitting out of the three. Accordingly, for subsequent analyses of beliefs about genetic scientists, dimensions of trust will be modelled with parallel indicators (i.e. equal factor loadings and error variances). Standardised parameter estimates are shown on the path diagram in figure 7.2 for the fitted final model.

All the factor loadings are high, with none lower than .83. R^2 is correspondingly high for all the observed items. For example, 90% of variance in each of the two risk items RISKPER and RISKGEN is explained by the common factor, risk. There are also high correlations between the latent variables risk, values, competence and care. The highest of these is the one between the latter two variables. Competence and care correlate at .94, which is very high. This means that the first hypothesis, H1, is supported. People who think that scientists are competent at the technical aspects of their role are also very likely to think that they are responsible and honest. In fact, paradoxically, the very high correlation invites the suggestion that these two dimensions of trust, competence and care, are not really distinguished in the public mind. In other words, do these two dimensions of trust (as measured here at least) possess any discriminant validity (Campbell & Fiske, 1959)? To test this, another model was fitted which constrained the correlation between the competence and care factors to unity. A significantly worse fit was found. Therefore it is reasonable to think that these two dimensions do have some independent meanings for the public in regard to genetic scientists, although empirically there is not much difference between them.

Looking at the other correlations between factors, one can see that risk perception is strongly and negatively related to all the trust dimensions. That is to say that people who have relatively more trust in scientists will tend to see less risk from GM food. The correlations of competence and care with risk perception are almost the same as each other. This adds weight to the possibility that the public really does not make a great deal of distinction between these dimensions of trust in the formation of attitudes towards GM food risk. Consensual values, as expected, are strongly negatively correlated with risk perception and positively correlated with the other trust dimensions.

Turning now to beliefs about Government ministers, a similar model-fitting procedure was carried out to that described in relation to genetic scientists. In table 7.6 are the results of the nested model comparisons carried out to select a final measurement model. The only difference with the procedure described earlier is that the measurement model for the risk items was specified with equal factor loadings and error variances at each stage, as this had already been established from the results for genetic scientists.

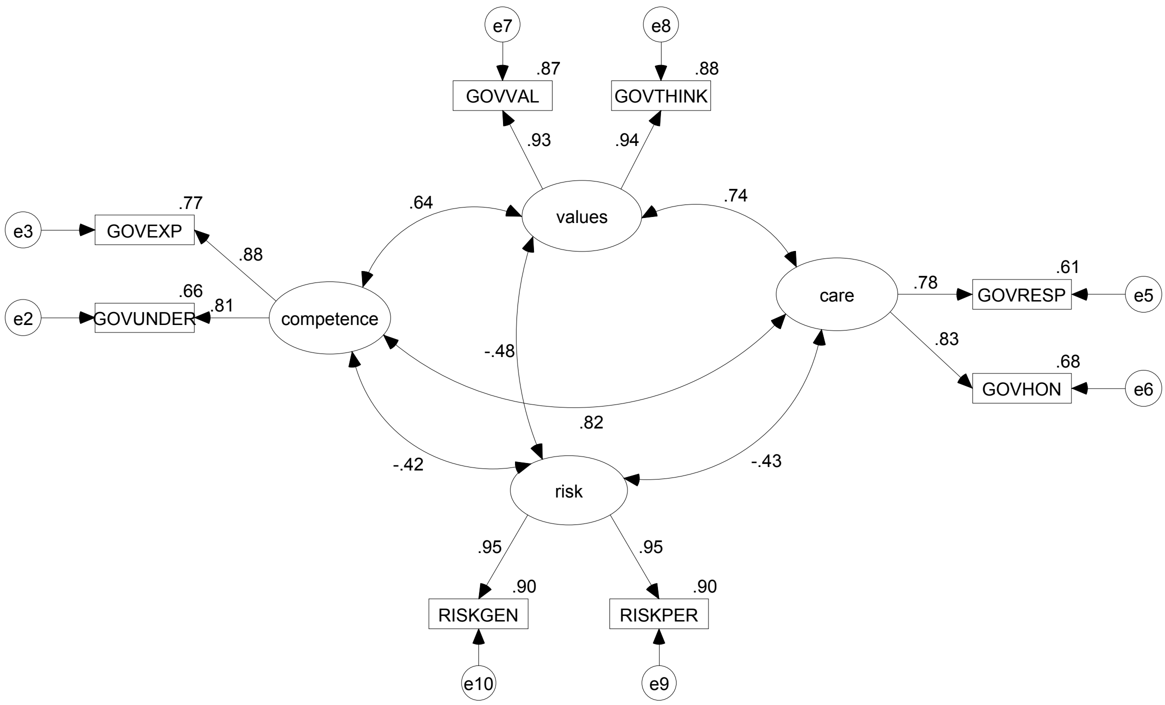
Table 7.6 Nested comparisons of CFA models - Government ministers

Model	Chi²	df	p	Δ Chi²	Δ df	RMSEA	CFI	SRMR
1. Unconstrained* (baseline)	57	16	<.001	-	-	.047	.99	.020
2. Equal factor loadings*	78	19	<.001	21	3	.052	.99	.029
3. Equal factor loadings and error variances	179	22	<.001	122	6	.079	.98	.024

* Trust variables only. Equal error variances and factor loadings for 'risk' in all models

The unconstrained model fits approximately, although again, on the Chi2 criterion, does not fit exactly. RMSEA and SRMR are within the bounds of the recommendations of Hu and Bentler for close fitting models. Constraining pairs of factor loadings to equality leads to a significant loss of fit (Chi2 21, df 3). RMSEA increases slightly, to .052. Model 3, where error variances are also constrained to be equal, fits even more badly (Chi2 122, 6 df). RMSEA also rises substantially, to .079. On the basis of these results, model 1 was chosen as the best measurement model for beliefs about Government ministers. This model allows the factor loadings and error variances of the trust items to be freely estimated. The standardised parameter estimates are shown on the path diagram in figure 7.3.

Figure 7.3 Full measurement model - Government ministers



Looking at the estimates in figure 7.3, one can see that the general picture is much the same for Government ministers as it is for genetic scientists. Consensual values are positively correlated with competence and care whilst being negatively correlated with risk perceptions. H1 is supported, as evidenced in the estimated correlation of .82 between competence and care. The correlation between these two dimensions in relation to Government ministers is estimated as lower than the corresponding one in the genetic scientists model (.82 compared to .94).

Both of these correlations are high but it looks as if the public might make a greater distinction between these concepts in relation to Government than in relation to scientists. The fact that neither model 2 or 3 fitted the data also suggest that the competence and care items have more specific meanings to people when applied to Government ministers. Overall this suggests that more differentiated views of the trustworthiness and ability of politicians exist in relation to GM food issues than to the scientists also involved. That is to say, while it is possible that a person could think that the Government is incompetent but nevertheless honest, it is less likely that the same combination of views be held about genetic scientists.

It is also interesting to note that the correlation between risk perception and trust is weaker than it is for the scientists' model. This might indicate that risks from GM are seen as emanating more from the behaviour of scientists than of the Government.

In the analysis so far support has been found for the first research hypothesis, along with quite a bit of supplementary evidence pertaining to dimensions of trust. In the final part of the analysis, the two remaining hypotheses are addressed. Can the link between the views about competence and care be explained by a third causal variable, the perception of shared values? And, after taking these values into account, do perceptions of competence and care any longer have any effect on people's attitudes towards risks from GM food?

7.4.3 Structural models of trust and risk perception

In order to evaluate hypotheses H2 and H3, a set of nested model comparisons was once again carried out. In this case though, the first models to be tested were the most restrictive ones, relaxing more constraints progressively until a final model could be selected. The reason for this is that the theoretical predictions discussed in the introduction to this chapter are operationalised empirically as restrictions on the values of certain model parameters. It therefore makes sense to test the most restrictive model first, as this would be the strongest evidence in favour of the theory if supported by the data. In fact, as mentioned in Chapter Six, it is always these restrictions or constraints that are tested in omnibus tests of model fit in SEM. The logic will become apparent from considering the models used to test H2 and H3 in the present case. The basic form of the model is shown in figure 7.4. Omitted for clarity is the measurement part of the model - the observed variables and residual variances. The theoretical parameters of interest are C1, W1 and W2.

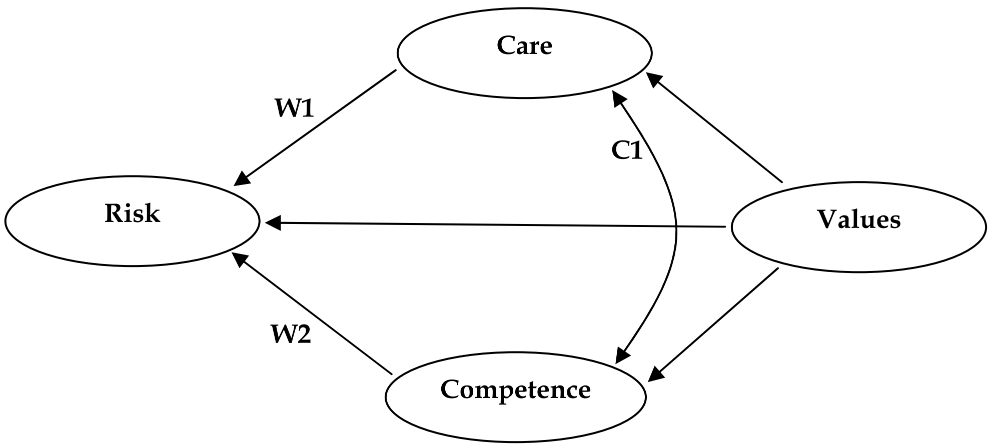
The first hypothesis arising from the SVS theory of trust is that people's beliefs about the competence and care of actors in risk management issues are driven by whether or not these actors are perceived as sharing similar values with the perceiver. The fact that the logically independent attributes of competence and care are psychologically linked is precisely because perceptions of these are influenced by the initial, less cognitively demanding, 'summary' assessment of an actor's similarity of general goals and values compared to the respondent. Hence the empirical hypothesis is that the correlation between competence and care as predictors of risk perception should disappear if shared values are their only common cause. If the correlation is markedly reduced once the extent of perceived shared values is taken into consideration, this is also evidence, albeit slightly weaker, in support of the same hypothesis. If there is little or no reduction in the correlation, this is evidence that the association between perceptions of scientists competence and care is not due to perceived shared values with scientists, even though shared values may themselves exert a separate influence on both competence and care.

In figure 7.4, this relationship is represented by C1, which is the correlation between competence and care, conditioned on shared values. The strong theoretical prediction is that it is zero in the population. Another way of expressing this is to say that perceptions of competence and care are 'conditionally independent' of each other with respect to values (Pearl, 2000). The weaker version is that it is substantially reduced from its uncontrolled value (estimated in the measurement models fitted earlier).

The other hypothesis concerns regression weights W1 and W2. Here the prediction is that these too are both zero, conditioned on shared values. This would be the empirical result if it really were the case that the observed association between beliefs about risks from GM food and beliefs about the competence and care of scientists and Government ministers was caused by variation in the extent of perceived shared value similarity. Again, the weaker version is that these regression weights are substantially reduced once values are controlled.

It is probably obvious that this is a quite simple elaboration of a multiple regression model to predict risk perception from the three dimensions of trust. The advantages of using SEM are firstly that the overidentifying (theoretical) restrictions can be formally tested, secondly that both hypotheses can be jointly and simultaneously evaluated and that, thirdly, by modelling measurement error and using latent variables for each construct, the estimates of the structural (theoretical) relationships between these constructs are disattenuated.

Figure 7.4 Risk perception and dimensions of social trust - outline of the model



The analytic procedure I decided upon was as follows. First I would fit a model where C1, W1 and W2 are all fixed at zero. If this fitted the data well, both hypotheses would be supported. If it did not fit well, another model, freely estimating C1 would be fitted. If this fitted well, H3 but not H2 would be supported. If further substantial improvement in fit could be gained by freeing W1 and W2, neither H2 nor H3 would be supported. This procedure was carried out for both actor groups and two sets of models fitted. The results for genetic scientists are shown in table 7.7.

Model 1 is the most constrained model of the four shown. It tests both H2 and H3 by fixing C1, W1 and W2 to zero. The fit of this model to the data is very poor, with all fit indices out of acceptable ranges for exact or close fit. RMSEA is .14, well above the suggested cut-off of .06. CFI is below the suggested .95, and SRMR above the recommended .06. The modification index for C1 is the higher than all others, at 314.

Table 7.7 *Nested comparisons of alternative theoretical models predicting GM risk perception from dimensions of trust in genetic scientists*

	Model	Chi^2	df	P	Δ Chi^2	Δ df	RMSEA	CFI	SRMR
1.	**Baseline**	580	25	<.001	-	-	.140	.93	.075
2.	**Free covariance**	217	24	<.001	363	1	.083	.98	.065
3.	**Free both structural paths**	69	22	<.001	511	3	.043	.99	.020
4.	**Free comp only**	70	23	<.001	510	2	.042	.99	.020

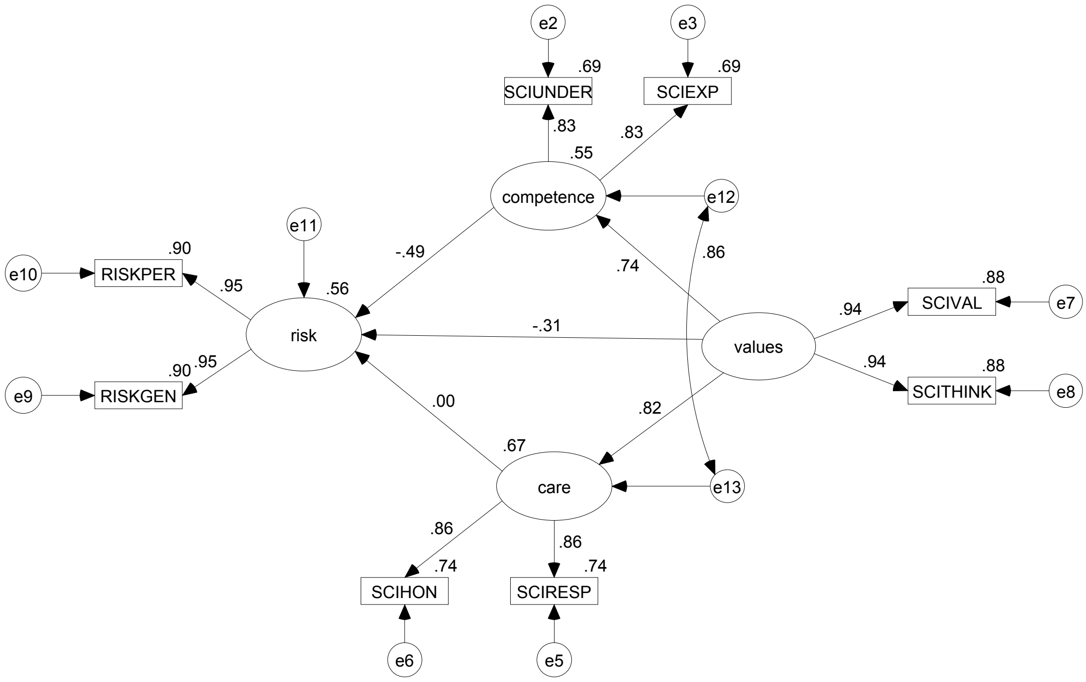
Inspection of the matrix of standardised residuals comparing observed and implied covariances also revealed large values, of between 3 and 6, between the competence and care indicators. In a good model, no residual should exceed 2 (Arbuckle & Wothke, 1999). This provides clear evidence against the strong version of H2 – that competence and care are uncorrelated after taking shared values into account.

Model 2 allows C1 to be freely estimated whilst still fixing W1 and W2 at zero. The fit of this model is much better but it is still not a good-fitting model on conventional criteria. Both SRMR and RMSEA exceed the recommended cut-offs and the Chi2 statistic is highly significant. Modification indices for W1 and W2 are high (27 and 46 respectively) with the implication that a substantially better fitting model would be obtained by freeing these regression weights.

This provides evidence against the strongest version of H3 – that there are no effects from competence and care on risk perception after controlling for shared values.

Model 3 sees a substantial improvement in fit, with all indices of approximate fit showing acceptable values. The model still does not fit according to the Chi2 statistic, but with a large sample as there is here, even trivial model misspecifications will produce a statistically significant discrepancy between the model-implied and observed covariances.

Figure 7.5 Dimensions of social trust as predictors of the perception of risks from GM food – genetic scientists



Inspection of parameter estimates reveals that the regression weight from care to risk is not significantly different from zero (unstandardised regression weight =.08, SE=.11). Hence a further model (model 4) is estimated, fixing this path to zero again. The addition of this constraint produces no significant loss of fit compared to model 3 and is therefore selected as the final one. The full model, showing standardised parameter estimates is shown in figure 7.5.

There are several interesting features of the model worth noting. Firstly, the estimated correlation between the disturbance terms of endogenous latent trust variables care and competence. This correlation is functionally equivalent to the parameter C1 in the outline model in figure 4.[8] The estimated value is .86. This is only just below the zero order correlation of .94, from the measurement model shown in figure 2. H1 is not strongly supported, if at all; it seems that the tendency to agree that scientists are technically competent if one also agrees that they are honest and responsible cannot be much attributed to the perception of similar shared or consensual values. If that were the case, C1 would be zero, or certainly very much reduced compared to its original value. However, this is not to say that shared values do not influence competence and care separately. The standardised regression weights for the path from values to competence and care are .74 and .82 respectively, which shows a strong influence on both. 67% of the variance in care is explained by variation in values while 55% of the variance in competence is explained by values. The apparent paradox that shared values can simultaneously account for a lot of variance in the two other trust dimensions, yet they remain highly intercorrelated after controlling for values, simply implies that they share other substantial unmodelled common causes. The possibility that one of these may be a 'method' factor, for instance a general tendency to respond positively to all statements, was investigated by adding another latent variable emitting paths to all the observed indicator variables for competence and care. This model fitted, but only reduced the residual correlation between the two trust

[8] In AMOS, a correlation between the latent residuals or 'disturbances' (here e12 and e13) is equivalent to the residual correlation between the two latent variables themselves. This is because the variance of an endogenous latent variable is simply the sum of the squared standardised regression coefficients of its predictor variables (in this case from one predictor: values). The residual unexplained variance is captured in the disturbance terms e12 and e13. It follows that the correlation of these variables is functionally equivalent to the covariance between competence and care 'left over' after partialling out the variance due to the effect of values.

dimensions to .81. Hence one can conclude that there are other factors than acquiescence response bias at work here.

Turning now to the prediction of risk perception, the model shows mixed support for H3 in that scientists' competence remains a significant predictor of risk perceptions, even after controlling for shared values, whereas scientists' perceived care does not. This is, of course, specified in the final model because the freely estimated regression weight was not significantly different from zero in model 3. The standardised coefficient for values onto risk is -.31 which means that when perception of shared value similarity goes up by one standard deviation, the perception of risk is expected to go down by .3 of a standard deviation. The corresponding coefficient for competence is -.49. As expected, people who have more trust and a greater degree of perceived value similarity in scientists tend to see smaller risks from GM food. The finding that beliefs about scientists' competence remain a significant predictor of risk perception is interesting. This tends to suggest that the correlation between care and risk perception, shown in figure 7.2, is brought about because those who think that scientists are honest and responsible do so because they perceive scientists' values as being close to their own. Consequently, once controlled for differing levels of value similarity, there is no additional effect of beliefs about honesty and responsibility on perceptions of risk. However, in the case of beliefs about technical competence, these have an effect on risk perception over and above that due to value similarity alone. Perceptions of the technical competence of scientists are somewhat independent of whether a person thinks that they share values with these scientists and they have an independent effect on risk perception.

This makes some sense in that shared values, whilst possibly including commitments to employing high technical ability, are more likely to be concerned with expectations about motivations, duties and responsibilities. Hence it is plausible to imagine someone thinking: "genetic scientist X shares my commitment to feeding the developing world but I am still worried about

GM food because similar people have in the past made scientific errors in their work". It is less easily imaginable (but by no means impossible) that someone might think "genetic scientist X doesn't share my goal of protecting the ecosystem, but because she is unlikely to make any scientific mistakes, I am less worried about the risks from GM food". On the other hand, given that SVS is based on the idea of simple non-cognitive assessment of actors, perhaps one should not over-interpret these details.

Table 7.8 Standardised total effects – risk perception and trust in genetic scientists

	Values	Care	Competence
Care	.817	-	-
Competence	.739	-	-
Risk	-.671	.000	-.487

Table 7.8 shows the standardised total effects of all the explanatory variables. The direct effect of shared values on risk is -.31, as can be seen from figure 5. However, the total effect of values on risk, including the indirect effect, through competence, is -.67. Assuming that the structure of the model is correct, the interpretation is that perceiving shared values with genetic scientists makes people more likely to think they are also competent in the role, and this has the additional effect of reducing the perception of risk from GM food. In this sense, competence acts as a mediating variable (Baron & Kenny, 1986) between values and risk perception. Recall that the simple correlation between values and risk, shown on the measurement model ,in figure 7.2, was .67. With the inclusion of competence as a mediator, this falls to .31 in the final structural model. There is, therefore, partial mediation of values on risk.

The same nested model-fitting procedure as earlier described for genetic scientists was carried out for trust in Government ministers. The results are shown in table 7.9. The same steps were carried out as before and, in fact, the choice of final model was the same as for genetic scientists. Looking at the table one can clearly see that model 1 fits very badly. Model 2 fits much better but a significantly better fit is found by moving to model 3. Once again, the path from care to risk was estimated as not significantly different from zero. Re-fixing the path to zero in model 4 does not lead to any loss of fit compared to model 3 and so model 4 is the final selection. The path diagram for this model is presented in figure 7.6.

The main noteworthy feature of this model is its similarity to the one for genetic scientists shown in figure 7.5. Structurally, of course, it is identical, but the general pattern of coefficients is similar too. Values strongly predicts both competence and care. The regression weight for the latter is slightly higher, as is the case for genetic scientists.

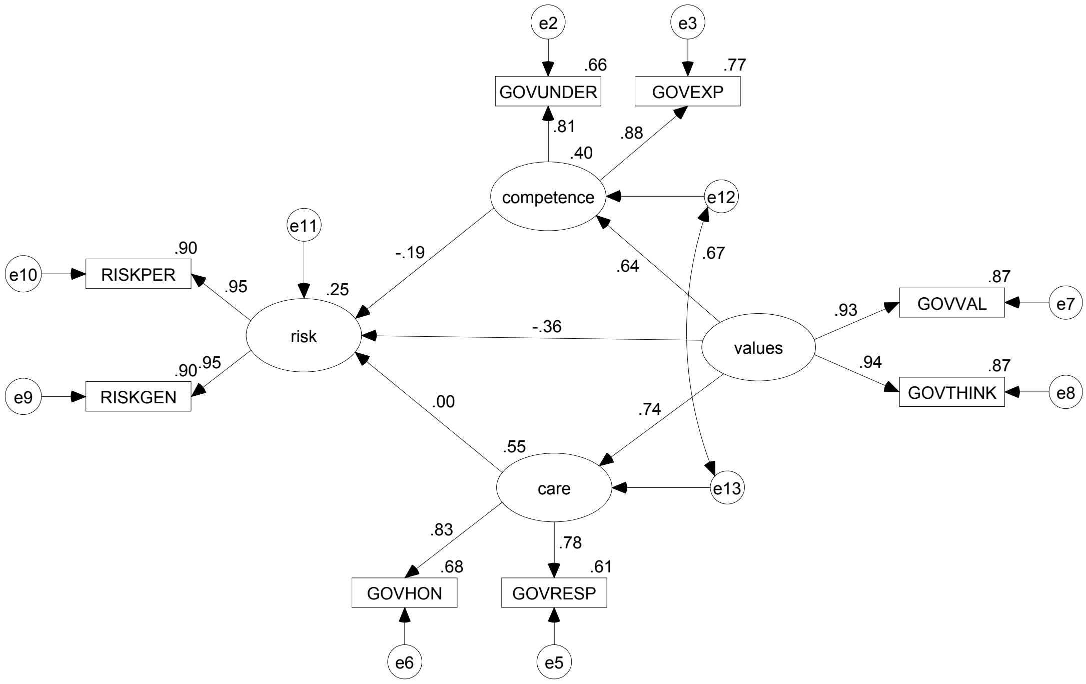
Table 7.9 Nested comparisons of alternative theoretical models predicting GM risk perception from dimensions of trust in Government ministers

	Model	Chi^2	df	p	Δ Chi^2	Δ df	RMSEA	CFI	SRMR
1.	**Baseline**	315	18	<.001	-	-	.120	.96	.077
2.	**Free covariance**	78	17	<.001	237	1	.056	.99	.038
3.	**Free both structural paths**	56	15	<.001	259	3	.049	.99	.020
4.	**Free comp only**	56	16	<.001	259	2	.047	.99	.020

A difference is seen when comparing the direct effects on risk perception of values and competence. In the genetic scientists model, the difference between these two parameters (in their unstandardised form) is not significant (Z=1.7). For Government ministers, the difference is significant (Z=2.6). For the latter group, the direct effect of perceived shared values is more important than perceptions of competence. Technical competence is evidently not such a relevant attribute of Government ministers as far as worries about GM food risks are concerned as it is in relation to scientists. This makes some intuitive sense. People probably do not expect ministers to understand recombinant

DNA technology (recall that the mean scores for government competence variables are very low). Their influence over possible risks from GM food come about through their behaving more or less honestly and responsibly in the way they make decisions about policy, the development of GM food and how much correct information they give to the public.

Figure 7.6 Dimensions of social trust as predictors of the perception of risks from GM food – Government ministers



Looking at table 7.10, a similar result holds as in the case of the genetic scientists model. Values has the larger total effect on risk compared to competence. However, a smaller indirect effect through competence is implied. There is only a difference of .12 between the direct effect of values on risk (-.36, seen in figure 6) and the total effect, at -.48. The corresponding difference for the previous model is .36.

As a final point, the intercorrelations between both observed and latent trust variables in the model for government are lower than those for genetic scientists. If one assumes that the constructs being measured have some correspondence to real psychological phenomena, the fact that they are less well distinguished for the latter group of actors may indicate that people in general have more differentiated attitudes towards the government than to genetic scientists. This would not be surprising, given the remoteness of this group to most people's everyday lives compared to Government ministers, who are constantly seen in the media and make decisions on a range of matters probably more relevant to people than GM food issues.

Table 7.10 Standardised total effects – risk perception and trust in Government ministers

	Values	Care	Competence
Care	.740	-	-
Competence	.635	-	-
Risk	-.483	.000	-.188

7.5 Discussion

In this chapter, the dimensionality of hazard-related trust has been investigated with regard to the particular case of GM food. Risk attitudes and public trust in genetic scientists and in the Government were assessed using an Internet survey that included new items to measure three putative dimensions of trust: (1) competence or technical expertise; (2) care, honesty and responsibility; (3) consensual or shared values.

The descriptive results show that the British public has a wide range of opinions about the possible risks from genetically modified food. About one quarter thinks that GM food carries a lot or a great deal of risk. About one third thinks that there is little or no risk. Just under half agrees that there is 'some risk'. On average, and in line with most previous research, people tend to see the risks to others as greater than the risks faced by them personally.

People were asked the extent to which they believed that Government ministers and genetic scientists shared their values in relation to their role in the development of GM food. On the whole, both groups are thought not to share the same values as the public on this issue. Genetic scientists are seen as slightly closer to the public than Government ministers. This pattern is broadly replicated when people were asked their views about the technical competence, responsibility and honesty of scientists and Government ministers. Less than one quarter of respondents view Government ministers as remotely competent on the issue of GM food. Even fewer see them as honest or responsible. Overall, perceptions of Government are very negative. Scientists are seen in a slightly more favourable light but even here there are a wide range of views from very sceptical to very trusting. While people are split quite evenly on the question of whether or not scientists take their social responsibilities seriously, a greater proportion believes that they are at least technically competent to deal with GM food issues. On the whole, the public seems to be fairly convinced that Government ministers are not to be trusted, while views about genetic scientists are more varied, perhaps indicating more ambivalence or less firmly held beliefs.

Perceptions of the competence and care of the two actor groups are quite strongly correlated. The average correlation of responses to each of the competence and care questions between actor groups is .42. This means that people who trusts scientists also tend to trust the government on GM issues. The most likely reason for this is that both groups are seen as promoters of GM food and crops.

In the second part of the analysis, a series of structural equation models were fitted, firstly evaluating the six trust items in the survey and secondly testing three theoretical hypotheses. For both actor groups, only two out of the three items for each of competence and care scales were retained, leaving each construct being measured by two indicators in subsequent analysis. Given more space in the survey, many more items could have been assessed and a better scale developed. This is an area where more research would be useful.

The SVS theory of trust proposes that trust is accorded to people that are perceived to share the same values as the perceiver in relation to the risky situation at hand. The first hypothesis was that perceptions of the competence and care would be positively correlated because they are each driven by the more general perception of value-similarity. For both genetic scientists and Government, this expectation was supported. In fact the correlation between the two facets of trust was high enough to invite suspicion that the two are hardly distinguished by the public, at least in relation to the scientists. For Government, the correlation between competence and care was somewhat lower, indicating that people think it more possible, for example, that a Minister could be incompetent but nevertheless honest than would be likely for a genetic scientist.

The second hypothesis was that this correlation would disappear or be considerably reduced when controlling for SVS. Confirmation of this would provide evidence that perception of shared values underlies more specific judgments of trustworthiness. The analysis shows that the correlation between the two aspects of trust was not much reduced when values were controlled. Nevertheless, there was a strong effect of shared value similarity on perceptions of both competence and care. So while perceptions of shared values are strongly linked to how both scientists and Government are judged competent, honest and responsible, there are other, unknown factors that also explain the correlation between them.

The final hypothesis investigated was that on controlling perception of shared values, the effect of competence and care on perception of risk from GM food would disappear. This again follows from the idea that if it is the perception of shared values that is at the heart of hazard-related trust, then this factor could account for the relationship between more specific trust judgments and the perception of GM food risk. The results provide substantial support for this hypothesis, although the conclusion that the perception of shared values is the only relevant aspect to hazard-based trust cannot be sustained. Shared values are the most important factor in explaining variation in risk perception, compared to judgments of the competence and care of both scientists and Government. Once the effect of shared values is taken into account, the effect of perceptions of the actors' care (honesty and responsibility) disappears. The same is not true, however, in relation to perceptions of competence or expertise. How competent people consider the actors to be has an effect on their perception of GM food risk, over and above the extent of shared values. This is true for both genetic scientists and Government ministers, only the independent effect of competence is much smaller for the latter actor group. This result is interesting as it points to the notion that the shared values concept of Earle and Cvetkovitch is linked more to the normative expectations and motivations of actors – what Barber terms their 'fiduciary responsibility' than it is to ideas about their technical competence or ability to carry out their jobs.

Overall these results suggest that perceived shared value similarity with scientists and with Government is an important component of trust in relation to the risks associated with GM foods. Whether or not people believe a risk manager to be competent and/or responsible is strongly related to the extent to which people believe that the risk manager shares similar values to them. What is also striking is the extent to which all of these theoretical constructs are so weakly differentiated in the general public. That is to say that the correlations between measures of competence, care and shared values are all very high. This is particularly so in the case of the public's perception of genetic scientists. One can only speculate on the reasons for this but two in particular come to mind. One is the possible limitation of the measures used in the survey. Only two of the three items selected for each of the competence and care constructs were usable in the analysis. With more space in a survey, a much wider selection of items may capture the differences between the two more successfully. The other possibility is that people are using an overall summary heuristic for judging these actors and their likely performance in relation to GM food risk. Of course, this is precisely what the SVS theory of trust proposes – the heuristic is a quick judgment of perceived value similarity. However, this cannot be the whole story. Even taking into account SVS as a common cause of perception of both competence and care, the two constructs remain highly correlated. This indicates another type of heuristic or basis for judgment at work or, alternatively, and to reiterate, that there is little discriminant validity in the constructs' measurement.

Slovic's 'affect heuristic' is a possible explanation, in a general sense, for these results. Where in Slovic and Finucane's conception, judgments about hazards are made on the basis of an overall feeling of like or dislike, here the same mechanism may be at work in people's judgments of the risk managers. This possibility is perhaps given some more weight by the fact that it is scientists for whom the judgmental differentiation is least clear. One could reasonably assume that most people have thought less in their daily lives about the motivations and abilities of genetic scientists than they have of Government ministers. One of the predictions of the affect heuristic theory is that the less cognitive deliberation there is about a risk, the more affect comes into play (Slovic, Finucane, Peters, & MacGregor, 2002). Equally though, a version of this story told in terms of general social attitudes rather than 'affect' towards these actors is also consistent with the results.

This chapter has explored the dimensionality of hazard-based trust in relation to actors in risk management. An emerging theme characterising this and all the empirical studies thus far presented is the way in which people might use general orientations of some kind towards gene technology risks in forming specific judgments. This theme is further explored, along with several other issues, in the next chapter, which considers the role of scientific and other knowledges in the formation of attitudes towards science in general and towards GM food risks in particular.

8 KNOWLEDGE, ATTITUDES AND THE PERCEPTION OF RISK

8.1 Introduction

In this chapter I investigate the links between domains of knowledge and the perception of risks from GM food. In earlier empirical chapters I have shown that although it may be the case that people are not well informed about gene technology, they can nevertheless form relatively stable attitudes towards GM food risks by drawing on pre-existing psychological schema, frames of reference and more general social attitudes and values. But what of the people who *are* well informed about gene technology, about science in general and its intersection with politics and government? What is the effect of such knowledges on perceptions of risk? In short, does knowledge make a difference, and if so, how? A consideration of these questions forms the basis of the final empirical investigation of the thesis, taking as its starting point the notion of the 'public understanding of science'.

At the beginning of the chapter, I introduce some key concepts and empirical findings from the public understanding of science literature and draw links with the substantive question of how different forms of knowledge might relate to perceptions of GM food risk. From this discussion I derive a model of risk perception and knowledge. Next I outline the method used to test this model and present some descriptive results from the same survey that was used in Chapter Seven. The results from some structural equation models are presented next, followed by a discussion of these results and their implications.

8.1.1 Attitudes and scientific knowledge

As I pointed out in Chapter Two, much of the original motivation for social psychological studies of risk perception was to try to explain the divergence between 'expert' and 'lay' estimates of risk. The most obvious attribute that separates an expert from a lay person in relation to any particular topic is knowledgeability or command of information. In the present case there is a near-consensus among experts that risks to the public from GM food are extremely small (UK Food Standards Agency, 2003). Given the public's perception that they are much greater, the obvious conclusion to draw is that the public's overestimation of the risks is due to a lack of expert knowledge.

Of course, with the increasing specialisation of scientific and other knowledges in contemporary societies, it is unrealistic to expect that lay people would or should acquire the level of expertise necessary to understand complex discourses about recombinant DNA technologies. Nevertheless, it has been argued that in a well-functioning modern democracy, the electorate should possess at least a basic 'scientific literacy' that should enable people to understand science stories in the media and make informed judgments about the direction of science policy (e.g. Miller, 1983; Miller, Pardo, & Niwa, 1997). Where lay publics are seen as lacking in scientific understanding, it is seen as a barrier to the effective social stewardship of science policy that comes through informed public debate. Simply, ill-informed citizens might make bad decisions - in the sense that they cannot connect their own best interests to the appropriate science policy choices. This view is analogous to one that concerns political questions of the most general kind too. The idea of 'civic competence' is central to most normative theories of democracy. Citizens need to have at least some level of political awareness and factual information in order to connect their best interests and preferences with the political decisions available to them – chiefly by choosing amongst candidates in elections (Delli Carpini & Keeter, 1996). While there are differences between exactly how great a role the informed citizen plays in varieties of democratic theory, all ascribe at least some role to citizen competence (Barber, 1984).

These kinds of assumption underlie the so called 'deficit model' of public understanding of science, introduced in Chapter Two. However, in its crudest characterisation, the deficit model not only suggests that scientific knowledge affects the ways in which people form (or do not form) attitudes towards science, but also predicts negative attitudes towards science and technology as a result of lack of knowledge and understanding. In this respect, it corresponds to the oft heard notion that people erroneously perceive risks from new technologies such as gene technology because of irrational, scientifically unfounded fears (Evans & Durant, 1995; Ziman, 1991).

Most survey research on the link between knowledge and attitudes to science (e.g. Bauer, Durant, & Evans, 1994; Grimston, 1994; e.g. McBeth & Oakes, 1996; Miller, Pardo, & Niwa, 1997; Sturgis & Allum, 2000; Sturgis & Allum, 2001) has only considered general attitudes towards science. Here, though, the empirical evidence certainly provides some support for the deficit model: knowledge about scientific facts and processes is generally correlated with more positive attitudes. However, there is evidence that this link is much weaker, and may not even necessarily be positive, for attitudes to specific technologies. Evans and Durant (1995) found that for the UK public, whilst 'textbook' knowledge of general science was positively correlated with favourable attitudes to science in general, for specific technologies a variety of correlations were found, including a negative one for human embryo research. Elsewhere I, with others, show that in Europe, perceptions of the 'riskiness for society' of medical applications of gene technology are greater amongst those who are less interested and knowledgeable about genetics. By contrast, in the case of GM food, no such differences are found (Gaskell, Allum *et al.*, 2001). It appears, then, that scientific knowledge may tend to be associated with more positive attitudes to science in general, but be less predictably related with attitudes towards specific technological applications.

This phenomenon should come as no surprise to political scientists who have studied the links between people's general political attitudes and belief systems and their attitudes to specific political issues (e.g. Converse, 1964; Sturgis, 2001). The more specific the issue under consideration, the more will specific issue-relevant beliefs, compared to general attitudes and values, contribute to a person's final judgment. Hence a person may in general hold social democratic values and be positive towards higher taxation but oppose the imposition of higher taxes on air travel because he or she happens frequently to travel by air.

Analogously, social psychologists have been particularly concerned with predicting specific intended or realised behaviours from expressed attitudes. Fishbein and Ajzen (1975) developed their Theory of Reasoned Action partly in response to the fact that the attitude-behaviour link was empirically rather weak (Eagly & Chaiken, 1993). They demonstrated that it was only by eliciting more specific attitudes about the particular behaviours and intentions in question that more accurate predictions of behaviour could be made.

Closer to present concerns, in the PUS field, Miller developed a model to explain specific policy preferences for scientific issues that recognises the role of general attitudes towards science and technology (Miller, Pardo, & Niwa, 1997). He uses the concept of psychological schema (Tesser, 1978) to explain how people react to new information and form preferences about scientific and technological issues. This literature suggests that faced with a large number of sources and types of information about a given issue, people rely on a smaller number of general frames based on existing knowledge, attitudes and values to filter the incoming information. These frames or schema simplify both the selection and storage of new information and the generation of preferences, attitudes or opinions about specific issues according to how these issues fit with or resemble existing information. The prediction is that when someone is asked their views on a particular issue, in the present case risk from GM food, schemas they hold for science and technology in general, food, farming and so on, are activated and act as cues which contribute to the formation of views about GM food risk even in cases where no previous deliberation about this specific issue has taken place.

A general model of attitudes and beliefs about particular technologies can be derived from this discussion. Firstly, those who are more knowledgeable about science in general will tend to hold more positive attitudes towards science and technology in general. This prediction derives mainly from past empirical findings. Secondly, people who hold more positive general attitudes to science will tend to view any particular technological development more favourably than those who are more sceptical about science and technology in general. In other words, to the extent that greater scientific literacy leads to more favourable views about any specific technology, its influence comes through its effect on people's general disposition towards science and technology. The more easily any specific technological issue fits with a person's schema, or general feelings about science and technology, the closer will be the association between them and, therefore, with scientific knowledge. In the present case, the expectation is that greater knowledge about science and genetics will tend to attenuate risk perception only to the extent that it is related to more general attitudes towards science.

8.1.2 Contextualising knowledge about science

In Chapter Two, I drew attention to a fundamental critique of the deficit model of public understanding of science that has been articulated by many writers since the work of Miller and of Evans, Durant and Thomas began during the 1980s. To recapitulate briefly, the main tenet of this critique is that there exist other knowledge domains that can influence attitudes towards science and technology in opposite or conflicting ways to factual scientific knowledge, and that the locations of these domains are contingent on the context in which people are engaging with the issue at stake.

Jasanoff, for example, suggests that what is important for people's understanding of science is not so much the ability to recall large numbers of miscellaneous facts but rather 'a keen appreciation of the places where science and technology articulate smoothly with one's experience of life…and of the trustworthiness of expert claims and institutions' (Jasanoff, 2000 p.55). Wynne, probably the most well known of the deficit model's critics lambastes survey-based PUS research's over-reliance on simple 'textbook' knowledge scales. Wynne suggests that in order to capture the range of knowledge domains relevant to lay attitudes towards scientific research programmes 'three elements of public understanding have to be expressly related: the formal contents of scientific knowledge; the methods and processes of science; and its forms of institutional embedding, patronage, organisation and control' (Wynne, 1992 p.42).

I refer to this general view as the 'contextualist' perspective. The implication of this position is that the deficit model considers at best only the first two of these elements and that, in neglecting the different forms of engagement that individuals and groups might have with science in a variety of contexts, PUS research has overstated the importance of the simple deficit model. Other knowledges - intimate knowledge of working procedures at a nuclear power plant or awareness of the practical political interdependencies between government, industry and scientific institutions - will always be moderating or contextualising factors on the way people perceive the attendant risks. The ways in which people utilise their factual scientific knowledge is contextualised by the circumstances under consideration. As a corollary to this line of argument I make the assumption that the third element in this formulation – knowledge of the forms of institutional embedding, patronage, organisation and control of science - will influence public attitudes in ways opposite to or conflicting with the first two elements. If not, then it would appear to be nothing other than a somewhat more elaborated restatement of the deficit model.

Much of the criticism of the deficit model has arisen from qualitative case studies, with the exemplar being Wynne's study of Cumbrian sheep farmers and radioactive fallout from the Chernobyl reactor disaster. In this case study, Wynne shows that government scientists in charge of precautionary measures taken to prevent the contamination of sheep by radioactive fallout in the soil was based on false assumptions about local conditions. Local farmers, on the other hand, expressed concerns based on intimate knowledge of variation in local farming practices, soil types and the actual behaviour of flocks. This 'local knowledge' was largely ignored by officials, even after it had become clear that the scientists were acting on erroneous assumptions. The point is, according to Wynne, that lay knowledges may not be captured in survey questions about textbook scientific facts but may nevertheless be highly relevant for the formation of attitudes and beliefs about the way science and practice interact. Alternative relevant lay knowledge is not restricted to that concerned with local practices. Hence Wynne suggests that, from a more general public understanding perspective, 'lay public response to science is frequently – and legitimately – based upon understandings of science's "body language" (for instance whether it is reproducing private profits or public services) when scientific experts themselves imagine that they are or should be based only on its propositional contents' (Wynne, 1996, p.79)

One of the central axioms of the contextualist perspective seems to be that survey-based methods are at best procrustean and at worst fundamentally misleading for understanding lay publics' knowledge of and interactions with science (Wynne 1995). The principal contention is that 'surveys take the respondent out of [their] social context and are intrinsically unable to examine or control analytically for the potentially variable, socially rooted meanings that key terms have for social actors' (Wynne 1995). Methodologically, as I have indicated, the contextualist perspective has relied instead on qualitative case studies for empirical support (e.g. Irwin and Wynne 1996, Kerr, Cunningham-Burley and Amos 1998, Michael 1992, Michael 1996). A contextualist theoretical outlook and a quantitative methodological approach are, apparently, incommensurable from this perspective. However, this conflation of theory and method - with contextualist perspectives requiring a qualitative approach and quantitative research seen as good only for propounding the deficit model – is, I believe, an unnecessary and an unhelpful state of affairs. One of the purposes of this chapter is to integrate both contextualist and deficit model hypotheses into a model of attitudes in relation to GM food risk using quantitative methods.

With any research design, one of the key issues is how to transform a theoretical concept of interest into something that has empirical consequences that can be observed. In the case of 'institutional' or 'contextual' knowledge of science, there are some difficulties in operationalising the concept in a series of survey questions. There have been few attempts to measure 'institutional knowledge' of science in the past. Miller has long suggested that knowledge of the impacts of science and technology on society should be incorporated as part of the concept of scientific literacy (Miller, 1983). Unfortunately, neither Miller nor others have followed this exhortation and developed any appropriate measures. In a recent article, Bauer et al recently presented measures of 'institutional knowledge of science'. They analyse attitudes towards and knowledge of science comparing samples of British and Bulgarian citizens (Bauer, Petkova, & Boyadjieva, 2000). Whilst the approach these authors take is a welcome first step to measurement of a more complex conception of the public understanding of science, their operationalisation is not entirely successful because of the blurring of the boundary between objective knowledge and attitudes to science that is inherent to some of their survey items. For instance, statements such as 'the reward of scientific research is recognition rather than money' are presented with true/false response alternatives. In this case, as for many of their items, there is not an unambiguously 'true' answer. There is no particular reason, though, why it is not possible in principle to find measures of institutional knowledge of science. In fact, I attempted this in pilot work while developing the Internet survey. I wrote several survey items that tapped people's knowledge of several aspects of the science and its link with politics and society at large, partially based on the ideas behind Bauer et al's items. The problem that arose when analysing these items was that they did not form a very reliable or consistent scale when piloted and so could not be used as indicators of an underlying construct common to all respondents. On the one hand this could have been simply that the items were not well written. Another possibility is that the particular knowledge in question is so specialised that it is simply not distributed among the general population with sufficient variation to be amenable to measurement in this way (see Converse, 2000 for a discussion of this type of problem in relation to the measurement of objective knowledge in surveys).

A viable alternative to these various approaches is suggested by research in political science over many years that has demonstrated that people tend to be 'generalists' in the types of political knowledge they possess (Delli Carpini & Keeter, 1996; Luskin, 1987, 1990). Citizen's knowledge about how science, politics, economics and society interrelate is in all likelihood correlated with their knowledge of straightforward political facts. Certainly this is the conclusion of Delli Carpini and Keeter who review evidence from 40 years of opinion polling in the US. They show that people who are knowledgeable about, for example, foreign policy or social welfare issues tend also to possess much greater knowledge about the names of senators, people in the current administration, the structure of political institutions like the Senate and House of Representatives and so forth. Hence it is not unreasonable to suppose that by using valid and reliable measures of political knowledge, it is possible to tap the extent of contextual, political knowledge that people have in relation to the practice of science in its political and institutional contexts. After all, scientific issues that have consequences for the public are really nothing more than a particular sample taken from a universe of possible political issues in which people may be more or less interested and knowledgeable. This then is a way of operationalising Wynne's concept of other contextualising knowledge about science, its 'body language', 'institutional embedding, patronage and control' (Wynne, 1992)

I have taken this approach in a previous study where my co-author and I fitted OLS regression models to predict attitudes to science using political and scientific knowledge, and the product term interaction between the two, to evaluate the joint effect of different knowledge domains on attitudes (Sturgis & Allum, 2004). The expectation, based on the contextualist perspective, was that more political knowledge would lead to more sceptical attitudes to science, and that the interaction would be negative – so that the positive effect of scientific knowledge would be attenuated with higher levels of political 'contextualising' knowledge. In fact, both the main effect and interaction were positive, suggesting that while political knowledge does appear to moderate the simple relationship propounded by the deficit model, the effect is in the opposite direction to the expected one. In the present study, I attempt to replicate this work using SEM techniques, using different knowledge measures and extending the model to include perception of GM food risk as well as general attitudes to science.

8.1.3 Knowledge and interest

The final aspect of the relationship between knowledge and attitudes to GM food risk that I aim to address in this chapter concerns the link between knowledge of and interest in science. One of the possible criticisms of the simple deficit model of PUS is that the apparent association between more knowledge of science and more positive attitudes towards it is spurious. The real causal variable is interest in science. People who are already interested in science tend to seek more information about it and become better informed. The apparent link between knowledge and attitudes masks the true relationship between interest and positive attitudes. This is inherently plausible. On the other hand, if becoming more knowledgeable about science leads one to become more interested and at the same time form more optimistic opinions about science, then the basic tenet of the deficit model, 'to know science is to like it' (Allum, Boy, & Bauer, 2002), remains true. Disentangling these relationships is not easy especially as it is likely that the two are in reality reciprocally related. Learning about science might lead to greater interest in aspects of science and this interest may in turn encourage people to seek more information and understanding. Drawing again from the political science field, for some commentators, knowledge and interest, in political issues at least, are often seen as components or indicators of an overall degree of political 'sophistication' (Luskin, 1987, 1990) and in many ways functionally equivalent.

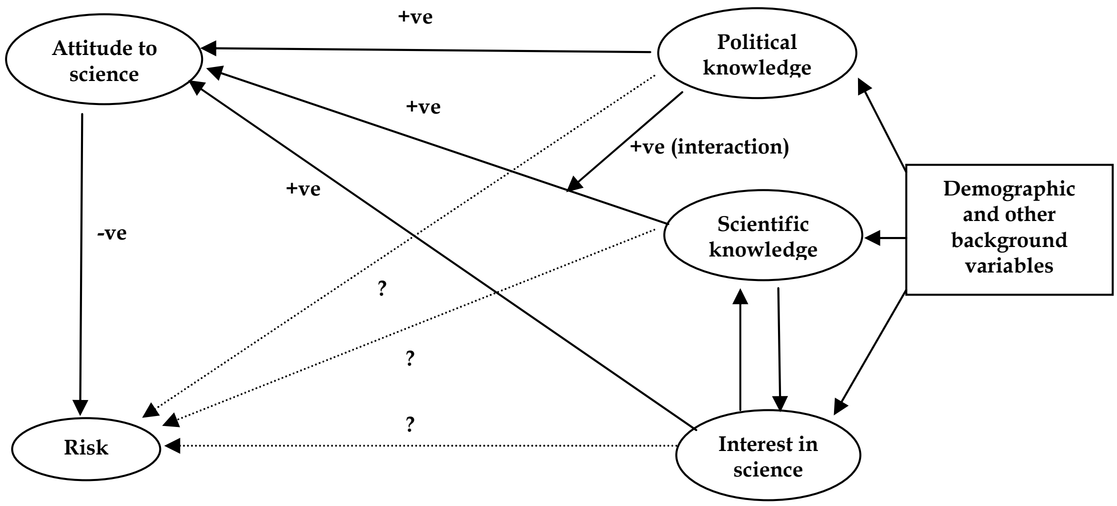
Others, though, see knowledge and interest as distinctly different, albeit related, concepts (Delli Carpini & Keeter, 1996; Popkin & Dimock, 1999). The second view is the one adopted here. This is firstly because the empirical findings from the latter writers convincingly show that political knowledge has independent effects, net of interest in politics, on outcome variables such as voter turnout. Secondly, in the case of a controversial technology such as GM food, one can imagine that interest in the issue may come from people not usually interested or particularly informed about science but who have concerns about GM food perhaps because of its high profile media coverage and the fact that it has become a 'hot' political issue. In the analysis that follows, I attempt to test the possible reciprocal relationship between knowledge of and interest in science while at the same time evaluating the effects of both on attitudes to science and on the perception of risk from GM food. As far as I am aware, this type of reciprocal model, although sometimes mentioned informally in PUS research, has not before been the subject of empirical investigation.

8.1.4 Modelling knowledges, interest and risk perception

The discussion so far suggests a possible explanatory model of the links between knowledge, interest, attitudes to science and perception of GM food risk. Following my previous work (Sturgis & Allum, 2004), scientific knowledge and political knowledge are expected to directly and positively influence attitudes to science in general. All things being equal, more optimism about science in general should make it more likely that a person will be less concerned with possible risks from GM food. The direct links to risk perception from knowledge and interest are a matter for uncertainty, as no general pattern can be predicted for all risk issues, as previous research attests. However, given that general knowledges are expected to influence general attitudes, the initial assumption is that no direct link between knowledges and risk perception exists. Instead, the effect of knowledge on risk should be mediated through general attitudes to science.

The contextualising role of political knowledge is expected to manifest itself in the following way: at greater levels of political knowledge, the effect of scientific knowledge on attitudes to science will be more pronounced. In other words, there should be a positive interaction between political and scientific knowledges as predictors of attitudes. The link between scientific knowledge and interest is expected to be one of reciprocal causation, although the alternative hypothesis, perhaps implicit in the deficit model of PUS, is that knowledge acquisition leads to interest, engagement and, presumably, positive attitudes towards science in general - and not the other way around. This model can be explored through the use of SEM, in a similar way that trust and risk perception were investigated in Chapter Seven. The basic form of such a model is shown in figure 8.1.

Figure 8.1 Outline model of knowledge, attitudes and risk perception



A set of demographic and other background measures used as control variables is indicated on the far right of the diagram. Using appropriate control variables will ensure that the effects of knowledge and interest are not confused with, for example, educational background. This model can be specified using a set of structural equations and estimated using the AMOS 5 software package. The next section describes the survey measures used in the analysis and presents some descriptive results. The results from fitting the model follow in subsequent sections.

8.2 Measures and preliminary results

8.2.1 Scientific and political knowledge

The Internet survey described in the previous chapter contained questions designed to tap 'textbook' knowledge of biology and genetics, knowledge about UK parliamentary politics, attitudes towards science, interest in science and in GM food. The two items tapping people's beliefs about GM food risk were described in Chapter Seven. The knowledge items were posed as a series of statements. Respondents were asked to say if they thought each of the statements were true, false or that they did not know the answer. Five of these items for each of the two knowledge domains were included in the survey. Ideally it would have been desirable to include more items than these ten. This would have increased both the reliability and the range of conceptual coverage of the measurement. However, this was not possible due to budgetary constraints.

The biology knowledge items were chosen from a larger set of ten that have been deployed in previous surveys about biotechnology and have proven to be reasonably reliable and discriminating (Gaskell, Allum, & Stares, 2003; Gaskell, Allum *et al.*, 2001). The political knowledge items were derived from a series of questions developed by Martin et al (1993) and used in some of the British Election Study surveys during the 1990s (Thomson, Park, & Taylor, 1999). It will be clear that these political knowledge questions do not directly refer to any science policy issues. They tap knowledge about parliamentary procedures and other institutional arrangements. However, as I pointed out earlier, most research on political knowledge and sophistication suggests that people who are knowledgeable about one aspect of political affairs are also likely to be knowledgeable about others. For example, Delli Carpini and Keeter have shown that, in two recent US surveys, the average correlation between scales measuring knowledge about political 'players' and the policy stances of political parties is approximately .80 (Delli Carpini & Keeter, 1996). They also find that, in a range of US surveys, the lowest correlation between sub-domains of political knowledge (drawn from a pool of ten different domains) is as high as .52, while the greatest is .97. Given the constraints of this survey, the chosen strategy for operationalising political knowledge using a (necessarily small) set of previously validated items tapping general knowledge of political institutions seems appropriate.

Table 8.1 shows the weighted frequency distributions of the ten knowledge questions. Cells underlined in bold indicate the percentage of people making the correct response to each item. Cronbach's alpha, a rough measure of scale reliability, is shown for each of the two scales.

There is a very high proportion of people correctly answering the biology knowledge questions. Practically no one fails to select the correct answer to questions 1 and 3, concerning bacteria and yeast. More than 80% of people know that the cloning of living things produces genetically identical offspring. Only between 60 and 70% of respondents know that genetically modified tomatoes and ordinary tomatoes both contain genes and that genetically modified animals are not always bigger than ordinary ones. These items were selected to have a range of difficulties in order that they would discriminate between respondents of all abilities. Unfortunately, these results show that for this sample of Internet respondents, questions 1 and 3 are much easier to answer than intended. Partly as a result of this, Cronbach's alpha is only .42, which is only just adequate. A summated scale score was created for respondents by assigning them one for each correct answer given and zero for incorrect or don't know responses. The resulting new variable ranges from 0 to 5 with a mean of 4.2 and standard deviation of .97. Clearly people are, in general, quite well informed about basic biology and genetics.

The political knowledge questions show a much wider spread of responses. For example, nine out of ten people know that Britain has separate elections for the European and British parliaments while under one third realise that British Prime Ministers are appointed by the Queen. Cronbach's alpha is .64, which is quite acceptable for a 5-item scale. Again, a summated scale score was created for respondents by assigning them one for each correct answer given and zero for incorrect or don't know responses. The resulting new variable ranges from 0 to 5 with a mean of 3.4 and standard deviation of 1.37. There is greater variation in scores on political knowledge than for scientific knowledge.

Table 8.1 Distribution of answers to knowledge quizzes

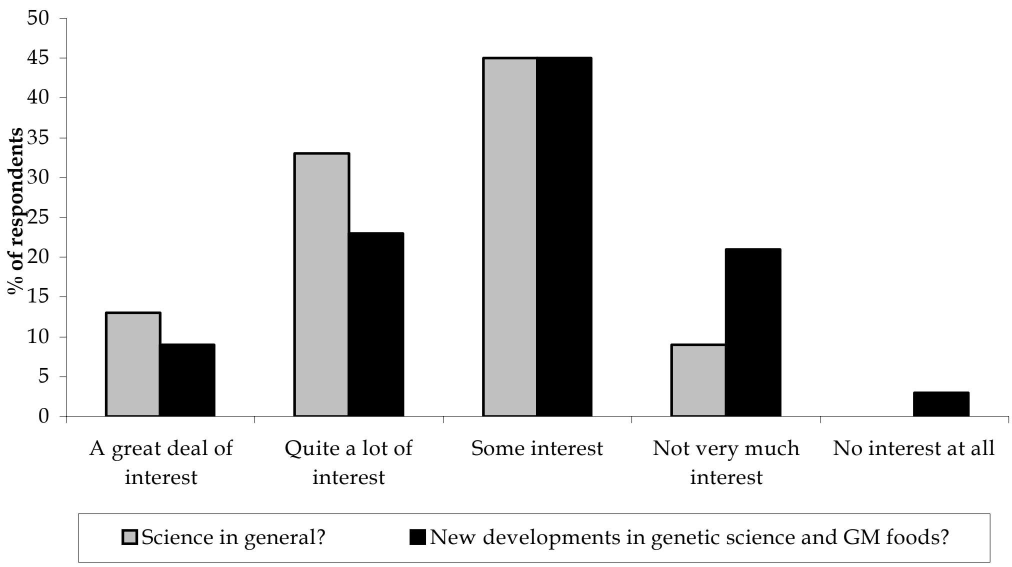
(Weighted %)	**True**	**False**	**Don't know**
Biology Knowledge			
1. There are bacteria which live from waste water	**94**	2	4
2. Ordinary tomatoes do not contain genes, while genetically modified tomatoes do	10	**67**	23
3. Yeast for brewing beer consists of living organisms	**94**	2	4
4. The cloning of living things produces genetically identical offspring	**84**	8	8
5. Genetically modified animals are always bigger than ordinary ones	6	**61**	33
(Alpha=.42)			
Political Knowledge			
6. The number of Members of Parliament is about 100	10	**73**	18
7. The longest time between General Elections is four years	52	**42**	4
8. British Prime Ministers are appointed by the Queen	**32**	63	6
9. Britain's electoral system is based on proportional representation	22	**66**	12
10. Britain has separate elections for the European parliament and the British parliament	**87**	5	8
(Alpha=.64)			

A note of caution should be added here. The unweighted frequencies (not shown, but see appendix A) signify a more knowledgeable public than the weighted frequencies shown here, suggesting systematic differences between the 'online' and 'offline' populations in the UK. Respondents in this Internet sample appear to be more knowledgeable about politics and science than the general public.[9] Even the weighted results should probably be considered as an overestimate of actual knowledge levels in the population.

8.2.2 Interest in science and GM food

Two questions concerning people's interest in science and in the issues of GM food and genetics were asked prior to the knowledge questions. People were asked '*generally speaking, how much interest do you have in… science in general*' and '*new developments in genetic science and GM food*'. A bar chart showing responses to both of these questions is shown in figure 8.2. At least 80% of people claim to have at least some interest in either science or genetics.

Figure 8.2 Interest in science and genetics

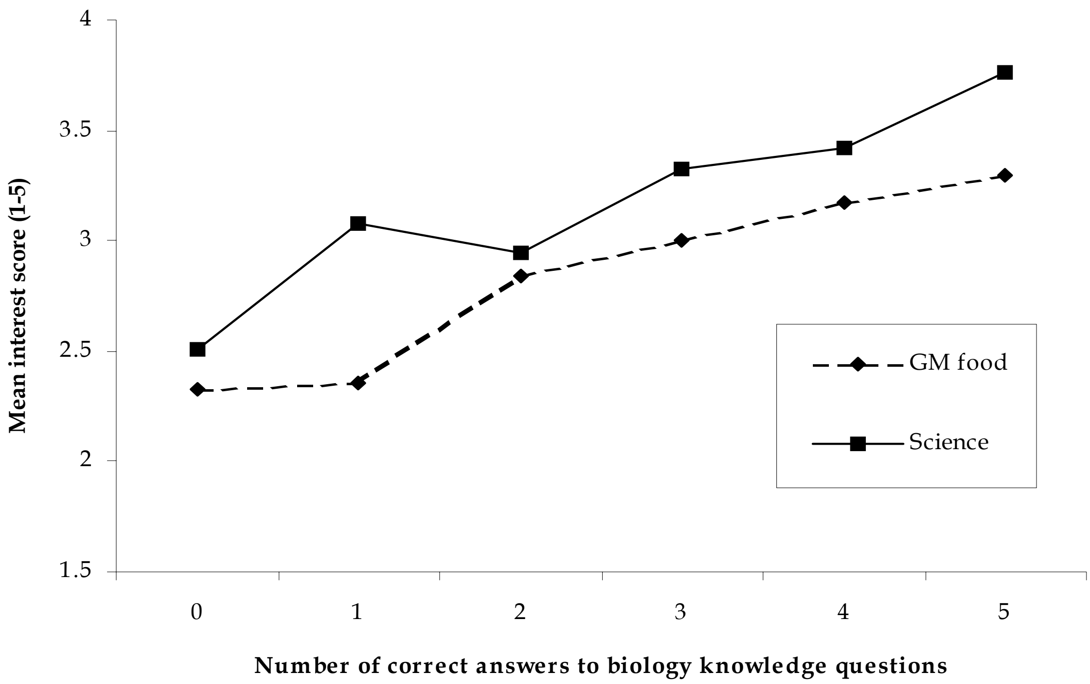


No one at all in the sample reported a complete lack of interest in science, and only one quarter claimed to have not very much or no interest in genetics and GM food. These results are not unexpected as a high level of interest in science and technology is a common finding in this type of survey (e.g. Durant, Evans, & Thomas, 1989; e.g. Miller, Pardo, & Niwa, 1997)

[9] For a more complete analysis of the differences between Internet and probability sample surveys and the effect of weighting on these knowledge items under several schemes, see Allum and Sturgis (2003)

The two measures of people's interest in science and in genetics are strongly correlated (Pearson's R =.64). They are also have a similar strength of correlation with biology knowledge (.32 and .24 respectively), which can be seen in figure 8.3.

Figure 8.3 Correlations between knowledge and interests



Clearly, biology knowledge and interest in science and genetics are all associated, as one would expect. There is no reason to expect greatly different relationships between these two types of interest and other criterion variables. For this reason, I treat the two measures of interest as indicators of a more general construct: interest in science and technology. The resulting new variable ranges from 0 to 8 and is approximately normally distributed with a mean of 5.0 and standard deviation of 1.6.

8.2.3 Attitudes towards science

A series of items tapping attitudes to science in general have been used in successive PUS surveys since the late 1980s in Britain and Europe (Durant, Evans, & Thomas, 1989; Evans & Durant, 1995; Sturgis & Allum, 2004). Whilst these attitude items have not been without criticism as constituents of a multi-item scale (Pardo & Calvo, 2002), they have the advantage of providing comparability with previous studies. For this study, I used a subset of these items, most recently used in the British Social Attitudes (BSA) survey in 1996. The items were chosen because of their face validity and their discriminatory properties in relation to the whole attitude scale, based on a factor analysis of the BSA data. In common with other parts of the questionnaire, it would have been desirable to include more than three items in this scale, but budgetary constraints made this impossible.

The wordings of the three attitude statements, along with frequency distributions, are shown in table 8.2. There is a widely held view that science and technology are making our lives easier and healthier, with as many as 94% in some form of agreement with the statement.

Table 8.2 Attitudes towards science and technology

	Weighted %						
	Strongly agree	**Moderately agree**	**Slightly agree**	**Neither agree nor disagree**	**Slightly disagree**	**Moderately disagree**	**Strongly disagree**
Science and technology are making our lives healthier, easier and more comfortable	38	42	14	4	1	1	0
We depend too much on science and not enough on faith	5	12	16	20	11	14	23
Science makes our way of life change too fast	7	17	25	20	11	9	11

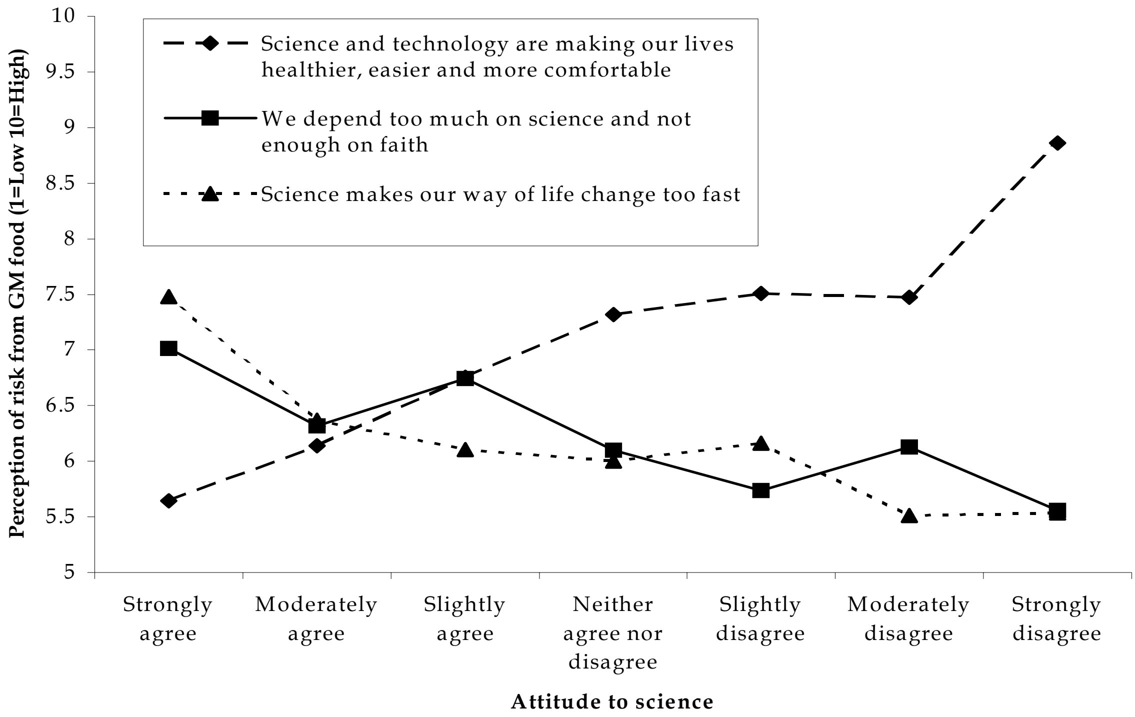
On the remaining two statements, there is a much more dispersed set of responses. Nearly half agrees that science makes our way of life change too fast while only a third thinks that we rely too much on science and not enough on faith. The last two statements both involve some kind of value judgment about what constitutes 'too much' or 'too fast' and, perhaps as result, elicit many more equivocal answers than the first. One fifth of all respondents cannot come to a firm view on these items.

These results are fairly similar to those obtained in a recent Eurobarometer survey on attitudes to science (European Commission, 2001). In that survey, fielded in 2001, 85% of Britons agreed that science and technology are making our lives easier and healthier, 58% think that science makes our way of life change too fast and 57% believe that we rely too much on science and not enough on faith. On each of the three items, the YouGov sample is more favourable towards science and technology than the Eurobarometer sample. This is in keeping with what has emerged so far about the likely differences between Internet and non-Internet respondents: the former's enthusiasm for the Internet seems to extend to other science and technology as well. Hence the estimates here should again probably be treated as upper bounds on the true population proportions.

An initial evaluation of the association between responses to these items and perception of GM food risk was carried out by plotting them against the mean of a summated scale score of people's responses to the two risk questions described in Chapter Seven (personal and general risk). The resultant variable ranges from 1 to 10. Means for this variable were plotted at each level of agreement or disagreement with each of the attitude statements. The results are shown in figure 8.4.

The graph clearly shows that higher risk perception is associated with more negative attitudes to science and technology. The slope is positive for the 'healthier and easier' item and negative for the other two because of the opposite direction of wording. For the SEM analysis that follows, rather than create a summated scale for these three items, they will each be used as an observed indicator of a single latent 'attitude to science' variable.

Figure 8.4 Correlation of attitudes to science with perception of GM food risk



8.2.4 Demographic and other background variables

The following background variables are also used in the SEM analysis. They are all coded as dichotomous dummy variables except for age, which is treated as continuous.

- Occupational status[10] (salariat/other)
- Religion ('Do you regard yourself as belonging to any particular religion?' - Yes/all others)
- Marital status (Married/not married)
- Vote choice (Voted Labour in last election/all others)
- Higher education (University degree/others

[10] Based on Goldthorpe classification (Goldthorpe, 1997)

- Science education (Taken at least one college level natural science course/all others)
- Sex (Male/Female)
- Age (continuous)

This information, with the exception of the science education question, which was part of the main survey, is gathered from respondents when they sign up to the YouGov panel.

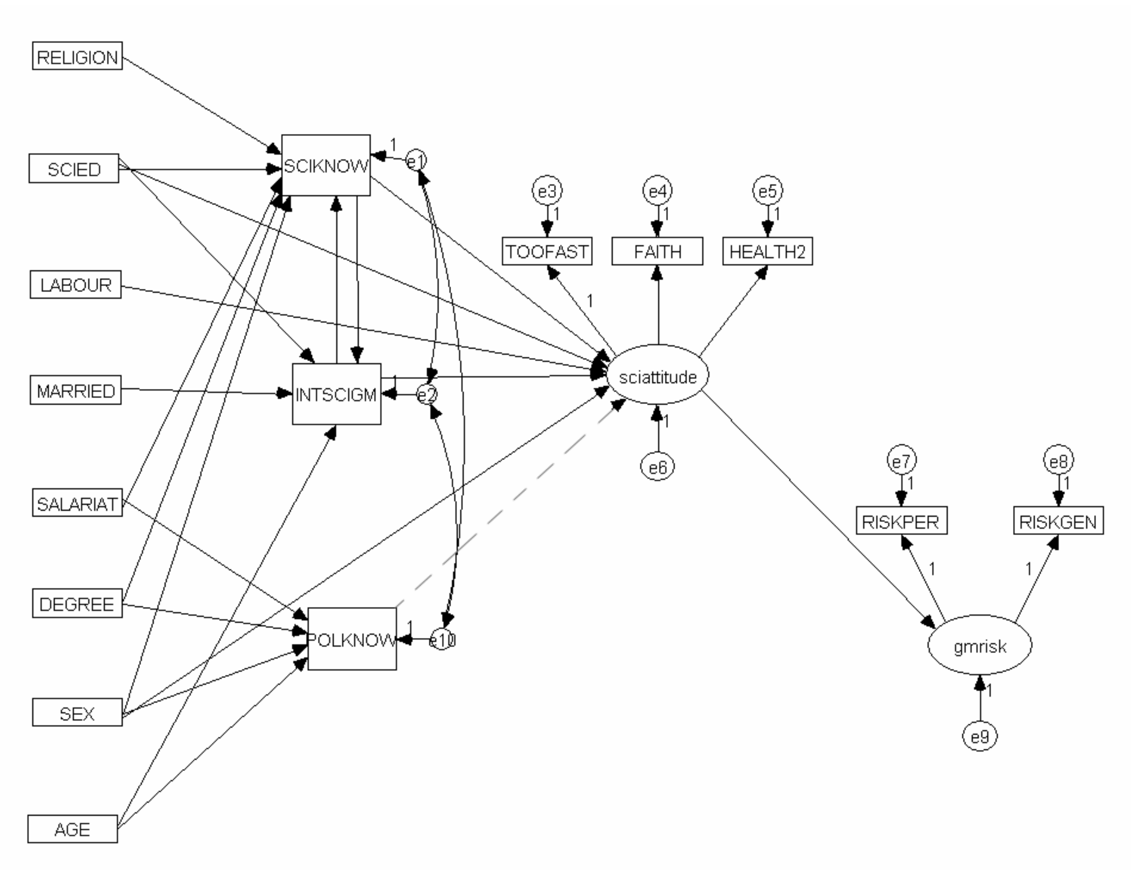
8.3 Main results

A structural equation model was specified using the AMOS 5 software package. Two latent variables were estimated, with the remainder of variables in the model being directly observed. A measurement model was not estimated as a preliminary to the full structural model because with only three indicators in the attitudes to science construct, a CFA would be only just identified, so little useful information would have been gained beyond that which could be achieved by starting out with the hypothesised theoretical model. The other latent variable for perception of GM food risk had already been evaluated in Chapter Seven. The structural model to be fitted is shown in figure 8.5. Manifest, observed variables are identified with uppercase names; latent, unobserved variables in lower case. The number of cases, after listwise deletion of cases with missing values, is 1201.

The model can be considered in blocks with the leftmost variables being exogenous, or 'prior'. The assumption is that the effects of variables such as age, education, sex and occupation are logically prior to those to their right in the model. The middle block contains the endogenous 'intervening' or 'mediating' variables of knowledge, interest and overall attitudes to science and technology. These are assumed to be influenced by the prior variables but not by the rightmost 'dependent' variable, perception of GM food risk. In other words, causality in this model flows from left to right.

It is worth adding here that the assumption that knowledge and interest influence people's general attitudes and not the other way around cannot easily be empirically tested with the present model. Reversing the causal arrows between these two intervening blocks would, in all likelihood, not provide a very different fit to the data.

Figure 8.5 Outline of baseline main effects model



This is an example of the more general problem of equivalent models in statistical research (Lee & Hershberger, 1990). It therefore remains an assumption but one which I consider to be much more plausible than the reverse hypothesis. People learn about science from an early age, follow certain paths through school and college. It is likely that for the majority of people, attitudes to science, if they have a link with knowledge, are formed in light of past learning and experience. The idea that people might for other reasons develop strongly positive attitudes to science and then, as a result, acquire knowledge and greater interest is not impossible, but much less likely. I assume that the first situation described is the much more common one.

Note too that the interaction between political and scientific knowledges is not tested here. It is not possible to employ product-term interaction variables in standard SEM as one can in OLS regression. Interactions are usually tested instead using multi-group SEM. Such an analysis is described later in this chapter.

In fact, the first step was to fit a model identical to this except that regression paths were estimated from the entire block of control variables to each of the intervening variables (POLKNOW, SCIKNOW, INTSCIGM, sciattitude). This was carried out so as to eliminate any spurious relationships that might otherwise be interpreted as causal if the model were to be estimated without controls. For instance, it is important to ensure that the observed relationship, if any, between scientific knowledge and interest in science is not the result of a shared common cause – the most likely being education.

After estimating this model, all of the statistically non-significant paths were deleted leaving the model re-specified as in figure 8.5. Not shown on the diagram, for the sake of clarity, are covariances that are also freely estimated between all of the exogenous variables. Allowing exogenous variables to covary is the usual practice, as it is assumed that they almost certainly share one or more common causes that are, of course, not specified within the model.

8.3.1 Main effect of political knowledge

The dotted path from political knowledge indicates that when the model was estimated with the control paths freed, the path from POLKNOW to sciattitude was not significantly different from zero. This represents a failure to replicate previous results (Sturgis & Allum, 2004) that political knowledge is associated with more positive attitudes to science. Of course, this result does not provide any support either for the 'contextualist' perspective, at least as I interpret it, that would suggest that greater political knowledge should lead to more scepticism about science. Holding all other intervening and prior variables constant, a person's political knowledge is uncorrelated with their general attitudes to science. Some possible explanations for this inconclusive result will be considered in the discussion at the end of the chapter. The path from POLKNOW to sciattitudes was deleted and the result used as a baseline for further model development described in the following section.

8.3.2 Model development

The strategy for model development was to look at likely sources of misfit in the model, based on the inspection of modification indices and residuals between observed and implied covariance matrices. Recall that a high modification index for a fixed parameter indicates the minimum fall in the omnibus Chi2 test statistic that would result if the parameter were to be freely estimated. Any modifications must, of course, have plausible theoretical explanations. The fit statistics for the series of nested models tested are shown in table 8.3.

Model 1, the baseline model does not fit according to the Chi2 statistic, Nor does it fit according to at least one of the approximate fit indices. CFI, at .94, is slightly below the .95 cut-off recommended by Hu and Bentler (1999). Inspection of the modification indices showed that the fit would improve very considerably if the error term (e4) for the sciattitude indicator FAITH were allowed to covary with RELIGION. Model 2 incorporates this change. Chi2 changes by 91 for 1 degree of freedom compared to the baseline model, which is highly significant. There is an improvement in all of the approximate fit indices too. The correlation between considering oneself religious and responding to the statement 'we rely too much on science and not enough on faith' is easily explained. Agreement with the latter statement is partially driven by one's attitude to science but also by the extent to which one has a religious conviction. As a result, there is systematic variation in people's responses to this question even when conditioned on (controlling for) their attitude to science, as measured by the latent variable sciattitude. This systematic variance is correlated with responses to the question about religion as they both share a common cause – religiosity.

Table 8.3 Nested model comparisons

Model	Chi²	Df	p	Δ Chi²	Δ df	RMSEA	CFI	SRMR
4. Baseline	332	65	<.00	-	-	.059	.94	.048
5. Free error covariance: RELIGION-e4	241	64	<.00	91	1	.048	.96	.041
6. Free error covariance: e3-e4	205	63	<.00	127	2	.043	.97	.038
7. Free path: INTSCIGM -->sciattitude	155	62	<.00	177	3	.035	.98	.032

This is an interesting finding in relation to this attitude item, as it has been used frequently in PUS surveys as part of a scale that has, as it now seems, to some extent conflated religious feeling with attitude to science and technology. The advantage of using SEM is that it is possible to control for this error by modelling it explicitly, as is done here.

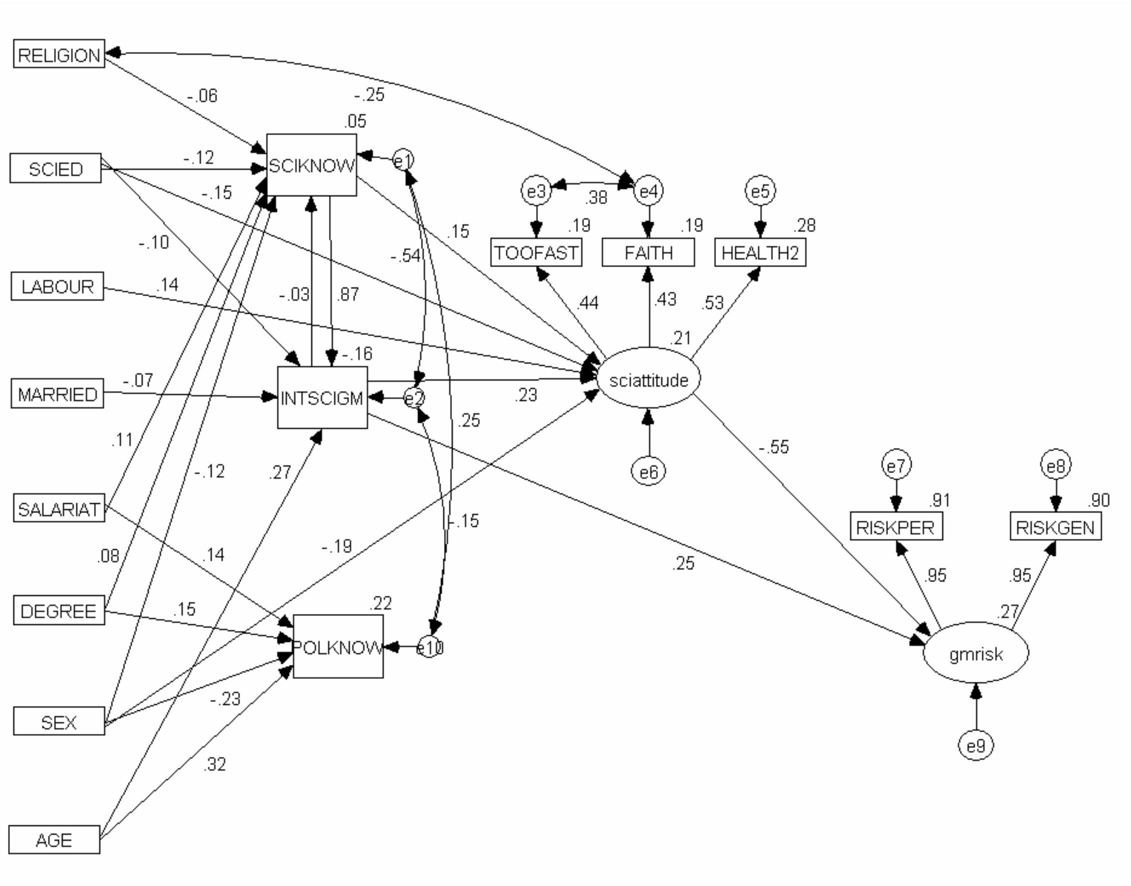
The largest modification index for model 2 indicated that allowing the error term (e5) for the sciattitude indicator HEALTH to covary with gmrisk would lead to an improvement in fit. This should not be the case if the sciattitude latent is correctly specified because the indicator variables should be uncorrelated with all other variables, conditioned on the latent. Of the three indicators of sciattitude, two of them, TOOFAST and FAITH are worded negatively (i.e. agreement indicates a negative attitude towards science) and the remaining one, HEALTH, worded positively. It is well known that including items with opposite valences with respect to the underlying construct being measured often introduces an additional response bias 'factor' (Billiet & McClendon, 2000). In order to take account of this, a covariance was freed between error terms (e2 and e4) of the two negative items. This should have the effect of ‘purifying the latent variable. As expected, when this modification is made, the standardised factor loading for HEALTH goes up, and modification indices no longer indicate a residual correlation between this and gmrisk. All fit indices show improvement with this change.

Model 4 was suggested by inspecting modification indices for model 3. The only large remaining index suggested that fit would be substantially improved if a direct path were to be estimated from interest in science and genetics (INTSCIGM) to perception of GM food risk. Inspection of the standardised residuals between observed and model implied variance/covariance matrices also showed large residuals, in excess of 4.0, for the covariances of RISKGEN and RISKPER with INSCIGM. With this additional path freely estimated, the model fit increases once again, with RMSEA showing quite a steep decline from .043 to .035 compared to model 3; from .059 to .035 compared to the baseline model.

Intriguingly, the estimated standardised coefficient for this path is positive, as can be seen in figure 8.6. This is interesting because there is a positive relationship between interest in science and attitude toward science while there is a negative relationship between perception of GM food risk and general attitudes. Were this model true, it would mean that people’s interest in science and genetics leads them to have more positive attitudes towards science in general – and this leads them to view the risks from GM food in a more relaxed way. At the same time, the direct effect of becoming more interested in science and genetics is to make people more concerned about the risks from GMOs. Is this a plausible interpretation?

Consider again what the model implies. The more one becomes interested in science and genetics, the more risks one can see might be associated with GM food (direct effect of interest). But having more interest also tends to increase one’s favourability towards science and technology. Because having a more positive view about science tends to ‘rub off’ on one’s views about specific technologies, or structure the way in which new information about them is received and processed, this offsets the tendency to see more risk as one's interest increases (indirect effect of interest). For different novel technologies, perhaps less controversial ones such as solar energy, it may be that this pattern would be different and that being more interested in science and technology would have self reinforcing direct and indirect effects.

Figure 8.6 Non-recursive model (standardised parameter estimates)



In fact, this situation is common in psychological and sociological research and is known as a 'suppressor effect' (Maassen & Bakker, 2001). An example of this from political science is the effect of educational attainment on social attitudes. More education leads one to adopt more liberal positions on social issues. At the same time, more education leads one to generate higher income. The effect of higher income tends to be to lead one to more conservative attitudes. Hence the effect of education on social attitudes is complex, with direct and indirect effects differing in their 'polarity' (Davis, 1985).

8.3.3 Interpreting the model parameters

The endogenous latent variable that is the final outcome of the model is the perception of GM food risk (gmrisk). 27% of the variance in gmrisk is directly explained by INTSCIGM and sciattitude. There is a negative relationship between attitudes to science and perception of risk from GM food, with a standardised regression weight of -.55. This suggests that people's overall orientation towards science and technology has a strong influence on how they make up their minds about the risks from GM food. Those who are more optimistic about science are much less likely to see GM food as a risk.

There is, as discussed earlier, a positive direct influence of interest in science and genetics on risk perception. The standardised regression weight of .25 means that for a one standard deviation rise in interest (this equates in this case to about 1.5points on the 10-point interest scale), risk perception goes up by one quarter of a standard deviation. This is true when sciattitude is held constant. Interestingly, because of the previously discussed suppressor effect of attitude to science, the absolute sum of indirect and direct effects of interest on risk perception is of greater magnitude than the zero order correlation between the two. Summing the absolute values of the direct and indirect (through sciattitude) paths yields .38 (.23x.55+.25)[11] while the zero order correlation is only .12.

There are five direct paths to attitudes to science and technology. Both scientific knowledge and interest in science have direct effects on attitudes, net of all the control variables. Both are positively related, with standardised effects of .15 and .23 respectively. Political knowledge does not, counter to expectations, predict attitudes to science, holding all other variables constant. The strongest

[11] See Chapter Six for an explanation of the calculation of indirect effects in path models.

predictor of attitudes to science besides interest is sex. Women are less likely to be optimistic about the role of science and technology than men, even after controlling for differences in the other background variables as well as knowledge and interest. This accords with most previous work in PUS, which finds women to be consistently less impressed by the role of science in society than men seem to be. With an absence of a direct effect of sex on gmrisk, the model suggests that differences between attitudes to GM food risks between men and women are reflective of an overall difference in orientation towards science, rather than to issues about GMOs in particular.

Taking a college level natural science course also a predictor of more positive attitudes to science (note that SCIED is coded 1 for no college science, 2 for at least one course). This is interesting as the effect is significant even controlling for general education, biology knowledge and interest in science and genetics. Of course what is missing from the model are any variables that might explain the choice of college level science in the first place. This would be a fruitful area for further research as it is not clear whether taking a natural science course imbues one with positive feelings towards science or whether people who already have these feelings are the ones taking the courses in the first place.

Being a Labour voter is also associated with more positive attitudes to science. Whilst there are no doubt many reasons why this might possibly be so, in the absence of any immediately obvious theoretical frontrunner, I leave the reader to draw his or her own conclusions.

Turning now to the predictors of political and scientific knowledge, figure 8.6 shows that there are three that are shared by both domains of knowledge. Sex, higher education and occupation are all associated with differences in knowledge levels. Reinforcing results from many other studies, it appears that women tend to be less knowledgeable about both politics and science than men. Standardised regression weights indicate this effect is not especially strong. Inspection of unstandardised path coefficients (not shown in the diagram) indicate that, holding all other prior variables constant, the predicted score on political knowledge for women is about one quarter of a scale point below that for men. The corresponding difference for political knowledge is greater, at about half of a scale point (both scales run from 0 to 5). People with higher degrees tend to be a little more knowledgeable in both areas than those without a degree. The same is true for members of the so-called 'salariat' – white collar workers and professionals. These groups are also more likely to be knowledgeable than people in other types of occupation.

Older people tend to more knowledgeable about politics but not about biology and genetics. Those that have taken at least one university level natural science course are perhaps unsurprisingly slightly more knowledgeable than those who have not. Finally, considering oneself as belonging to a religious denomination is associated with possessing slightly less scientific knowledge.

As far as interest in science and genetics is concerned, there are three background variables that have independent effects. The older one is, the more interested one is in science. Although treated as a continuous variable here for the sake of parsimony, it is possible that there may be some non-linearity in this relationship where the very young and very old are somewhat less interested. Further research on this would be instructive. Being married seems to depress scientific interest to some extent. One might speculate that the demands of family life may displace some of the time that might have been spent following an interest in science and genetics.

The picture in relation to socio-demographics is very much what one might expect given previous research on PUS. The typical person knowledgeable and interested in science is male, well educated, unmarried and a white collar worker. In turn, being more knowledgeable and interested leads to more positive general attitudes towards science. An interesting result pertains to the direct effect of sex on attitudes to science. Some previous research has suggested that the reason why women tend to be more sceptical about science is because of their differential educational opportunities and the concomitant difference in their level of knowledge, compared to men (Hayes & Tariq, 2000, 2001; Sturgis & Allum, 2001). These results suggest otherwise. Whilst there is an indirect effect of sex through knowledge on attitudes, this is over and above the effect of education. Furthermore, the direct effect of sex on attitudes suggests that even controlling for a host of social-structural and knowledge based measures, differences persist between the attitudes and risk perceptions of men and women.

The hypothesis that political knowledge, as a proxy for knowledge about the practice of science and its link with politics, is, as I remarked earlier, not supported here. This analysis shows that both scientific and political knowledges share common causes. Once these are controlled, along with interest in science, there is no independent effect of political knowledge on attitudes towards science or perception of risk from GM food.[12] However, figure 8.6 also shows a residual correlation, of .25, between scientific and political knowledge. This means that beyond the covariates already used as predictors, there are other, unmeasured, reasons why knowledge of these two domains should go hand in hand.

8.3.4 The relationship between scientific knowledge and interest in science

The remaining issue for discussion in relation to these modelling results is the relationship between knowledge and interest in science and genetics. Recall that the purpose of this part of the model is to try to cast some light on the causal processes linking these two constructs. By specifying a causal path from knowledge to interest and from interest to knowledge, it may be possible to see whether these variables might be reciprocally caused, in other words, there is a kind of 'feedback loop' between them, or whether the dominant direction of causality is more likely to be in only one direction. Although this technique may seem somewhat outlandish, given that there is only cross sectional data to

[12] When an OLS regression model is fitted that includes only political and scientific knowledges, and a product-term interaction, the results are in line with those found by Sturgis and Allum.

be analysed, with sufficient conditions for formal identification, it is relatively straightforward. The main requirement is that each of the reciprocally caused variables have at least one predictor or 'instrumental' variable that is not also a predictor of the other and that the residuals of the endogenous variables are permitted to covary in the model. It can be shown that, given these circumstances, the regression coefficients that form the loop can be successfully estimated.[13] Simulation studies have shown that parameter estimation is affected by the strength of the relationship between instrumental variables and their reciprocally caused, endogenous, variables. The weaker the relationship the less reliable the estimates (Wong & Law, 1999). The instrumental variables here are, unfortunately, quite weak predictors of knowledge and interest. This is likely to lead to large standard errors. Notwithstanding this, it is still worth looking at the model estimates, taking into account their possible lack of precision. The reliability of estimates in this block of the model does not, in any case affect the other blocks of the model because as a general rule, misspecification of causal paths between intervening variables does not result in biased estimates of relationships between prior and consequent blocks in a causal model (Davis, 1985). Evidence of reciprocal causation exists if there are significant paths in both direction between knowledge and interest in science. If one path is estimated at near zero, or is statistically insignificant, this is evidence for a unidirectional effect.

The standardised parameter estimates for paths between INTSCIGM and SCIKNOW are shown in figure 8.6 and also in column 2 of table 8.4. Standard errors, in column 3, were derived by bootstrapping in AMOS 5 as parametric standard errors are not estimated for standardised parameter estimates (Arbuckle & Wothke, 1999; Yung & Bentler, 1996). The table also shows the upper and lower bounds of the 95% confidence intervals. There is evidence here for unidirectionality. The path from scientific interest to knowledge is estimated at practically zero (-.03), while the opposite path, from knowledge to

[13] A very readable explanation and example is given by Berry (1984)

interest, is estimated to be very large (.87). However, standard errors are also very large and the confidence interval for knowledge to interest has an upper bound of 1.2.

Table 8.4 Knowledge and interest: bootstrapped reciprocal estimates

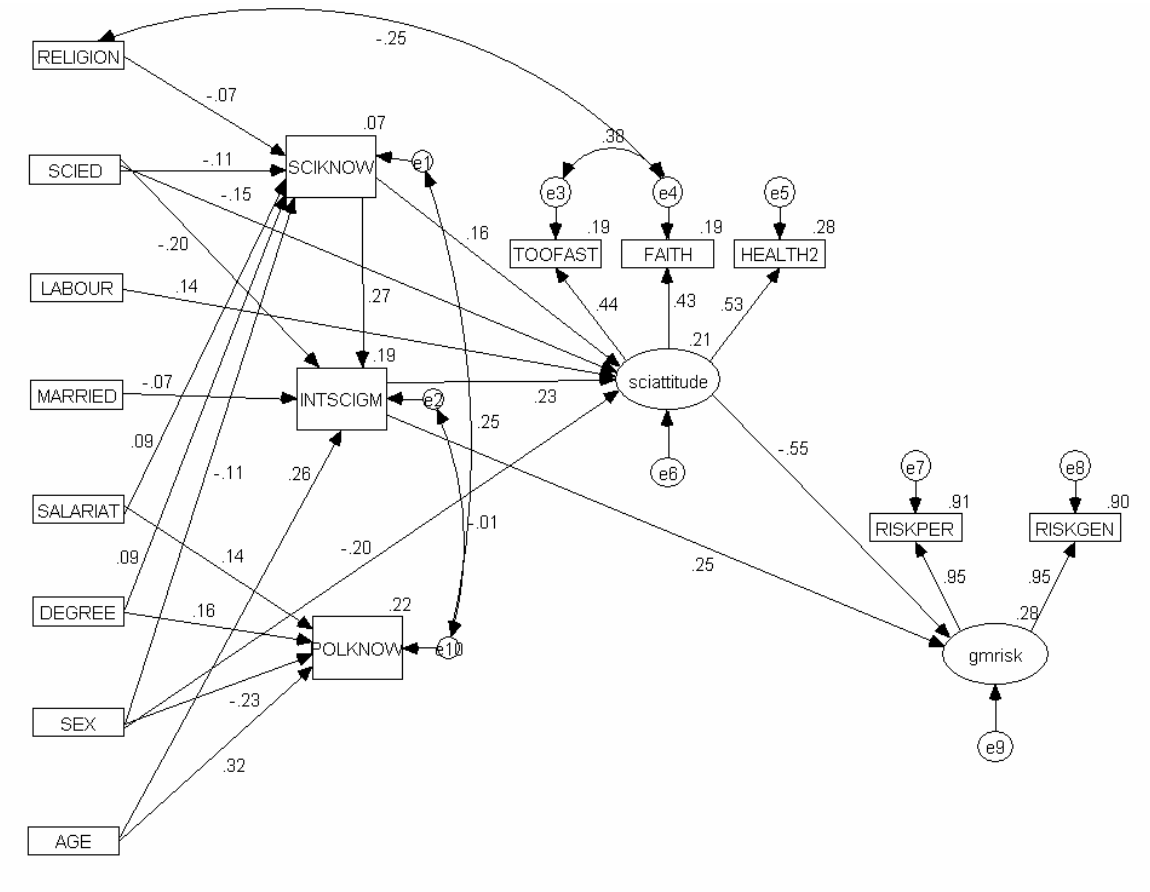
					(α=.05)		
			Standardised regression coefficient	**SE**	**Lower bound**	**Upper bound**	**P**
INTSCIGM	→	**SCIKNOW**	-.032	.131	-.275	.154	.740
SCIKNOW	→	**INTSCIGM**	.872	.172	.628	1.197	.004

Covariances: (Group number 1 - baseline)

It is not entirely unusual to have a standardised estimate of greater than unity in SEM. This is sometimes due to model misspecification, but sometimes due to sampling fluctuation, indicated by large standard errors (Joreskog, 2003). In the present case, standard errors are large probably because of the weakly associated instrumental variables. RELIGION, SALARIAT, DEGREE and SEX have standardised regression weights on SCIKNOW of at most -.11; MARRIED and AGE, the instrumental variables for INTSCIGM, have weights of -.07 and .26 respectively. There is, quite apparently, a great degree of uncertainty in these estimates and therefore they should be taken as only suggestive evidence for the idea that being knowledgeable about science is in general the precursor to interest.

To investigate this further, eight models, that exhausted all the combinations of the two reciprocal paths and the error covariance (linking e2 and e1), were evaluated using a variety of fit indices. The two best fitting models turned out to be model 4, as shown in figure 8.6, and one that specified only a single arrow from knowledge to interest, with no covariance between e2 and e1. For the remaining analyses in this chapter, the latter model, which is now recursive, with no feedback loops, is used. The revised model with standardised parameter estimates is shown in figure 8.7. Although the change has no bearing on the results concerning the interaction between scientific and political knowledges, it is needed to obtain meaningful estimates of the standardised total effects that are presented in the final analysis of the chapter.

Figure 8.7 Final model predicting GM risk perception



8.3.5 Interaction of political and scientific knowledges

As is clear from the models estimated so far, political knowledge has no 'main effect' on either attitudes to science and technology or on GM risk perception. It is still possible, though, that there may be a significant interaction effect. Recall that the hypothesis is for a 'contextualising' effect of political knowledge on the positive effect of scientific knowledge on attitudes. That is to say that dependent on people's level of political knowledge, the effect of scientific knowledge on attitudes will be different. This can be tested quite straightforwardly in AMOS 5 by fitting a multi-group model. The idea is that the sample is divided into two or more groups according to level of political knowledge (e.g. low, medium, high) and a model is specified with the constraint that the path from SCIKNOW to sciattitude must be equal across all groups. If this model fits significantly worse than the baseline model, where the path is estimated separately for each group, there is evidence that the magnitude of the relationship between scientific knowledge and attitudes is different for people with differing levels of political knowledge. Additionally, constraining factor loadings on latent variables to be equal across groups should usually be imposed in order to ensure that latent constructs are really the 'same thing' being measured across groups. (For a more detailed explanation of multigroup analysis, see for example Kline, 1998).

The sample was divided into tertiles of political knowledge as follows:

- Low - scoring 0, 1 or 2; N=307
- Medium – scoring 3 or 4; N=616
- High – scoring 5; N=278

These groups were used as the basis for the multi-group SEM. The results from fitting three nested models are shown in table 8.5.

Table 8.5 Nested multi-group models grouped by political knowledge

Model	Chi^2	Df	p	Δ Chi^2	Δ df	RMSEA	CFI	SRMR
1. Unconstrained	264	165	<.00	-	-	.022	.974	.05
2. Equal factor loadings	271	169	<.00	7	4	022	.974	.05
3. Equal regression weight	272	171	<.00	8	6	022	.974	.05

In all three models, POLKNOW has been removed, along with all paths pointing towards it. This is carried out because it is obviously not possible to include the same variable in the model as is used for dividing the sample. Because POLKNOW has no main effects on any other variable, all other aspects of the model and its interpretation remain unaltered. Model 1 is the unconstrained model. No parameters are constrained to equality across the three groups. Model 2 constrains the factor loadings for sciattitude to be equal, in order to check for equivalence of the construct across groups. Model 3 contains the restrictions in model 2 and additionally constrains the regression path from SCIKNOW to sciattitude to be equal in all groups. A significant increase in Chi2 for this model would mean that the effect of scientific knowledge on attitudes must be different for people with different levels of 'contextualising' political knowledge.

As can be seen from table 8.5, there is no significant loss of fit compared to the unconstrained model when constraints are added in model 2 and model 3. In fact there is no visible change at all in the approximate fit indices, with only the Chi2 statistic changing as additional model constraints are imposed. The implications of this are firstly that the factor loadings for sciattitude are equal in all groups - the construct 'means the same thing' for each group. Secondly, and most importantly, the hypothesis that political knowledge 'contextualises' the effect of scientific knowledge on attitudes is not supported. Fitting a model where the regression coefficient from SCIKNOW to sciattitude is forced to be the same in each group does not fit significantly worse than a model without this constraint. There is, therefore, no evidence that the relationship between scientific knowledge and attitudes to science varies with levels of political knowledge.

8.3.6 Factors underlying perception of GM food risk

The final results to be presented in this chapter show the total effect of all the variables on the model on risk perception and on all other endogenous variables. For each pair of variables, these effects are calculated by adding the direct path, if any, to the product of all the indirect paths. Total effects are presented here in standardised form for ease of comparison. Table 8.6 shows endogenous variables of interest in the rows. The columns contain the exogenous and other variables that emit paths. One can think of the columns containing the 'independent' variables and the rows containing the 'dependent'

Table 8.6 *Knowledge, interest, attitudes and risk perception: standardised total effects*

	SCIKNOW	INTSCIGM	sciattitude	SCIED	AGE	SEX	DEGREE	LABOUR	MARRIED	RELIGION	SALARIAT
SCIKNOW	-	-	-	.112	-	-.114	.091	-	-	-.071	.086
POLKNOW	-	-	-	-	.323	-.231	.157	-	-	-	.139
INTSCIGM	.273	-	-	.232	.262	-.031	.025	-	-.072	-.019	.023
sciattitude	.219	.234	-	.220	.061	-.220	.020	.138	-.017	-.015	.019
gmrisk	-.053	.117	-.549	-.064	.031	.113	-.005	-.076	-.008	.004	-.005

Note: coding of SCIED reversed for clarity variables, even though in SEM, a variable can of course be both 'independent' and 'dependent'.

The bottom row of table 8.6 contains the standardised total effects of all the model variables on the perception of risk from GM food. Column 2 shows the effects of scientific knowledge. There is a small but significant effect of knowledge on risk perception, holding all other variables constant. This comes indirectly through its effect on attitudes and also via its effect on interest in science and genetics. The total effect is negative, meaning that the greater a person's knowledge, the less risk they will perceive in relation to GM food. By contrast, the total effect of interest in science on risk perception is positive. More interest is associated with greater concern about GM food risk, even though it is also linked to more favourable attitudes to science in general. These paradoxical findings should be treated with some caution until they can be replicated elsewhere, as the suppressor effect that is observed was not anticipated and was a data-driven addition to the model.

Attitude towards science and technology in general has the greatest single influence on risk perception in the model. The standardised effect size is -.54, more than twice as large as effects from any other variable. The ways in which people view the promise and problems of science and technology in general is a crucial determinant of their beliefs about the particular risks that might be associated with GM food.

Having some form of natural science education, at degree level at least, also seems to act to diminish the perception of risks from GMOs. Older people tend to see more risks, as do women. Labour voters are more sanguine about the dangers posed by GMOs too. Could this be because the Labour government in the UK is perceived as supporting GM food and crops, and voters are adopting the position of their party? Because the effect of voting labour is indirect, in that it comes through the fact that Labour voters tend to be more optimistic about science in general, the answer is probably no. The reason must therefore remain an open question at this stage. Other effects on risk perception are too small to be significant. Effects on intervening variables can be seen in the remaining rows in the table. These have largely been discussed in earlier sections of the presentation of results and so will not be discussed further here.

8.4 Discussion

In this chapter I developed a model linking scientific and political knowledge with attitudes to science and the perception of risks from GM food. I elaborated on a simple 'deficit model' of public understanding of science that links scientific knowledge with attitudes towards science and extended it to look at the effects of both scientific and political knowledge, as well as interest in science. In this model, the effects of these variables, and of other socio-demographic characteristics, on the perception of GM food risk are indirect, mediated by attitudes towards science and technology in general. This mediational model was supported by the data, although the hypothesis that political knowledge, and its interaction with scientific knowledge, would have an effect on attitudes towards science was not supported.

8.4.1 Scientific knowledge, interest and the perception of risk

The results of previous studies on the relationship of knowledge and the perception of particular technological risks have been inconclusive. As far as the effect of scientific knowledge on general attitudes to science is concerned, there have been many studies that have shown that there is a moderate, positive correlation between knowledge and attitudes. The finding has been broadly replicated here. However, previous studies have sometimes presented only bivariate correlations; the results presented in this chapter are more robust than this because other relevant variables are simultaneously controlled in the analysis. The correlation between scientific knowledge and attitudes remains even after controlling for likely confounding variables sex, social class, age, general and scientific education and religiosity. Even more importantly, the link between knowledge and attitudes to science survives even after taking into account the extent of people's interest in science and genetics – something that has seldom been shown before. With more evidence now of the robustness of the knowledge-attitudes link, future research needs next to address the mechanisms by which knowledge of and attitudes towards science are connected. Does a lack of understanding mean that people rely on erroneous beliefs about science that cause them to entertain negative expectations and 'irrational' fears? Or perhaps a lack of scientific understanding causes people to feel alienated from science and the benefits it might bring to them and others? Future research might profitably address these, and other possible explanations.

In relation to the perception of GM food risk, the analyses presented here have supported the notion that people's attitudes to specific technological risks are to some significant degree determined by how that specific risk fits with their overall attitude towards the role of science and technology in society. In the case of risks from GM food, all of the variables usually associated with differences in risk perception, particularly sex, age and scientific knowledge, have only indirect effects on the way GM risks are viewed, via their effects on general scientific attitude. The surprising and intriguing exception to this is the dual role of scientific interest in the model. Whilst those who are more interested in science tend to be more positive about it and consequently see fewer risks from GM food, greater interest is also directly associated with heightened risk perception. It seems that being attentive to and interested in science and genetics is not the simple panacea for 'curing' a sceptical public of its opinions about GMOs that some would probably like to believe. Raising people's interest and engagement in scientific issues may in some cases lead to people becoming more risk averse, at least in the case of GM food risks, than if they had remained unengaged and uninterested. This analysis suggests that although knowledge and interest in science in general may tend to 'work in the same direction' in relation to the formation of attitudes and could under some circumstances be considered functionally equivalent, in the case of risks from specific technological hazards, the two concepts should be considered independently, as they may be indicative of opposing influences on risk perception.

These findings may go some way to explaining why the evidence for links between attitudes to specific technological risks and technical knowledge has been inconsistent – because knowledge and interest tend themselves to be correlated, but sometimes have opposite influences on attitudes. In this chapter, a model of reciprocal causation was tested, in order to try to elaborate on the nature of the correlation between scientific knowledge and interest in science. The results provide some evidence that knowledge tends to lead to interest but not the other way around. The type of knowledge measured in the survey is rather general 'textbook' knowledge about biology and genetics and the idea that adults who begin with more of this knowledge tend to become interested in and attentive to science and technology is intuitively more plausible than the reverse hypothesis. However, if one accepts that greater knowledge tends to lead to greater interest in science and technology, but that greater interest leads people not only to more positive attitudes towards science in general but also heightened perception of risk from GM food, then one begins to see the complex and sometimes contradictory effects of greater knowledge and understanding of genetic science by the public. Again, the simple deficit model of PUS is an inadequate representation of the complexity inherent in the formation of attitudes towards gene technology risk. Nevertheless, scientific knowledge clearly has an important part to play.

8.4.2 Contextual knowledge

One of the principal criticisms of the 'deficit model' of PUS is that there exist other knowledge domains that can influence attitudes towards science and technology in opposite or conflicting ways to factual scientific knowledge, and that the locations of these domains are contingent on the context in which people are engaging with the issue at stake. Brian Wynne suggests that, beyond the formal contents of scientific knowledge and the methods and processes of science, knowledge of 'its forms of institutional embedding, patronage, organisation and control' (Wynne, 1992 p.42) is also a key resource in attitude formation about science and technology. In this chapter this hypothesis was tested, in relation to perception of GM food risks and attitudes towards science in general, by specifying both main effects and interaction effects of a political knowledge scale. This scale, while unrelated to 'institutional' knowledge of science per se, was used as a proxy measure. In the event, neither hypothesis could be sustained. As discussed earlier, this result is rather inconclusive and provides no evidence for either Wynne's implicit contention that knowledge of the way science and technology is embedded in political and economic systems should lead to more sceptical attitudes nor the reverse finding, by Sturgis and Allum (2004), that this type of knowledge may on the contrary lead to more positive attitudes. There are several reasons that could account for the inconclusiveness of the results. Firstly, the present study used only a three item attitude to science scale and five item knowledge scales. In the Sturgis and Allum study, more items in were used in both of these scales. Secondly, slightly different types of knowledge scale were used. In the Sturgis and Allum study, a long scale tapping knowledge of general scientific facts and scientific processes was used, whereas in the present study, a short scale of items relating only to biology and genetics was used. The political knowledge scales were somewhat different too, with the present analysis using items relating mainly to parliamentary procedures compared to one which tapped respondent knowledge of political parties' issue positions. The results speak to the need in future research to develop a much broader scale that taps a wider range of political issues, including the intersection of science, technology and politics. Thirdly, given that this is only the second time that an analysis of this kind has been carried out, and the first that links political knowledge and gene technology risk, there is simply more replication needed before being able to come to any firm conclusions about the putative role of political knowledge, attitudes to science and risk perception.

9 SUMMARY AND CONCLUSIONS

This chapter summarises the main results from the thesis and provides some concluding comments. After a brief recapitulation of the research problem, the next section summarises the findings from each of the four empirical studies. This is followed by a discussion of the limitations of the research that should be borne in mind when interpreting the findings. Following a summary of the main conclusions that might be drawn from the investigation, the chapter closes with some thoughts on future directions for research in the area.

9.1 The research problem

This thesis is about the perception of technological risk in modern societies. To investigate risk perception I have focussed on one particular case, gene technology (especially GM food), and one particular society, modern Britain. The pairing of these two particularities has resulted in a useful vehicle for investigating the general question of how people perceive and evaluate technological risks in modern societies. It has also afforded the opportunity to gain more insight into a scientific controversy that in recent years has received widespread media coverage and been the subject of much political manoeuvring. In the thesis I have been concerned firstly with the structure and stability of people's perceptions of gene technology risk and secondly in examining some of the factors that underlie these perceptions.

9.2 The empirical work: design and results

The empirical work in the thesis was designed as four separate studies that were intended to address the key research questions identified in the review of the literatures on risk and gene technology. A mixed method approach was chosen overall, although three out of the four studies used only quantitative methods. Two of the quantitative studies used data from an Internet survey that was commissioned by me from a commercial survey company. Another was a reanalysis of an existing dataset from a panel survey. The qualitative study used data from focus groups that were carried out by me along with colleagues from the European research project, *Life Sciences in European Society* (LSES), of which I was a member.

9.2.1 Study A: lay discourses of gene technology

This was a qualitative investigation into lay discourses, beliefs and representation of gene technology risks. Four focus groups were run as part of a wider study by the LSES project on attitudes towards gene technology. Participants were recruited by a market research agency to specified demographic profiles. The sample was stratified according to level of education, parenting status and newspaper readership in order to gain a range of 'lay' viewpoints. No specialists or those declaring a particular interest in science or gene technology were selected. The four group interviews were transcribed verbatim and initially coded using software package Atlas/Ti according to a frame developed alongside colleagues within the LSES project. A topic guide, also developed as part of the LSES project, formed the basis for the interviews. It began with a general think-aloud, moved on to a card-sort procedure to elicit opinions about a range of gene technology applications before focusing in more depth on GM food, cloning, and on participants' views of regulation and their confidence in government and genetic scientists. For the purposes of the analysis presented in this thesis, I recoded the transcripts, developed new code hierarchies within the relevant higher order codes and used these and their cross-classifications as the basis for interpreting the textual data.

One of the most striking features of the results is that people rarely if ever spontaneously used the term 'risk'. People discussed possible future harm and negative consequences from GM food and cloning in particular, but there was no sense in which quantifiable probabilities were part of the discourse. An important belief that was expressed by participants was that they were concerned about 'delayed effects'. Effects that were perhaps unknowable now but might well emerge in the future. This was mainly talked about in relation to human health. A recurring anchoring representation for this discussion was, as has been observed before, the BSE crisis, but there was also mention of the case of Thalidomide. The invisibility of potential threat was something that seemed to come to mind as a worrying feature of developments in GM food and crops in particular.

Alongside delayed health effects were concerns about the social consequences of cloning animals and the perception that there was a ‘slippery slope’ leading from this towards human reproductive cloning. These interviews, it must be borne in mind, took place before recent claims about the birth of a cloned human baby in the press (Burkmann & Goddard, 2002). These concerns were anchored in ideas about eugenics, master-races and ‘mad dictators’. The idea of a Pandora’s Box of worrying possibilities was raised consistently, although that particular metaphor was not used.

People’s knowledge about gene technology, unsurprisingly, appeared very flimsy. People were quite open about their ignorance, often suggesting that it was something they were quite interested in but didn’t have time to find out more. The lack of knowledge and sureness about the topic meant that much of the discussion was in the form of hypothetical questions and scenarios. A great deal of discourse was of a qualified and conditional nature. An exception to this was in discussion about people’s confidence in politicians, where opinions were much stronger. In general, people were highly sceptical of politicians’ motives in making policy on gene technology, feeling that government and industry could be colluding behind closed doors. A similar feeling was also expressed by some in relation to the motivations of scientists. Some felt that scientists had their own agendas which did not always match with the public interest.

Other themes repeatedly arose as people mulled over the arguments about gene technology applications. There was a questioning of whether it was necessary to take any risks when there was no real need for any new solutions to old problems. Often people considered that there were alternatives – for instance more organ donation as an alternative to xenotransplants or therapeutic cloning. Human and animal cloning also provoked discussion about the idea of taboo. This seemed mainly related to the fact that cloning and other gene technologies blurred familiar boundaries between, for example, family/not family; human/animal; plant/animal.

Very often the discussion about hypotheticals would turn to whether or not the democratic rights of the public were threatened by the introduction of these new technologies, and whether scientists, the government and industry would exhibit adequate responsibility in taking account of the public interest. Some people expressed a faith in these institutions to 'do the right thing', and most agreed that ordinary people have no real choice but to simply hope that this will happen, regardless of their doubts.

Overall, this study showed its participants to be grappling with or feeling their way around a new topic. Many people admitted that it was the first time they had ever talked about the issue, despite half the groups being selected for their regular readership of newspapers that had only recently campaigned about GM food. This undoubtedly accounts for the conditional, hypothetical nature of much of the discussion. People used familiar examples of other scientific controversies, notably BSE, to anchor the starting points for conversation. What was particularly striking was the speed with which people's thoughts would turn to the social management of gene technology and away from the actual science itself.

This study 'set the scene' and generated some insights into the structure and strength of lay opinion and reasoning about gene technology. The next empirical study sought to investigate the extent to which opinions, beliefs and attitudes exhibit stability over time, or whether, as seemed possible, the British public's lack of engagement with gene technology meant that attitudes and opinions are rather labile and dependent on the vagaries of the particular context in which they are elicited.

9.2.2 Study B: structure and stability in the perception of risk

Although there have been many studies of public attitudes towards gene technology there are relatively few that show the trajectory of public attitudes over time. Nearly all of those that do include a time dimension rely on cross-sectional surveys. Because of this, only aggregate estimates of stability and change in attitudes can be made. This is a severe limitation. In this study I sought to overcome this limitation by making use of panel data from a survey of people's views about various food-related risks, including questions about GM food. Using these data I was able to analyse intra-individual stability and change in views about GM food risk over a period of approximately 18 months. Thus the analysis could go some way in answering the questions raised by the findings from the study of lay discourse presented in Chapter Five.

Preliminary results showed that people's aggregate level of agreement with ten items that tapped psychometric risk characteristics changed very little over the three waves of the survey. However, when individual absolute change was investigated, a different picture emerged. Between 40 and 60 percent of people switched responses on these items between waves, demonstrating that there is considerable intra-individual instability over time in views on GM food risk. Across time correlations ranged between .39 and .68. An interesting result was that the highest interwave correlations were observed for three questions that tapped the most general summary beliefs about risk: how worried was the respondent about GM food risk, how serious was it considered to be and how likely was it to occur. Beliefs about the other psychometric risk characteristics were less stable than these broadly based measures.

The original plan for the analysis was to examine the structure of people's views about GM food risks to see if it corresponded with the psychometric dimensions of 'dread' and 'unknown' risks and then to assess the stability of this structure over the three waves of data available. It was noted in the literature review that most psychometric studies aggregate individual responses to multiple hazards and that, as a result, inferences about the dimensions of individuals' perceptions of any particular risk are not really warranted. Therefore a confirmatory factor analysis of the perceived characteristics of GM food risk was carried out that tested the psychometric dread/unknown factor structure. This model, estimated using structural equation modelling (SEM) techniques, turned out not to fit very well at all. This was, in itself, an interesting finding, calling into question as it does the generality of some key findings about the structure of risk perceptions emanating from the psychometric approach.

Subsequent exploratory factor analysis revealed that in fact only three items loaded strongly on a single factor – the same items on worry, seriousness and likelihood that looked most stable in the preliminary analysis. These items were chosen as indicators of a common factor to be evaluated in the modelling phase of the analysis. In this phase, the key task was to evaluate the extent to which people gave 'top of the head' responses to questions about GM food risk and the extent to which some of these responses could be indicative of more enduring, stable views. I used a latent state-trait model and conceptualised state residual variance as 'opinion' and trait variance as 'attitude'. The model allowed me to decompose variance due to attitude and opinion in each of the indicators over time. The results showed that in the first wave, the ratio of attitude to opinion variance was about two and a half to one. This ratio increased over time, with most of the increase coming between waves one and two. The item that exhibited the greatest degree of trait, or attitude, variance was the one about how much respondents worried about GM food risk. This item is the one that taps into the affective attitudinal component of risk, where the other two tap cognitive components. In other words, one of the key findings from this study suggests that the affective components of risk attitudes are the ones most likely to endure within the individual and, by extension, to be most diagnostic of resilient differences between individuals and groups over time. The more general finding was that the majority of variance in responses over time to these questions about people's views on GM food risk was attributable to stable underlying attitudes towards GM food. The structure of these attitudes, though, did not closely correspond to the dimensions proposed by the psychometric approach to risk perception.

This study suggested, then, that despite widespread lack of engagement and knowledge about gene technology, it would be wrong to characterise the British public as entirely bereft of meaningful attitudes towards gene technology risk (at least insofar as GM food is concerned). Therefore, in the two final empirical studies in the thesis, I went on to investigate, in turn, some important hypothesised explanations for differences in risk perceptions between individuals and groups.

9.2.3 Study C: risk perception and the dimensionality of trust

An important issue in risk research that has recently come to the fore is the role of trust in explaining variation in attitudes towards potentially hazardous technology. In research on attitudes towards gene technology in particular, it is commonly found that trust in regulators, governments and scientists working on gene technology is related to the perception of risk from GMOs, gene therapy and human and animal cloning. Much less is known, however, about the social psychological basis of such hazard-related trust. In the third empirical study in the thesis, I synthesised recent literature on risk perception and the dimensionality of trust and from this developed several hypotheses linking trust and the perception of risk from GM food. An Internet survey was the chosen method of data collection and the primary analytic tool was, again, SEM. In particular, the aim of the study was to look at the status of a relatively new theorisation of hazard-related trust, the salient values similarity theory (SVS) in relation to more traditional approaches. For this purpose, new survey items to measure three putative dimensions of trust were developed.

The measure of risk used as the main dependent variable was based on measures previously used in the psychometric literature. Responses from two questions asking respondents how much risk they thought there was to them personally and to people in general were combined to form a summary indicator. Descriptive results suggested that the British public is divided about the possible risks from genetically modified food. According to the findings here, about one quarter thinks that GM food carries a lot or a great deal of risk. About one third thinks that there is little or no risk. Just under half agrees that there is 'some risk'. These results were mostly in line with other surveys that have investigated attitudes to gene technology risk, although probably, for methodological reasons, they over-represent the proportion of people favourable towards GM food and crops.

When asked the extent to which they believed that Government ministers and genetic scientists 'shared their values' in relation to their role in the development of GM food, people tended to think that they did not. Genetic scientists seem to be held in slightly higher regard than Government ministers on GM issues. This pattern was evident again when the survey tapped people's beliefs about scientists and Government ministers in relation to the two other dimensions of trust on which I focussed: technical competence and responsibility (also referred to as 'care'). Strikingly, less than one quarter of respondents believed that Government ministers are remotely competent in dealing with policy on GM food and crops. Even fewer saw them as honest or responsible. Genetic scientists were thought to be somewhat more trustworthy on these dimensions, although attitudes seemed to be less firmly held. Interestingly, people who trust scientists also tended to trust the government on GM issues. The most likely reason for this is that both groups are seen as promoters of GM food and crops.

In the second part of the analysis, a series of structural equation models were fitted, firstly to evaluate the six new trust items in the survey and secondly to test several theoretical hypotheses. Only two out of the three items for each of 'competence' and 'care' scales were retained due to their poor measurement properties. Henceforth these two constructs were measured with only two items for each.

The SVS theory of trust proposes that trust is, at base, accorded to people or institutions that are perceived to share the same values as the perceiver in relation to a risky situation. Expectations about the technical competence and care, or responsibility, exhibited by these actors are, so the argument goes, driven by the perception of shared values. My first hypothesis was therefore that perceptions of competence and care would be positively correlated because they both share this common cause. In the case of both genetic scientists and Government, this expectation was supported.

The second hypothesis was that this correlation would disappear or be considerably reduced when controlling for SVS. Confirmation of this would provide evidence that perception of shared values underlies more specific judgments of trustworthiness. The results showed that the correlation between the two aspects of trust was only slightly reduced when values were controlled. Nevertheless, there was still a strong effect of shared value similarity on perceptions of both competence and care. The conclusion from this was that shared values are important in explaining more specific trust judgments but that this is not the only variable that could account for their intercorrelation.

The third hypothesis was that controlling for perception of shared values, the effect of competence and care on perception of GM food risk would disappear. This again follows from the idea that the perception of shared values is the basis of specific trust judgments and that perception of shared values is the key element of hazard-related trust. The results provided substantial support for this hypothesis. Shared values were shown to be the most important factor in explaining variation in risk perception, compared to judgments of the competence and care of both scientists and Government. Once the effect of shared values was taken into account, the effect of perceptions of the actors' care (honesty and responsibility) disappeared. The same was not true, however, for perceptions of competence or expertise. No matter how much a person feels they share the same values as scientists or Government ministers, their judgment of the competence of these actors is still a significant predictor of how risky they think GM food might be.

This result is an important one. It suggests that the shared values concept of Earle and Cvetkovitch is really an expression mainly of normative expectations and motivations of actors – what Barber terms their 'fiduciary responsibility'. It is much less linked to judgments about actors' technical competence or ability to carry out their jobs. These judgments perhaps remain more the result of cognitive, rational consideration.

9.2.4 Study D: knowledge, attitudes and the perception of risk

The final empirical study of the thesis turned to the vexed question of how the possession of more or less knowledge of various kinds influences the way in which people perceive gene technology risks. Again, the example used was GM food and the study was carried out with data from the same Internet survey that I made use of in the preceding study. I used SEM to test and develop a model that linked scientific and political knowledge with attitudes to science and the perception of risks from GM food.

It is not an exaggeration to say that the 'deficit model' of public attitudes to science and technology has become the 'Aunt Sally' of PUS research. However, I have sought to rehabilitate this model and, furthermore, connect it with risk research. I elaborated on the simple 'deficit model' of public understanding of science and extended it to look at the effects of both scientific and political knowledge, as well as interest in science. In addition to integrating different domains of knowledge and interest, the main innovation in the model is that the effects of these factors are indirect, coming through their effects on more general attitudes towards science and technology.

For the most part, this mediational model described the data well. However, the hypothesis that political knowledge, and its interaction with scientific knowledge, would have an effect on attitudes towards science was not supported. The frequently observed correlation between scientific knowledge and attitudes to science was confirmed in this study. Moreover, the findings can be considered particularly robust as the correlation survives controlling for a range of demographic variables and respondents' declared interest in science and genetics. There was also very strong effect of general attitudes to science and technology on beliefs about GM food risk. Again, this is after controlling for all the other variables in the model. This can be regarded as supporting the mediational hypothesis: that the way people view particular risks is to a large degree dependent on how that risk fits into their scientific 'worldview'.

An unexpected but interesting finding was the dual role of interest in science and technology on perception of risk. The direct effect of interest on general attitudes was positive – the more interested a person is in science, the more positively they evaluate science as a positive force. This in turn leads to lower risk perception. However, a direct effect that linked greater interest to heightened perception of GM food risk was also suggested by the results of model fitting. This observation suggests that knowledge and interest in science in general may tend to 'work in the same direction' in relation to the formation of attitudes and could under some circumstances be considered functionally almost equivalent. But in the case of risks associated with specific technologies, heightened interest may lead to a keener appreciation or evaluation of the risks. Certainly future research should take care to distinguish between on the one hand interest, or attentiveness, to risks and, on the other, knowledge about the science and technology at their base.

The analysis also elaborated on the simple deficit model by considering the hypothesis that other forms of knowledge might also be predictors of attitudes to science and to gene technology risk. This notion has been advanced by numerous commentators as a critique of the simple deficit model but up to very recently never tested using quantitative data. The particular form of knowledge investigated here was political knowledge, which was assumed to act as a proxy for knowledge about the links between science, its political control and commercial exploitation. In the event, results were not supportive of the hypothesis that political knowledge is relevant to either the formation of attitudes to science in general or to GM food risk. This rather inconclusive result supports neither the implicit contention of critics of the deficit model such as Wynne or Michael (Michael, 2002; Wynne, 1995; Wynne, 2001) nor does it replicate recent results that I have reported elsewhere (Sturgis & Allum, 2004). Nevertheless, in view of the novelty of the approach, much more research is probably needed before establishing any firm conclusions in this interesting and potentially fruitful area.

9.3 Caveats and limitations

The issues on which I have tried to cast some light during the course of my work on this thesis are complex and I have touched on many aspects of my chosen topic, some at length, some more or less in passing. Empirically, I have chosen to undertake a series of linked but in many ways quite separate studies. An alternative strategy might have been to take one issue, for example the nature of social trust and its effect on perceptions of risk, and to build a series of analyses focused solely on this aspect of the public's uneasy relationship with new technology. However, by taking the more divergent approach that I have, my hope is that I have been able to contribute incremental advances in our understanding of the ways in which lay publics confront technological change from a somewhat broader set of standpoints of interest than would otherwise have been afforded. And partly as a result of this, the findings I have presented can, and indeed should, be considered as encouragement for some new and interesting lines of future enquiry rather than as definitive empirical or theoretical statements.

If part of this telling of a broader story is concerned with bringing a range of theoretical viewpoints to a single problem, another part is in the bringing together of an array of divergent sources of data and analytic tools to pursue questions and test hypotheses. Despite the advantages that I believe flow from methodological pluralism, the data and methods I have employed are not, of course, without their limitations and it is important to make these clear, as far as is possible. I have used one entirely secondary data source (the panel survey), one new data collection instrument with a new sample of respondents (the Internet survey) and a hybrid source (the London focus groups) whose raison d'être was as part of a separate project but one in which I had a major involvement as a contract researcher.

Two methodological limitations come to mind in relation to the focus group study in Chapter Five. First of all, there were not very many groups convened. This meant that the range of possible participant views was narrower than one might have liked. However, this limitation is true of probably the majority of qualitative research projects, generally because data collection and analysis are time consuming and costly. This study was certainly subject to those constraints too. The fact that the focus groups were organised and funded out of a separate project (LSES) meant that the interview topic guide and sample specification was tailored to a slightly different research purpose. To some extent this was a disadvantage, as there were some passages of the group discussions that would have benefited from more probing and questioning on particular topics that were a focus of this thesis. Participants' feelings of shared values with scientists and Government ministers is an obvious example. On the other hand, developing my own comprehensive coding frame and using that to generate my final interpretations circumvented some of the problems of using a 'secondary' source, as I was able to sift out irrelevant material quite efficiently and focus on what was important for the thesis. In fact, there were also significant benefits that arose from the 'second hand' status of the data. The principal one was, of course, that the cost of sampling, provision of venue and payments for participants were all met from a much larger pool of resources than would normally be available for a PhD project. Secondly, while I had the advantage of being present during the data collection and taking some part in the discussions, I also had the benefit of having a very experienced social researcher as moderator, with concomitant gains in eventual data quality.

In Chapter Six, I conducted a secondary analysis of a three wave panel survey. The response rate for the survey was low, although not out of line with what one would expect for this topic. Compounding this potential source of non-response error was another: namely the attrition in the original sample over successive waves. Balanced against these threats to reliability and validity is the fact that the achieved sample matched population proportions on key demographic variables and the issued sample size was sufficiently large to ensure that there were enough respondents in the achieved sample to enable me to conduct the analyses that were needed. The sample size was not, on the other hand, large enough to simultaneously investigate group differences, which would have been interesting.

The results of the analysis suggested that the public do hold enduring attitudes towards GM food risk, albeit very general ones, based strongly on affect. Given the problem with response rates and attrition, it is probably the case that the somewhat self-selected character of the sample has led to an overestimate of this attitudinal stability. As a result, the reported stability estimates should probably be treated as upper bounds on what is likely to have been the case in the wider population. Notwithstanding these caveats, having longitudinal data is in general an enormous advantage. In this case it allowed me to conduct a form of analysis that has not, to my knowledge, been done before in risk research and certainly not in relation to gene technology.

In the second part of the empirical work, I designed and fielded an Internet survey. Internet surveys are a new data collection method for large scale public opinion research, especially in Britain. I commissioned my survey from polling organisation YouGov, who maintain a large panel of respondents from whom they draw their samples. The advantages and limitations of using an Internet survey of this kind for making inferences to the population were discussed at length in Chapter Four. Strictly speaking, with a non-probability sample, one cannot draw on statistical theory to assess the reliability and validity of the results. This is compounded by the non-coverage error that arises from excluding potential respondents from the panel because they lack access to the Internet. Nevertheless, as I argued in Chapter Four, faced with the constraints on cost imposed by a PhD or other small scale academic research project, an online survey, run by a company that has a, so far, impressive record of political polling, is a sensible choice compared with a small postal or quota sampled questionnaire. However, it almost goes without saying that until replicated with data from good probability samples, all of the results reported in chapters Seven and Eight should be treated with an appropriate degree of caution.

More specifically, in Chapter Seven, the main limitation that became evident was the need for more items in the scales measuring the three dimensions of trust. Unfortunately there was really no way around this problem given the fixed budget and length of questionnaire. Even despite some preliminary pilot testing, two questions had to be dropped from the scales contained in the final survey following confirmatory factor analysis. In Chapter Eight too, a similar problem occurred with the items measuring attitudes towards science and technology. Only three items from a longer scale used in other comparable studies could be included in the survey. The biology and genetics knowledge scale was also a truncated edition of another longer one. The reliability was lower than expected for the latter scale, mainly because two items turned out to be too easy; consequently most people got these right, which made the whole scale less effective in discriminating between people possessing different amounts of scientific knowledge.

9.4 Conclusions

In this thesis I have presented an empirical investigation of the attitudes and beliefs that lay people in Britain hold about the risks from applications of gene technology, with a focus on GM food and crops. Theoretically, my concern has been to advance our knowledge and understanding about the ways in which people perceive technological risks and to investigate some specific factors, social trust and scientific and other knowledges, that can explain variation in perceptions of risk.

In reviewing the literature on risk research in earlier chapters it became amply clear to me that one could characterise this research as beginning with quite narrow, mainly cognitive explanations of lay perception of risk but which expanded over time to include ever more factors, social, cultural and emotional, that can be considered as useful for explaining these perceptions. I made the suggestion that it might be more helpful to consider perceptions of risky technologies as constituent parts of the constellation of social and political attitudes that people might hold at any given time, not as unique psychological phenomena 'in their own right'. And, as such, one might naturally expect that particular attitudes and beliefs about new technologies would be embedded in wider sets of political and social values and belief systems that serve to orient people's behaviours and shape their perceptions of the world as they encounter it. The series of studies that I have presented here have not been designed to 'test' this hypothesis. It is far too diffuse and general for such a test to be appropriate or interesting, if it were even possible. However, I consider many of the results to be quite consistent with a general interpretation of risk perception along the lines that I have proposed. As such, a key contribution to general debates about the social and psychological nature of risk that I have tried to make in the work presented here is to make the case for moving away from the assumption that perception of technological risk is a phenomenon *sui generis*. And this suggestion of course carries with it the idea that we should seek in future research to look for ways to embed our concepts of risk in other more widespread and general explanatory frameworks, be they social, cultural or psychological.

As far as the more specific issues are concerned, there are several general conclusions that can be drawn, based on the results presented. Firstly, lay discourses of gene technology did not rely on particular notions of probability or scientific risk. Instead discussion was wide-ranging and quickly gravitated towards the political and industrial embeddedness of the whole issue of gene technology. What was obviously a rather unfamiliar set of issues to most people was anchored in their existing frames of reference – in many cases the BSE crisis and other instances of science and technology 'gone wrong'. One could almost observe at first hand the way in which people were thinking about gene technology for the first time, and struggling to fit the new information into their pre-existing understandings. The most striking aspect of the discussion was the way in which people almost immediately focussed on considering what might be 'behind' developments in gene technology. In other words, what are the politics of GM food and crops? Who are the stakeholders and what are their motives? Here was a discussion that was primarily about the political economy of science, rather than particular technological hazards. The observation of this dynamic process of opinion formation amongst a largely uninformed group of the general British public leads to the conclusion that in the absence of detailed and specific knowledge about a technological risk, questions of trust and power can quickly come to the fore in public and private debates.

Secondly, and somewhat surprisingly, given the evident low salience of GM food risk for most of the British public, there is considerable stability over time in people's fundamental orientations towards GM food risk and quite conceivably to other kinds of gene technology risk. This stability does not seem to derive so much from the dimensions conventionally suggested by the psychometric paradigm. Instead, the most stable survey indicator reflected people's affective responses to GM food, 'how worried' they were about possible risks. This speaks to notions raised in recent work by Slovic et al that link affect, emotion and existing attitudes and predispositions very strongly with risk perception (Slovic, Finucane, Peters, & MacGregor, 2004). And again, if people's beliefs about risky technologies vary according to their pre-existent dispositions at a rather general level of specificity, I would argue that it makes little sense to try to understand a person's perception of gene technology risk as if it were somehow something set apart from their perception of other particular aspects of science, science policy and the political and social issues that they encounter in everyday life.

The third important conclusion to be drawn from the evidence presented in the thesis concerns the nature of hazard-related trust. Earle and Cvetkovitch's SVS theory of trust is quite strongly supported by the results from Chapter Seven. The public perception of GM food risk is strongly related to the extent to which people see their own values reflected in the actions and discourses of actors that are responsible for its management. However, to this conclusion should be added an important qualification, for I also show that beliefs about shared values do not lead people entirely to ignore actors' technical competence when evaluating risks. Hence it appears that shared values really concern shared norms and goals, rather than shared commitments to 'being competent'. This is a novel finding and one that places a limit on the power of the SVS perspective to fully account for the link between social trust and risk perception.

The final key contribution that I have attempted is to synthesise insights from risk research and PUS and to re-evaluate the role of scientific and other knowledges in the perception of technological risks. This I have done by firstly showing how risk perception, in the specific case of GM food, is largely a function of more people's general disposition towards science and, secondly, that these dispositions depend partly on differences between people's level of scientific knowledge or 'literacy'. These conclusions are strengthened by the fact that many other factors apart from knowledge were simultaneously taken into account, including people's interest in biology and genetics. Given this, one should probably take the view that the much maligned 'deficit model' of public understanding of science has a contribution to make to debates in risk research and in PUS more generally.

9.5 Where next?

In common with most social scientific studies, the research presented here raises as many questions as it provides answers. Concomitantly, there are several promising avenues of further enquiry that it would be useful to follow up in light of these results. I have suggested that the perception of gene technology risk could be more straightforwardly interpreted as a particular set of beliefs which are likely to form part of a wider set of attitudes and values concerning science and technology, politics and society. One of the ways in which this hypothesis could be tested is in the comparison of attitudes towards multiple risk issues, be they technological or socio-political. One would expect to see very many similarities in the way people view particular risks if these views spring from an overarching set of attitudes and values in relation to political and social issues. Recent work by Poortinga and Pidgeon (Poortinga & Pidgeon, 2003) has begun to address this issue and the approach could be extended to cover an even wider range of risks including perhaps crime, terrorism, economic and financial risks and others.

Recently Slovic et al have suggested that emotion is an overarching mechanism by which people form their beliefs about risk (Slovic, Finucane, Peters, & MacGregor, 2004), in combination with more rational, cognitively demanding processes. This is called the 'affect heuristic. It would be valuable to include explicit measures of affect in studies that also attempt to tap into more general belief systems that people rely on in forming attitudes towards particular risks. At the moment, one has the suspicion that 'values', for instance in the shared values idea of Earle and Cvetkovitch, 'affect' as described by Slovic et al and perhaps even 'attitudes' in Eiser's model (see Chapter Two, p.52) are empirically, if not conceptually, somewhat indistinct.

Both the theory and measurement of social trust in relation to risk perception are areas where more research is called for. As mentioned earlier, the present study suffered from a lack of questionnaire space in which to test enough items that measure the various dimensions of trust. A study that developed and tested a much more extensive set of items that tap people's beliefs about risk managers in terms of their competence, responsibility and extent of their perceived value similarity would be very useful. In the present study, the competence and care dimensions were difficult to distinguish for perceptions of scientists and it is difficult to know the extent to which measurement error was responsible. It would also be very instructive to begin to be able to understand what the notion of 'value similarity' means to people in different contexts. A qualitative approach to this question in relation to gene technology risk management might be very useful, particularly in view of the ongoing public debate in the Britain about public participation and the kinds of political, economic and moral values that could or should underpin a progressive science policy.

Much of the recent research on the relationship between knowledge and attitudes to science and to specific technologies has been framed as a critique or refutation of the unfortunately named 'deficit model' of public understanding of science. This line of argument has also called into question the validity of survey research as a method for researching public understanding of science. I hope that I have shown that it is possible to do much more than present bivariate correlations between textbook scientific knowledge and attitudes to science using survey methods. Structural equation modelling provides one sophisticated tool, amongst others, for exploring more complex questions and theories concerning the links between knowledge, attitudes and beliefs about technological risks. I would urge others in the field to consider rehabilitating surveys as a legitimate and effective research method for studying public understanding of science, and to ignore the currently fashionable orthodoxy within some circles that to even attempt to measure the scientific literacy of citizens is somehow to denigrate them in the process. PUS and risk research could do worse than look to the wealth of theoretical and empirical knowledge generated by mainly American political scientists on the effects of differential information holding on political preferences, attitudes and behaviour (Delli Carpini & Keeter, 1996). Future work might in particular focus on the development of new scales for measuring different domains of scientific knowledge – knowledge of scientific institutions and the effects of scientific and technological developments on society at large. Given the manifest importance of knowledge of one kind or another, work needs now to be done on what are the social and psychological mechanisms that might link information holding with variegated beliefs about technological risks and attitudes towards science.

Finally, many of the questions that we have about the factors that underlie beliefs about risk could be approached much more effectively through the use of longitudinal panel studies. For instance, the correlations, highlighted in Chapter Eight, between scientific knowledge, interest, attitudes and risk beliefs could be given much firmer causal interpretations with the added dimension of time. Linking changes over time in, for example, trust in scientists to shifts in the public's perception of risk would add a new dimension to our understanding of what drives attitudes and beliefs about technological risk in modern societies.

This thesis began by describing the controversy that in Britain and elsewhere has accompanied the development and subsequent commercialisation of a number of gene technologies. There is little doubt also that the pace of developments in gene technology is likely to increase. This will no doubt be cause for concern for sceptics and outright opponents of gene technologies, whilst perhaps for many, particularly in governments and in industry, the concern is already that unfavourable public opinion will hold back the technological and economic promise of these developments. In reflecting on the results of the present investigation, it appears to me that the problems encountered by proponents of gene technology, particularly in the agri-food area, are not, or will not, prove to be uniquely linked to the inherent nature of gene technology and genetic modification. While this is doubtless part of the story, the risks that ordinary people perceive in relation to gene technology, and GM food and crops in particular, are strongly embedded in a whole host of attitudes, values and knowledges that people possess already and bring to their understanding and evaluation of a new technology and those social actors seen as responsible for its development and control. So it would come as no surprise if, for example, nanotechnology were to act as a new but very similar 'lightning conductor' for future public concerns about science policy, governance and the sensitivity of science and industry to citizens' goals and their social and democratic values. And it should not be forgotten that science and technology policy is not the only issue on which there has been declared, at one time or another recently, a crisis of public confidence. Trust in political institutions of many kinds has been falling for twenty five years or more (Putnam, 2000).

To the extent that people judge risks on the basis of what they already know, it almost goes without saying that enhancing the availability of reliable knowledge and information to the public is a sensible idea in pursuit of both an efficient and democratic process for securing sustainable science policies. To the extent to that people judge risks by how much they approve of the potential goals served, the individuals and institutions that manage them and the view of the world that is implied by taking such risks, the way is not so clear. In my view, the evidence thus far suggests that one probably needs to look well beyond current theories of risk perception towards more general explanations for how people come to hold the social or political attitudes and values that they do. If this view is a valid one, the key task then will become that of locating where the public's perception of risk and of new technology fits into this much broader picture.

APPENDIX A

YouGov Internet Survey Codebook (Unweighted Frequencies)

(N.B. codebook includes demographic variables collected when respondent first registered for panel)

1. first of all, some questions about your views on science and technology in ge	Freq.	Percent	Cum.
strongly agree	514	40.63	40.63
moderately agree	509	40.24	80.87
slightly agree	161	12.73	93.60
neither agree nor disagree	46	3.64	97.23
slightly disagree	25	1.98	99.21
moderately disagree	7	0.55	99.76
strongly disagree	3	0.24	100.00
Total	1,265	100.00	

faith

1. b) we depend too much on science and not enough on faith	Freq.	Percent	Cum.
strongly agree	64	5.09	5.09
moderately agree	173	13.75	18.84
slightly agree	185	14.71	33.55
neither agree nor disagree	203	16.14	49.68
slightly disagree	125	9.94	59.62
moderately disagree	185	14.71	74.32
strongly disagree	323	25.68	100.00
Total	1,258	100.00	

toofast

1. c) science makes our way of life change too fast	Freq.	Percent	Cum.
strongly agree	94	7.44	7.44
moderately agree	213	16.85	24.29
slightly agree	307	24.29	48.58
neither agree nor disagree	217	17.17	65.74
slightly disagree	149	11.79	77.53
moderately disagree	131	10.36	87.90
strongly disagree	153	12.10	100.00
Total	1,264	100.00	

benvac

2. there has been a lot of talk in the newspapers and on tv during the last few	Freq.	Percent	Cum.
very beneficial	360	29.13	29.13
fairly beneficial	281	22.73	51.86
somewhat beneficial	282	22.82	74.68
not very beneficial	131	10.60	85.28

not at all beneficial	182	14.72	100.00
Total	1,236	100.00	

benfresh

2. b) genetically modifying fruits so that they stay fresh for longer in the sho	Freq.	Percent	Cum.
very beneficial	123	9.88	9.88
fairly beneficial	217	17.43	27.31
somewhat beneficial	303	24.34	51.65
not very beneficial	290	23.29	74.94
not at all beneficial	312	25.06	100.00
Total	1,245	100.00	

benprchp

2. c) genetically modifying corn so that farmers can produce it more cheaply	Freq.	Percent	Cum.
very beneficial	186	14.93	14.93
fairly beneficial	254	20.39	35.31
somewhat beneficial	320	25.68	61.00
not very beneficial	226	18.14	79.13
not at all beneficial	260	20.87	100.00
Total	1,246	100.00	

riskper

3. now thinking about the overall risks, if any, that you think might be associa	Freq.	Percent	Cum.
no risk	52	4.18	4.18
very little risk	346	27.81	31.99
some risk	492	39.55	71.54
a lot of risk	174	13.99	85.53
very great risk	180	14.47	100.00
Total	1,244	100.00	

riskgen

3. b) how much risk for people in general do you think is associated with gm foo	Freq.	Percent	Cum.
no risk	36	2.89	2.89
very little risk	314	25.18	28.07
some risk	498	39.94	68.00
a lot of risk	193	15.48	83.48
very great risk	206	16.52	100.00
Total	1,247	100.00	

likefood

4. some people have suggested that bad things, or damage, might happen because o	Freq.	Percent	Cum.
not at all likely	61	4.93	4.93
not very likely	470	37.96	42.89
somewhat likely	427	34.49	77.38
very likely	156	12.60	89.98
extremely likely	124	10.02	100.00
Total	1,238	100.00	

likecrop

4. b) damage to the environment from planting gm crops	Freq.	Percent	Cum.
not at all likely	47	3.77	3.77
not very likely	319	25.56	29.33
somewhat likely	379	30.37	59.70
very likely	249	19.95	79.65
extremely likely	254	20.35	100.00
Total	1,248	100.00	

serfood

5. imagine that some of these bad things did come about. how serious do you thin	Freq.	Percent	Cum.
not at all serious	61	4.99	4.99
not very serious	405	33.14	38.13
quite serious	438	35.84	73.98
very serious	216	17.68	91.65
disastrous	102	8.35	100.00
Total	1,222	100.00	

sercrop

5. b) to the environment from planting gm crops	Freq.	Percent	Cum.
not at all serious	51	4.16	4.16
not very serious	296	24.14	28.30
quite serious	375	30.59	58.89
very serious	271	22.10	81.00
disastrous	233	19.00	100.00
Total	1,226	100.00	

encgm

6. do you agree or disagree that the government should be encouraging the develo	Freq.	Percent	Cum.
strongly agree	106	8.51	8.51

	Freq.	Percent	Cum.
moderately agree	155	12.44	20.95
slightly agree	183	14.69	35.63
neither agree or disagree	185	14.85	50.48
slightly disagree	132	10.59	61.08
moderately disagree	132	10.59	71.67
strongly disagree	353	28.33	100.00
Total	1,246	100.00	

sciával

7. the next questions are about two groups of people involved in the development	Freq.	Percent	Cum.
1 - very different values to mine	281	22.92	22.92
2	195	15.91	38.83
3	224	18.27	57.10
4	183	14.93	72.02
5	170	13.87	85.89
6	109	8.89	94.78
7 - very similar values to mine	64	5.22	100.00
Total	1,226	100.00	

scithink

7. b) on a scale of 1 to 7, to what extent do you think that scientists working	Freq.	Percent	Cum.
1 – think very differently to me	286	23.25	23.25
2	230	18.70	41.95
3	223	18.13	60.08
4	193	15.69	75.77
5	153	12.44	88.21
6	89	7.24	95.45
7 – think very like me	56	4.55	100.00
Total	1,230	100.00	

govval

7. c) on a scale of 1 to 7, to what extent do you think that government minister	Freq.	Percent	Cum.
1 - very different values to mine	362	29.36	29.36
2	240	19.46	48.82
3	245	19.87	68.69
4	221	17.92	86.62
5	102	8.27	94.89
6	36	2.92	97.81
7 - very similar values to mine	27	2.19	100.00
Total	1,233	100.00	

govthink

7. d) on a scale of 1 to 7, to what extent do you think that government minister	Freq.	Percent	Cum.
1 – think very differently to me	371	30.11	30.11
2	232	18.83	48.94
3	268	21.75	70.70
4	218	17.69	88.39

5	91	7.39	95.78
6	31	2.52	98.30
7 – think very like me	21	1.70	100.00
Total	1,232	100.00	

sciexp

8. here are some statements about scientists working on gm food. please indicat	Freq.	Percent	Cum.
strongly agree	91	7.35	7.35
moderately agree	268	21.65	29.00
slightly agree	246	19.87	48.87
neither agree nor disagree	118	9.53	58.40
slightly disagree	151	12.20	70.60
moderately disagree	169	13.65	84.25
strongly disagree	195	15.75	100.00
Total	1,238	100.00	

scicare

8. b) don't care about what happens to ordinary people	Freq.	Percent	Cum.
strongly agree	143	11.54	11.54
moderately agree	150	12.11	23.65
slightly agree	232	18.72	42.37
neither agree nor disagree	151	12.19	54.56
slightly disagree	194	15.66	70.22
moderately disagree	194	15.66	85.88
strongly disagree	175	14.12	100.00
Total	1,239	100.00	

sciunder

8. c) have a good understanding of all the issues relevant to the research	Freq.	Percent	Cum.
strongly agree	116	9.35	9.35
moderately agree	279	22.50	31.85
slightly agree	236	19.03	50.89
neither agree nor disagree	130	10.48	61.37
slightly disagree	179	14.44	75.81
moderately disagree	160	12.90	88.71
strongly disagree	140	11.29	100.00
Total	1,240	100.00	

sciresp

8. d) take their responsibility to society seriously	Freq.	Percent	Cum.
strongly agree	138	11.19	11.19
moderately agree	235	19.06	30.25
slightly agree	200	16.22	46.47
neither agree nor disagree	159	12.90	59.37
slightly disagree	215	17.44	76.80
moderately disagree	138	11.19	88.00
strongly disagree	148	12.00	100.00

```
--------------------------+-----------------------------------
                    Total |      1,233      100.00

scievdnc

 8. e) are good at looking |
     at the evidence about |
safety and judging what to |
                        do |      Freq.     Percent        Cum.
--------------------------+-----------------------------------
            strongly agree |         94        7.58        7.58
          moderately agree |        206       16.61       24.19
            slightly agree |        210       16.94       41.13
neither agree nor disagree |        144       11.61       52.74
         slightly disagree |        227       18.31       71.05
       moderately disagree |        175       14.11       85.16
         strongly disagree |        184       14.84      100.00
--------------------------+-----------------------------------
                    Total |      1,240      100.00

scihon

  8. f) are usually honest |
           with the public |      Freq.     Percent        Cum.
--------------------------+-----------------------------------
            strongly agree |         65        5.24        5.24
          moderately agree |        159       12.82       18.06
            slightly agree |        152       12.26       30.32
neither agree nor disagree |        124       10.00       40.32
         slightly disagree |        215       17.34       57.66
       moderately disagree |        221       17.82       75.48
         strongly disagree |        304       24.52      100.00
--------------------------+-----------------------------------
                    Total |      1,240      100.00

govexp

          9. here are some |
          statements about |
  government ministers who |
     make policy decisions |      Freq.     Percent        Cum.
--------------------------+-----------------------------------
            strongly agree |         15        1.21        1.21
          moderately agree |         32        2.57        3.78
            slightly agree |         84        6.76       10.54
neither agree nor disagree |         82        6.60       17.14
         slightly disagree |        180       14.48       31.62
       moderately disagree |        265       21.32       52.94
         strongly disagree |        585       47.06      100.00
--------------------------+-----------------------------------
                    Total |      1,243      100.00

govcare

    9. b) don't care about |
  what happens to ordinary |
                    people |      Freq.     Percent        Cum.
--------------------------+-----------------------------------
            strongly agree |        201       16.18       16.18
          moderately agree |        187       15.06       31.24
            slightly agree |        232       18.68       49.92
neither agree nor disagree |        157       12.64       62.56
         slightly disagree |        222       17.87       80.43
       moderately disagree |        142       11.43       91.87
         strongly disagree |        101        8.13      100.00
--------------------------+-----------------------------------
                    Total |      1,242      100.00

govunder
```

9. c) have a good understanding of all the issues relevant to the research	Freq.	Percent	Cum.
strongly agree	14	1.13	1.13
moderately agree	45	3.64	4.77
slightly agree	103	8.33	13.10
neither agree nor disagree	87	7.03	20.13
slightly disagree	165	13.34	33.47
moderately disagree	329	26.60	60.06
strongly disagree	494	39.94	100.00
Total	1,237	100.00	

govresp

9. d) take their responsibility to society seriously	Freq.	Percent	Cum.
strongly agree	50	4.05	4.05
moderately agree	135	10.94	14.99
slightly agree	221	17.91	32.90
neither agree nor disagree	159	12.88	45.79
slightly disagree	192	15.56	61.35
moderately disagree	234	18.96	80.31
strongly disagree	243	19.69	100.00
Total	1,234	100.00	

govevdnc

9. e) are good at looking at the evidence about safety and judging what to do	Freq.	Percent	Cum.
strongly agree	12	0.97	0.97
moderately agree	64	5.16	6.12
slightly agree	125	10.07	16.20
neither agree nor disagree	135	10.88	27.07
slightly disagree	225	18.13	45.21
moderately disagree	260	20.95	66.16
strongly disagree	420	33.84	100.00
Total	1,241	100.00	

govhon

9. f) are usually honest with the public	Freq.	Percent	Cum.
strongly agree	8	0.65	0.65
moderately agree	46	3.71	4.36
slightly agree	77	6.21	10.57
neither agree nor disagree	71	5.73	16.30
slightly disagree	187	15.09	31.40
moderately disagree	228	18.40	49.80
strongly disagree	622	50.20	100.00
Total	1,239	100.00	

intpol

10. generally speaking, |

how much interest do you have in . . .? a) what is going	Freq.	Percent	Cum.
a great deal of interest	305	24.44	24.44
quite a lot of interest	360	28.85	53.29
some interest	431	34.54	87.82
not very much interest	137	10.98	98.80
no interest at all	15	1.20	100.00
Total	1,248	100.00	

intsci

10. b) science in general	Freq.	Percent	Cum.
a great deal of interest	227	18.17	18.17
quite a lot of interest	475	38.03	56.20
some interest	463	37.07	93.27
not very much interest	82	6.57	99.84
no interest at all	2	0.16	100.00
Total	1,249	100.00	

intgm

10. c) new developments in genetic science and gm foods	Freq.	Percent	Cum.
a great deal of interest	141	11.26	11.26
quite a lot of interest	345	27.56	38.82
some interest	546	43.61	82.43
not very much interest	197	15.73	98.16
no interest at all	23	1.84	100.00
Total	1,252	100.00	

kbac

11. here is a short quiz about biology. please indicate whether you think the fo	Freq.	Percent	Cum.
true	1,194	95.60	95.60
false	13	1.04	96.64
don’t know	42	3.36	100.00
Total	1,249	100.00	

ktom

11. b) ordinary tomatoes do not contain genes, while genetically modified tomato	Freq.	Percent	Cum.

```
       true |        108        8.59        8.59
      false |        931       74.07       82.66
 don’t know |        218       17.34      100.00
------------+-----------------------------------
      Total |      1,257      100.00
```

kyeast

```
     11. c) |
  yeast for |
    brewing |
       beer |
consists of |
     living |
  organisms |      Freq.     Percent        Cum.
------------+-----------------------------------
       true |      1,201       95.39       95.39
      false |         22        1.75       97.14
 don’t know |         36        2.86      100.00
------------+-----------------------------------
      Total |      1,259      100.00
```

kclone

```
 11. d) the |
 cloning of |
     living |
     things |
   produces |
genetically |
  identical |
  offspring |      Freq.     Percent        Cum.
------------+-----------------------------------
       true |      1,084       86.31       86.31
      false |         92        7.32       93.63
 don’t know |         80        6.37      100.00
------------+-----------------------------------
      Total |      1,256      100.00
```

kbig

```
     11. e) |
genetically |
   modified |
animals are |
     always |
bigger than |
   ordinary |
       ones |      Freq.     Percent        Cum.
------------+-----------------------------------
       true |         53        4.22        4.22
      false |        862       68.58       72.79
 don’t know |        342       27.21      100.00
------------+-----------------------------------
      Total |      1,257      100.00
```

scifault

```
          12. imagine that |
 scientists, funded by the |
   government and the food |
             industry, dev |      Freq.     Percent        Cum.
---------------------------+-----------------------------------
            strongly agree |        225       17.97       17.97
          moderately agree |        264       21.09       39.06
            slightly agree |        286       22.84       61.90
neither agree nor disagree |        201       16.05       77.96
         slightly disagree |        150       11.98       89.94
       moderately disagree |         76        6.07       96.01
```

strongly disagree	50	3.99	100.00
Total	1,252	100.00	

scisack

12. b) scientists should be sacked when they make this sort of mistake	Freq.	Percent	Cum.
strongly agree	173	13.91	13.91
moderately agree	123	9.89	23.79
slightly agree	169	13.59	37.38
neither agree nor disagree	249	20.02	57.40
slightly disagree	202	16.24	73.63
moderately disagree	167	13.42	87.06
strongly disagree	161	12.94	100.00
Total	1,244	100.00	

kmparl

13. and now here is a short quiz about people and politics. please indicate whet	Freq.	Percent	Cum.
true	89	7.07	7.07
false	1,012	80.38	87.45
don’t know	158	12.55	100.00
Total	1,259	100.00	

kelec

13. b) the longest time between general elections is four years	Freq.	Percent	Cum.
true	579	46.43	46.43
false	637	51.08	97.51
don’t know	31	2.49	100.00
Total	1,247	100.00	

kqueen

13. c) british prime ministers are appointed by the queen	Freq.	Percent	Cum.
true	484	38.88	38.88
false	717	57.59	96.47
don’t know	44	3.53	100.00

Total	1,245	100.00	

kprop

13. d) britain's electoral system is based on proportional representation	Freq.	Percent	Cum.
true	205	16.55	16.55
false	946	76.35	92.90
don't know	88	7.10	100.00
Total	1,239	100.00	

keuro

13. e) britain has separate elections for the european parliament and the britis	Freq.	Percent	Cum.
true	1,122	89.90	89.90
false	51	4.09	93.99
don't know	75	6.01	100.00
Total	1,248	100.00	

worrygm

14. some people worry about possible dangers from gm food and crops, other peopl	Freq.	Percent	Cum.
never been worried	313	25.16	25.16
occasionally been worried	368	29.58	54.74
sometimes been worried	274	22.03	76.77
often been worried	168	13.50	90.27
very often been worried	121	9.73	100.00
Total	1,244	100.00	

trustsci

15. overall, how much trust do you have in scientists to make the right decision	Freq.	Percent	Cum.
complete trust	23	1.85	1.85
a lot of trust	239	19.27	21.13
some trust	444	35.81	56.94
very little trust	371	29.92	86.85
no trust at all	163	13.15	100.00

Total	1,240	100.00	

trustgov

16. overall, how much trust do you have in the government to make the right deci	Freq.	Percent	Cum.
complete trust	8	0.64	0.64
a lot of trust	51	4.11	4.75
some trust	334	26.91	31.67
very little trust	449	36.18	67.85
no trust at all	399	32.15	100.00
Total	1,241	100.00	

gmview

17. overall, which of the following statements comes closest to your view about	Freq.	Percent	Cum.
i strongly support the development of g	80	6.49	6.49
i am generally in favour of the develop	457	37.06	43.55
i am generally opposed to the developme	426	34.55	78.10
i strongly oppose the development of gm	270	21.90	100.00
Total	1,233	100.00	

scied

18. have you ever taken a university course in any of the following: biological	Freq.	Percent	Cum.
yes	95	7.56	7.56
no	1,161	92.44	100.00
Total	1,256	100.00	

gmstrong

19. some people feel very strongly about issues concerning gm food and crops rai	Freq.	Percent	Cum.
extremely strongly	130	10.46	10.46
very strongly	223	17.94	28.40
somewhat strongly	447	35.96	64.36
not very strongly	395	31.78	96.14
not at all strongly	48	3.86	100.00
Total	1,243	100.00	

total

total	Freq.	Percent	Cum.
1	1,273	100.00	100.00

```
------------+-----------------------------------
      Total |      1,273      100.00

sex

   are you? |      Freq.     Percent        Cum.
------------+-----------------------------------
       male |        621       48.78       48.78
     female |        652       51.22      100.00
------------+-----------------------------------
      Total |      1,273      100.00

year

 which year |
   were you |
   born in? |      Freq.     Percent        Cum.
------------+-----------------------------------
before 1930 |         21        1.65        1.65
       1930 |          6        0.47        2.12
       1931 |          9        0.71        2.83
       1932 |         13        1.02        3.85
       1933 |         11        0.86        4.71
       1934 |         21        1.65        6.36
       1935 |         19        1.49        7.86
       1936 |         25        1.96        9.82
       1937 |         27        2.12       11.94
       1938 |         35        2.75       14.69
       1939 |         44        3.46       18.15
       1940 |         27        2.12       20.27
       1941 |         33        2.59       22.86
       1942 |         46        3.61       26.47
       1943 |         17        1.34       27.81
       1944 |         22        1.73       29.54
       1945 |         19        1.49       31.03
       1946 |         17        1.34       32.36
       1947 |         18        1.41       33.78
       1948 |         34        2.67       36.45
       1949 |         31        2.44       38.88
       1950 |         26        2.04       40.93
       1951 |         18        1.41       42.34
       1952 |         28        2.20       44.54
       1953 |         15        1.18       45.72
       1954 |         18        1.41       47.13
       1955 |         19        1.49       48.63
       1956 |         21        1.65       50.27
       1957 |         18        1.41       51.69
       1958 |         24        1.89       53.57
       1959 |         26        2.04       55.62
       1960 |         22        1.73       57.34
       1961 |         22        1.73       59.07
       1962 |         32        2.51       61.59
       1963 |         31        2.44       64.02
       1964 |         35        2.75       66.77
       1965 |         26        2.04       68.81
       1966 |         33        2.59       71.41
       1967 |          8        0.63       72.03
       1968 |         30        2.36       74.39
       1969 |         18        1.41       75.81
       1970 |         23        1.81       77.61
       1971 |         29        2.28       79.89
       1972 |         21        1.65       81.54
       1973 |         22        1.73       83.27
       1974 |         26        2.04       85.31
       1975 |         20        1.57       86.88
       1976 |         26        2.04       88.92
       1977 |         22        1.73       90.65
       1978 |         16        1.26       91.91
       1979 |         17        1.34       93.24
```

1980	19	1.49	94.74
1981	18	1.41	96.15
1982	16	1.26	97.41
1983	13	1.02	98.43
1984	20	1.57	100.00
Total	1,273	100.00	

home

which of these applies to your home?	Freq.	Percent	Cum.
own the leasehold/freehold outright	427	34.46	34.46
buying leasehold/freehold on a mortgage	555	44.79	79.26
rented from local authority	80	6.46	85.71
rented from private landlord	132	10.65	96.37
it belongs to a housing association	45	3.63	100.00
Total	1,239	100.00	

edage

at what age did you finish full-time education?	Freq.	Percent	Cum.
15 or under	170	13.35	13.35
16	309	24.27	37.63
17 - 18	337	26.47	64.10
20+	375	29.46	93.56
still at school/full-time student	69	5.42	98.98
can't remember	13	1.02	100.00
Total	1,273	100.00	

itv

which itv channel do you receive? if you receive more than one itv channel which	Freq.	Percent	Cum.
carlton / lwt (london)	245	19.26	19.26
central (midlands)	184	14.47	33.73
anglia (east anglia)	107	8.41	42.14
htv (wales / west)	108	8.49	50.63
west country tv (south west)	69	5.42	56.05
meridian (south)	148	11.64	67.69
granada (lancashire)	118	9.28	76.97
tyne tees (north east)	60	4.72	81.68
yorkshire	122	9.59	91.27
scottish tv (central scotland)	48	3.77	95.05
grampian tv (north scotland)	30	2.36	97.41
border	9	0.71	98.11
ulster	14	1.10	99.21
none	10	0.79	100.00
Total	1,272	100.00	

cars

how many cars does your household have the use of for private motoring?	Freq.	Percent	Cum.
none	141	11.08	11.08

1	625	49.10	60.17
2	408	32.05	92.22
3 or more	99	7.78	100.00
Total	1,273	100.00	

newspap

which daily morning newspaper do you read most often?	Freq.	Percent	Cum.
the express	68	5.34	5.34
the daily mail / the scottish daily mai	219	17.20	22.55
the mirror / daily record	98	7.70	30.24
the daily star / the daily star of scot	7	0.55	30.79
the sun	127	9.98	40.77
the daily telegraph	192	15.08	55.85
the financial times	3	0.24	56.09
the guardian	116	9.11	65.20
the independent	30	2.36	67.56
the times	93	7.31	74.86
the scotsman	9	0.71	75.57
the glasgow herald	10	0.79	76.36
the western mail	5	0.39	76.75
other local daily morning newspaper	52	4.08	80.83
other newspaper	31	2.44	83.27
none	213	16.73	100.00
Total	1,273	100.00	

newsnite

how often do you watch newsnight on bbc2?	Freq.	Percent	Cum.
most weekdays	149	11.70	11.70
once or twice a week	265	20.82	32.52
a few times a month	498	39.12	71.64
never	361	28.36	100.00
Total	1,273	100.00	

vote

thinking back to the general election in june 2001, do you remember which party	Freq.	Percent	Cum.
did not vote	163	13.23	13.23
labour	372	30.19	43.43
conservative	373	30.28	73.70
liberal democrat	215	17.45	91.15
scottish national party	22	1.79	92.94
plaid cymru	12	0.97	93.91
green party	5	0.41	94.32
uk independence party	22	1.79	96.10
other	20	1.62	97.73
not eligible/too young to vote	28	2.27	100.00
Total	1,232	100.00	

employ

which of these applies to you?	Freq.	Percent	Cum.
working full time (30 or more hours per	561	44.07	44.07
working part time (8 - 29 hours per wee	164	12.88	56.95
working part time (less than 8 hours a	19	1.49	58.44

	Freq.	Percent	Cum.
full time student	67	5.26	63.71
retired	296	23.25	86.96
unemployed	28	2.20	89.16
other not working	138	10.84	100.00
Total	1,273	100.00	

occresp

please tell us which one of the following options best describes the sort of wor	Freq.	Percent	Cum.
professional or higher technical work	306	24.04	24.04
manager or senior administrator	252	19.80	43.83
clerical	222	17.44	61.27
sales or services	109	8.56	69.84
foreman or supervisor of other workers	44	3.46	73.29
skilled manual work	71	5.58	78.87
semi-skilled or unskilled manual work	91	7.15	86.02
other	155	12.18	98.19
have never worked	23	1.81	100.00
Total	1,273	100.00	

occpart

and please tell us which best describes the sort of work your husband, wife or p	Freq.	Percent	Cum.
no husband, wife or partner	316	25.14	25.14
professional or higher technical work	199	15.83	40.97
manager or senior administrator	161	12.81	53.78
clerical	125	9.94	63.72
sales or services	83	6.60	70.33
foreman or supervisor of other workers	32	2.55	72.87
skilled manual work	93	7.40	80.27
semi-skilled or unskilled manual work	121	9.63	89.90
other	127	10.10	100.00
Total	1,257	100.00	

marital

what is your marital status?	Freq.	Percent	Cum.
married	742	58.61	58.61
living as married	141	11.14	69.75
separated (after being married)	18	1.42	71.17
divorced	72	5.69	76.86
widowed	37	2.92	79.78
never married	256	20.22	100.00
Total	1,266	100.00	

peoplehs

how many people are there in your household? please include both adults and chil	Freq.	Percent	Cum.
1	170	13.50	13.50

2	564	44.80	58.30
3	218	17.32	75.62
4	196	15.57	91.18
5	82	6.51	97.70
6	19	1.51	99.21
7	9	0.71	99.92
8 or more	1	0.08	100.00
Total	1,259	100.00	

nchild

how many of those are under 18?	Freq.	Percent	Cum.
0	861	68.99	68.99
1	147	11.78	80.77
2	158	12.66	93.43
3	58	4.65	98.08
4	17	1.36	99.44
5	4	0.32	99.76
6 or more	2	0.16	99.92
don't know	1	0.08	100.00
Total	1,248	100.00	

highed

what is the highest educational or work-related qualification you have?	Freq.	Percent	Cum.
no formal qualifications	98	7.72	7.72
youth training certificate/skillseekers	1	0.08	7.80
recognized trade apprenticeship complet	33	2.60	10.39
clerical and commercial	45	3.54	13.94
city and guild certificate	81	6.38	20.31
city and guild certificate - advanced	41	3.23	23.54
onc	33	2.60	26.14
cse grades 2-5	32	2.52	28.66
cse grade 1, gce o level, gcse, school	237	18.66	47.32
scottish ordinary/ lower certificate	9	0.71	48.03
gce a level or higher certificate	192	15.12	63.15
scottish higher certificate	15	1.18	64.33
nursing qualification (eg sen, srn, scm	41	3.23	67.56
teaching qualification (not degree)	34	2.68	70.24
university diploma	30	2.36	72.60
university or cnaa first degree (eg ba,	165	12.99	85.59
university or cnaa higher degree (eg m.	59	4.65	90.24
other technical, professional or higher	121	9.53	99.76
don't know	3	0.24	100.00
Total	1,270	100.00	

relig

do you regard yourself as belonging to any particular religion?	Freq.	Percent	Cum.
yes	651	52.00	52.00
no	573	45.77	97.76
not sure/don't know	28	2.24	100.00
Total	1,252	100.00	

denom

if so, which denomination?	Freq.	Percent	Cum.
none	186	21.93	21.93
church of england/anglican/episcopal	425	50.12	72.05
roman catholic	96	11.32	83.37
presbyterian/church of scotland	37	4.36	87.74
methodist	29	3.42	91.16
baptist	20	2.36	93.51
united reform church	3	0.35	93.87
free presbyterian	2	0.24	94.10
brethren	1	0.12	94.22
jewish	6	0.71	94.93
hindu	2	0.24	95.17
islam/muslim	1	0.12	95.28
sikh	1	0.12	95.40
buddhist	5	0.59	95.99
other	34	4.01	100.00
Total	848	100.00	

ethnic

to which of these groups do you consider to belong?	Freq.	Percent	Cum.
white british	1,158	94.30	94.30
any other white background	42	3.42	97.72
white and black caribbean	4	0.33	98.05
white and black african	1	0.08	98.13
white and asian	4	0.33	98.45
any other mixed background	5	0.41	98.86
indian	6	0.49	99.35
pakistani	1	0.08	99.43
bangladeshi	1	0.08	99.51
any other asian background	1	0.08	99.59
black african	1	0.08	99.67
other ethnic group	4	0.33	100.00
Total	1,228	100.00	

orgresp

please tell us which type of organisation you do or did work for.	Freq.	Percent	Cum.
self-employed	139	11.05	11.05
private sector firm or company	558	44.36	55.41
nationalised industry or public corpora	36	2.86	58.27
other public sector employer	381	30.29	88.55
charity/voluntary sector	46	3.66	92.21
other	74	5.88	98.09
have never worked	24	1.91	100.00
Total	1,258	100.00	

orgpart

and please tell us which type of organisation your husband, wife of partner does	Freq.	Percent	Cum.
no husband, wife or partner	289	23.23	23.23
self-employed	90	7.23	30.47
private sector firm or company	447	35.93	66.40
nationalised industry or public corpora	43	3.46	69.86
other public sector employer	274	22.03	91.88
charity/voluntary sector	24	1.93	93.81
other	56	4.50	98.31
have never worked	21	1.69	100.00
Total	1,244	100.00	

YouGov Questionnaire

This survey is about your views on new developments in science and technology. It's very important to us to hear what you think about these issues. The results of this research will help to inform public debate about the way science and technology affects the lives of everyone in Britain today. All the information you give to us will be kept completely confidential and will only be used to examine variation in the opinions of different groups of people. We really appreciate you taking part in this survey.

1. First of all, some questions about your views on science and technology in general. Please read the following statements and say how much you agree or disagree.

a) Science and technology are making our lives healthier, easier and more comfortable
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

b) **We depend too much on science and not enough on faith**
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

c) Science makes our way of life change too fast
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

2. There has been a lot of talk in the newspapers and on TV during the last few years about genetic science, especially the genetic modification of crops like rice, soya and corn. You may have heard these referred to as 'GM crops' or GM foods. In the rest of this questionnaire, we are very interested in your own personal views, whatever they may be.

There has been a lot of disagreement about the risks and benefits of GM foods. First of all, for each of the following examples, please say how BENEFICIAL they would be.

a) Genetically modifying crop plants so that they contain vaccines to protect people from disease
Very beneficial, Fairly beneficial, Somewhat beneficial, Not very beneficial, Not at all beneficial

b) Genetically modifying fruits so that they stay fresh for longer in the shops
Very beneficial, Fairly beneficial, Somewhat beneficial, Not very beneficial, Not at all beneficial

c) Genetically modifying corn so that farmers can produce it more cheaply
Very beneficial, Fairly beneficial, Somewhat beneficial, Not very beneficial, Not at all beneficial

3. Now thinking about the overall risks, if any, that you think might be associated with GM food and crops.

a) How much risk FOR YOU PERSONALLY do you think is associated with GM food?
No risk, Very little risk, Some risk, A lot of risk, Very great risk

b) How much risk FOR PEOPLE IN GENERAL do you think is associated with GM food?
No risk, Very little risk, Some risk, A lot of risk, Very great risk

4. Some people have suggested that bad things, or damage, might happen because of GM food and crops. Thinking about the following examples, how likely do you think it is that the following things will actually happen?

a) Damage to people's health from eating GM foods
Not at all likely, Not very likely, Somewhat likely, Very likely, Extremely likely

b) Damage to the environment from planting GM crops
Not at all likely, Not very likely, Somewhat likely, Very likely, Extremely likely

7. Imagine that some of these bad things did come about. How serious do you think the damage would turn out to be. . .? a) to people's health from eating GM foods
Not at all serious, Not very serious, Quite serious, Very Serious, Disastrous

b) to the environment from planting GM crops
Not at all serious, Not very serious, Quite serious, Very Serious, Disastrous

6. Do you agree or disagree that the government should be encouraging the development of GM crops and foods?
Strongly agree, Moderately agree, Slightly agree, Neither agree or disagree, Slightly disagree, Moderately disagree, Strongly disagree

7. The next questions are about two groups of people involved in the development of GM food – scientists and Government ministers. Think about how you feel about these people and how they deal with the GM food issue. Even if you haven't thought much about this sort of thing before, try to give us your 'gut' feelings if you can.

a) On a scale of 1 to 7, to what extent do you think that scientists working on GM food have similar or different values to you? (where 1 is 'very different values to mine' and 7 is 'very similar values to mine')
1 – very different, 2, 3, 4, 5, 6, 7 – very similar

b) On a scale of 1 to 7, to what extent do you think that scientists working on GM food think like you or think differently to you? (where 1 is 'think very differently to me' and 7 is 'think very like me')
1 – think very differently to me, 2, 3, 4, 5, 6, 7 – think very like me

c) On a scale of 1 to 7, to what extent do you think that Government ministers making policy on GM food have similar or different values to you? (where 1 is 'very different values to mine' and 7 is 'very similar values to mine')
1 – very different, 2, 3, 4, 5, 6, 7 – very similar

d) On a scale of 1 to 7, to what extent do you think that Government ministers making policy on GM food think like you or think differently to you? (where 1 is 'think very differently to me' and 7 is 'think very like me')
1 – think very differently to me, 2, 3, 4, 5, 6, 7 – think very like me

8. Here are some statements about scientists working on GM food. Please indicate how much you agree or disagree with each of these statements.

Scientists working on GM food. . .?

a) have the necessary expertise to make the right decisions
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

b) don't care about what happens to ordinary people
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

c) have a good understanding of all the issues relevant to the research
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

d) take their responsibility to society seriously
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

e) are good at looking at the evidence about safety and judging what to do

Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

f) are usually honest with the public
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

9. a) Here are some statements about Government ministers who make policy decisions about GM food. Please indicate how much you agree or disagree with each of these statements. Government ministers who make policy decisions about GM food. . .

a) have the necessary expertise to make the right decisions
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

b) don't care about what happens to ordinary people
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

c) have a good understanding of all the issues relevant to the research
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

d) take their responsibility to society seriously
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

e) are good at looking at the evidence about safety and judging what to do
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

f) are usually honest with the public
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

10. Generally speaking, how much interest do you have in . . .?

a) What is going on in politics these days
A great deal of interest, Quite a lot of interest, Some interest, Not very much interest, No interest at all

b) Science in general
A great deal of interest, Quite a lot of interest, Some interest, Not very much interest, No interest at all

c) New developments in genetic science and GM foods
A great deal of interest, Quite a lot of interest, Some interest, Not very much interest, No interest at all

10. Here is a short quiz about biology. Please indicate whether you think the following statements are true or false. If you don’t know the answer, please just choose ‘don’t know’ (but please don’t go and ‘look the answer up’ somewhere else!).

a) There are bacteria which live from waste water
True, False, Don’t know

b) Ordinary tomatoes do not contain genes, while genetically modified tomatoes do
True, False, Don’t know

c) Yeast for brewing beer consists of living organisms
True, False, Don’t know

d) The cloning of living things produces genetically identical offspring
True, False, Don’t know

e) Genetically modified animals are always bigger than ordinary ones

True, False, Don't know

11. Imagine that scientists, funded by the government and the food industry, develop a GM lettuce into which genes from lemons have been introduced. This increases the lettuce's vitamin content. Later on, after it has become available in the shops, it is discovered that it can cause an allergic reaction in some people, and is withdrawn from the shelves. Please say whether you agree or disagree with the following statements about the scientists who developed the GM lettuce.

a) When things like this happen, it is usually the scientists' fault
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

b) Scientists should be sacked when they make this sort of mistake
Strongly agree, Moderately agree, Slightly agree, Neither agree nor disagree, Slightly disagree, Moderately disagree, Strongly disagree

12. And now here is a short quiz about people and politics. Please indicate whether you think the following statements are true or false. It doesn't matter if you don't know the answer - please just choose 'don't know' (but please don't go and 'look the answer up' somewhere else!).

a) The number of Members of Parliament is about 100
True, False, Don't know

b) The longest time between General Elections is four years
True, False, Don't know

c) British Prime Ministers are appointed by the Queen
True, False, Don't know

d) Britain's electoral system is based on proportional representation
True, False, Don't know

e) Britain has separate elections for the European parliament and the British parliament
True, False, Don't know

13. Some people worry about possible dangers from GM food and crops, other people don't worry about this issue at all. How often have you been worried about any possible dangers associated with GM crops and food?
Never been worried, Occasionally been worried, Sometimes been worried, Often been worried, Very often been worried

14. Overall, how much trust do you have in scientists to make the right decisions about the way GM foods are being developed?
Complete trust, A lot of trust, Some trust, Very little trust, No trust at all

15. Overall, how much trust do you have in the Government to make the right decisions about the way GM foods are being developed?
Complete trust, A lot of trust, Some trust, Very little trust, No trust at all

16. Overall, which of the following statements comes closest to your view about GM food?
I strongly support the development of GM foods, I am generally in favour of the development GM foods but could be persuaded against it if I thought it was not safe, I am generally opposed to the development of GM foods but could be persuaded in favour of it if I thought it was safe, I strongly oppose the development of GM foods

17. Have you ever taken a university course in any of the following: biological science, physics, chemistry or any other natural science subject?
Yes, No
18. Some people feel very strongly about issues concerning GM food and crops raised in this survey, others do not feel strongly at all about these things. Overall, how strongly would you say you feel about these things?
Extremely strongly, Very strongly, Somewhat strongly, Not very strongly, Not at all strongly

APPENDIX B

Topic Guide for Focus Groups

<u>Section 1</u>

1.1 Introduction (5 minutes)

- *Welcome the participants and thank them for coming along, and for their participation in a discussion about new applications of science and technology applications.*
- *In a confident manner say that the discussion is being tape (and video?) recorded but make clear and stress that no comments are associated with a particular person, since our interest lies in the ideas of the group in general.*
- *Stress that there are no right or wrong answers, we are interested in hearing as many opinions and ideas as there are. We do want everyone to have their say so all views and comments are of interest.*
- *Introduce yourself with your first name, since surnames connote a more formal discussion.*
- *In some focus groups the moderator asks people to introduce themselves (name. marital status, job or perhaps where they come from) and then he/she starts with the questions; this gets everybody used to the idea of talking in the group*
- *In others, if the people have already started talking before the session the moderator starts immediately with the questions. In Angela's experience if people start introducing themselves formally to the group, some may feel inferior when compared with the others, and in addition the personal introduction, at a symbolic level, does not facilitate the feeling of anonymity.*

Having warmed up the group and got everyone to say something, the discussion starts.

1.2 Opening the frame. (10-15 minutes)

purpose: elicitation of frames of discourse, and evaluation of frames. Bear in mind the media coding frames: "from what you are saying it seems as if you see the whole business in terms of (economic prospect, scientific progress or moral/ethics) does everyone agree with that?"

- "There has been a lot of coverage of biotechnology and genetic engineering in the press and on television recently, when you think about biotechnology and genetic engineering, what sort of things come to mind ?
  prompt "what do you mean by that? could you say a little more about that?)

- "And where did you hear that?

(The answer to this question will come up throughout the discussion because people will say "I read the other day in the newspaper, I had a discussion with…..You may want to follow such comments up with questions about media coverage, balance in the media etc)

- "And what do you think about that?" (pause for response)
- "Is this good or bad?" , (pause for response)
- "And why is that

1.3 Evaluation of specific applications (30 minutes)

Purpose: exploring the dimensions/criteria which are used to judge applications of biotechnology, the boundaries between acceptable and unacceptable applications and the reasoning implied in such thresholds.

All applications printed on largish cards.

1. *Using modern biotechnology in the production of foods, for example to make them higher in protein, keep longer or change the taste.*
2. *Taking genes from plant species and transferring them into crop plants, to make them more resistant to insect pests.*
3. *Introducing human genes into bacteria to produce medicines or vaccines, for example to produce insulin for diabetics*
4. *Developing genetically modified animals for use in medical research.*
5. *Introducing human genes into animals to produce organs for human transplants, such as into pigs for human heart transplants.*
6. *Using genetic testing to detect diseases we might have inherited from our parents such as cystic fibrosis.*
7. *Cloning animals such as sheep so that their milk can be used for drugs and vaccines*
8. *Cloning human cells or tissues for use in organ transplants*
9. *Cloning a human adult to enable an infertile couple to have children.*

Task 1.1
Hand out cards individually, ask for spontaneous views/reactions from the group.

Task 1.2
All the cards on the table: "Now I would like you to put them into piles or groups so that the ones that are similar in some way go together".

Task 1.3
Now ask the group to sort the applications on the four criteria of useful/not useful, risky/not risky, morally acceptable/not morally acceptable, is legal/is not legal and is being done today/is not done being done today.

(legal/illegal and done today/not done today opens issues of regulation and the effectiveness of regulation.)

<u>Section 2</u> (for each group select one of gm foods or cloning)

2.1 Focus on gm foods (15 minutes)

Purpose: delving into specific applications in detail, knowledge and images, sources of information about them, evaluation etc. Lying behind comments or possibly articulated explicitly will be the dimensions of public concerns. Follow these up with probes since this is a key objective of this qualitative research.

- "What do you understand by gm foods?" (description)

- "What do you think is going to happen about these gm foods?"

- "Why is that? What makes you think that?"

- "Imagine lots of foods were genetically modified, take for example – soya oil for cooking or tomato paste".
  "What sort of people would buy gm foods?"
  "Please describe such people, why would they buy it?"

- "And what sort of people would never buy such gm foods?"
  "Who would they be and why wouldn't they buy them?"
  "Do you think there is anything that would change these people's minds?".
  "What about if gm foods were made to be higher in vitamins or lower in fat levels?"

(when such issues as tampering, nature, messing, danger, unnatural are mentioned
'why do you say that, what do you mean by nature/natural and why is that a concern?)

- "If you wanted to know more about gm foods where would you look for information?"
- "Would you personally buy gm foods?"
  "Why yes? why no?"
  "If no, under which conditions would you buy them?"

2.2 Focus on cloning. (15 minutes)

- "Can someone tell me what this is all about?"

- “Where do see this cloning business going , what is likely to happen and why?”

- “If you wanted to know more about cloning where would you look for information?”

- “Who do you think would be in favour of this cloning business *and why*?”

- “Who would be against it and why?”

- “What do you think it would it feel like to be a clone? how would other people treat you and why?”

(again if terms related to risk or moral/ethics are mentioned follow up with ‘what do mean by that and why?)

Section 3 Regulation and trust (20 minutes)

Hypotheses to be explored as outlined in our research proposal.

1.there is a generalised loss of public trust in social and political institutions of all kinds, of which distrust in the institutions regulating biotechnology is one example;

2. there is rather more specific loss of public trust in social and political institutions regulating new technologies of all kinds, of which distrust in the institutions regulating biotechnology is one example;

3. there is specific loss of public trust in social and political institutions regulating particular areas of modern biotechnology.

A further set of scenarios concern the possible causes of specific distrust:

4. lack of trust may arise from ignorance, as when people simply fail to recognise the existence of regulations or regulatory agencies;

5. lack of trust may arise from knowledge, e.g., of the perceived mishandling of biotechnology;

6. lack of trust may arise from scepticism concerning the operation and efficiency of regulations or regulatory agencies, for example because of perceived "loopholes" or lack of transparency.

Focus 1: Awareness.

“How do you think these developments in biotechnology are controlled, assessed and monitored?”

“Who is doing the controlling of the scientists and companies involved in biotechnology, if any one?”

“Are you aware of any current controls or regulations.”

Focus 2: Actors

Set of show cards presenting relevant actors (tailored to national context, giving the name wherever possible) who have some involvement in the control and regulation of biotechnology.

Parliament
Advisory Committees
Government food standards department.
Ethical Committees

Consumer organisation
Environmental group

Industry
Scientists
Farmer’s organisation
Church
Medical profession.

Task 3.1
Hand out cards individually and ask “Thinking about how biotechnology is controlled and regulated – things like the safety of new medicines and foods, environmental protection for example, what comes to mind, what do you feel about each of these?”

Task 3.2
With all the cards on the table:

“Who should have more say in the control and regulation of biotechnology?”

“Why do you think that, what have they got to offer? (probe for such things as assessing risks, ethical monitoring, environmental aspects, watch dogs etc)”

“Do you think any of these people have common interests and perhaps are working together, if so, is this a good thing or not?”
(? the coalition of government and industry: consumer and environmental groups etc)

"Is anyone missing from this list? are there other people involved?"

Task 3.3
Select the cards with the actors who are involved in national biotechnology regulation eg. Government, Government Agencies, Government scientists.

"Now some people have been a bit critical of those people who have the responsibility for controlling and regulating biotechnology, why do you think that is?"

"What type of people do you suppose are involved in control and regulation, how do they get there?"

"Do you think they are concerned about the things that are important to you?"

"Is there something special or difficult about controlling biotechnology?
Do you suppose that people are doing a better job in other areas of regulating things like air traffic control or health and safety at work?"

If yes: "why is it easier to control other areas, but not biotechnology?"
If no: "why is this? Is it just getting more difficult to control and regulate things these days?"

Focus 3: National/International

"Do you feel that each country should be responsible for making its own rules and controls or should international rules be developed?" "Why?"

Summing up:

"All in all what would make you more confident about the control and regulation of biotechnology?"

Section 4
These topics may have been covered in detail earlier in the discussion but if not here is an opportunity to explore our over-arching interests in the dimensions of public concerns.

Risk, ethical and moral dimensions. (10 minutes)

"As I think about what has been said in the group, some of you have talked about things that we might call risks that come along with genetic engineering, and at other times people have talked about what I take to be ethical/moral issues.

What does ethical mean to you? Is there something about biotechnology that raises ethical questions which are not relevant to other technologies like nuclear power or information technology?

Is there a difference between risk and ethical concerns, if so which should be most important when it comes to control and regulation?

"Are these really the same thing in different words, or are they different ideas altogether? (With follow up probes to suit.)

<u>Section 5</u>: The ending.

Drawing to a close

"Well I seem to have covered all the issues I had in mind, but is there anything anyone would like to add, any points we have not covered, or issues on which you have had second thoughts?"

Thanks to everyone, hand their money in an envelope (£15 - £20 in Britain) and say what you will be doing with the discussion – transcript, analysis and comparison with views of other groups of people – and bid them a fond farewell.

(ENDS)

Focus Group Code Frequencies

(Top level codes are in uppercase. Subcodes are prefixed with top level code abbreviations, e.g. subcode A_environ.groups is a member of the ACTOR code.)

Code	Focus Group				
	One	Two	Three	Four	Total
A_church	0	0	4	0	4
A_consumer.union	0	0	6	0	6
A_doctors	0	2	0	0	2
A_environ.groups	0	0	2	5	7
A_EU	1	3	1	0	5
A_Family	0	0	0	0	0
A_farmers	0	0	2	0	2
A_food.agency	0	1	4	0	5
A_future gen	0	0	0	0	0
A_industry	3	5	5	1	14
A_Me	30	23	17	17	87
A_media	2	6	6	2	16
A_nat.govern	8	21	1	7	37
A_parliament	6	0	3	0	9
A_Patients	0	0	0	0	0
A_people	17	13	2	1	33
A_politicians	0	0	0	0	0
A_rogue.individuals	1	0	0	0	1
A_rogue.states	0	0	0	0	0
A_scientists	6	1	6	7	20
A_supermarket	0	1	0	5	6
A_they	8	39	11	13	71
A_Third World	0	0	0	0	0
A_UK	2	0	0	0	2
A_UN	0	0	2	2	4
A_USA	0	0	6	0	6
A_We	34	22	11	10	77
A_WHO	0	0	1	2	3
ACTOR_ATTRIBUTES	0	0	0	0	0
Actor_biased	8	38	18	16	80
Actor_competent	1	3	11	6	21
Actor_incompetent	5	9	5	3	22
Actor_independent	3	0	1	0	4
Actor_irresponsible	3	8	1	3	15
Actor_Mo_money	2	10	5	8	25
Actor_Mo_power	4	3	0	1	8
Actor_Mo_vocation	1	0	2	6	9
ACTOR_MOTIVATION	0	0	0	0	0
Actor_other	0	0	0	0	0
Actor_passive	2	1	3	0	6
Actor_Power.Relation	8	7	1	2	18
Actor_responsible	2	1	1	3	7
Actor_strong	0	1	0	0	1
Actor_weak	0	2	0	1	3
ACTORS	0	0	0	0	0
App_Cloning	15	20	8	12	55
App_GManimals	1	10	6	3	20

Code	Focus Group				
	One	Two	Three	Four	Total
App_GMfood	41	56	28	41	166
App_GMplants	2	11	7	6	26
App_human.complete	16	15	15	3	49
App_Human.organs	3	0	0	0	3
App_medicine	1	9	2	4	16
App_Pharmaceuticals	0	11	2	0	13
App_Testing	0	1	2	8	11
App_Xenotransplants	1	0	0	7	8
APPLICATION	42	56	33	23	154
D_Economic	9	1	0	3	13
D_Environment	20	13	2	4	39
D_Food	0	20	7	17	44
D_Health	25	61	17	5	108
D_other	0	1	0	0	1
D_Political	21	46	3	30	100
D_Procreation	0	11	0	4	15
D_Society	38	36	35	24	133
D_Wellbeing	2	7	22	14	45
Demo_Consent	13	8	4	17	42
Demo_contraBT	0	1	0	1	2
Demo_Fairness	0	0	0	0	0
Demo_Indiv.rights	1	2	1	3	7
Demo_proBT	0	0	0	0	0
DEMOCRACY	25	24	6	23	78
DOMAIN	0	0	0	0	0
Ex_BSE	5	8	2	8	23
Ex_computer	4	3	0	0	7
Ex_Hormones	0	0	0	0	0
Ex_IVF	5	7	0	3	15
Ex_nuclear	0	1	2	0	3
Ex_organic	7	5	2	5	19
Ex_other	18	62	28	38	146
EXAMPLE	23	83	37	43	186
food	29	42	30	32	133
Info_demand	1	6	4	7	18
Info_lack	1	27	11	6	45
INFORMATION(N)	2	30	15	10	57
Int_accept.time	0	0	0	0	0
int_ambiv	1	1	1	0	3
int_contra	6	5	0	2	13
int_pro	1	2	0	0	3
INTENTION	7	6	1	2	16
K_they.dk(N)	6	3	2	1	12
K_we.dk	31	31	21	10	93
KNOWLEDGE(N)	45	40	29	18	132
MORAL(N)	4	13	11	21	49
Re_compromise	0	1	0	0	1
Re_diverse	0	0	0	0	0
Re_impossible	0	0	0	0	0
Re_need	11	19	12	16	58
Re_not.okay	0	7	1	1	9
Re_not.play.rules	1	6	0	0	7
Re_okay	1	0	1	1	3
REGULATION(N)	14	31	19	22	86
Ri_accept	0	0	1	0	1

Code	Focus Group				
	One	Two	Three	Four	Total
Ri_ambiv	3	3	4	0	10
Ri_caution	2	3	0	0	5
Ri_controll	1	0	0	0	1
Ri_hypothetical	6	7	4	3	20
Ri_invisible	1	0	0	0	1
Ri_long.term	9	7	6	4	26
Ri_revenge	0	0	0	0	0
Ri_short.term	0	0	0	0	0
Ri_unaccept	0	0	0	0	0
Ri_uncontroll	2	1	0	0	3
Ri_unknown	19	20	12	3	54
RISK	34	66	31	14	145
Risk--	1	5	0	0	6
Risk-acceptability(N	0	0	1	0	1
Risk-cloning(N)	0	7	4	1	12
Risk-complexity(N)	4	2	3	2	11
Risk-delayed effects	13	12	1	4	30
Risk-environment(N)	3	2	5	0	10
Risk-everywhere(N)	0	1	1	0	2
Risk-fallible scienc	6	12	1	2	21
Risk-health(N)	12	11	7	2	32
Risk-invisible(N)	4	2	2	0	8
Risk-misuse(N)	0	4	0	0	4
Risk-precaution(N)	0	0	4	0	4
Risk-snowball(N)	0	3	2	0	5
Risk-tampering with	3	3	1	0	7
Risk-unknown(N)	7	13	7	0	27
Risk-voluntariness(N	0	2	1	1	4
Risk+	8	43	18	4	73
T_Particip	0	1	0	0	1
Trust-	8	32	3	11	54
Trust-competence	1	14	2	5	22
Trust-responsibility	0	22	4	5	31
Trust-values	0	8	1	7	16
TRUST(N)	9	39	7	17	72
Trust+	1	4	1	3	9
U_alternatives(N)	1	0	5	1	7
U_hypothetical	2	2	5	4	13
Utility--(N)	2	12	1	0	15
UTILITY(N)	22	29	17	12	80
Utility+(N)	15	12	4	2	33
V_human	9	0	1	0	10
V_limits	3	0	1	1	5
V_nature(N)	12	17	11	5	45
V_science	4	3	1	5	13
V_tradition	0	0	0	0	0
Veneration--	6	1	0	0	7
VENERATION(N)	45	31	19	13	108
VT_dignity(N)	6	1	4	0	11
VT_humility	2	0	0	0	2
VT_integrity	0	0	0	0	0
TOTALS	**942**	**1536**	**770**	**750**	**3998**

APPENDIX C

WAVE 1 QUESTIONNAIRE ON FOOD RISK FROM MAFF PANEL STUDY

ORDER: DIM A HAZ A

Social Psychology European Research Institute
UNIVERSITY OF SURREY

FOOD-RELATED RISKS AND HAZARDS SURVEY

Please read the instructions on the inside cover first.

Please do not write anything in these boxes

0 1 2 3 4 5 6 7 8 9

1000
100
10
1

Survey : 14

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Confidential

INSTRUCTIONS

In this questionnaire we are interested in how you think about various kinds of foods and potential food-related hazards.

Answering the questionnaire is mainly a matter of placing a tick in the box that best reflects your answer. This questionnaire will be read by an Optical Mark Reader - please make your ticks bold and clear by using a blue or black pen.

There are a few questions at the very end where we would like you to write in your answers.

Try to give the first answer that comes into your head. This is not a test - we are interested in how you naturally think about these food issues.

Please try to answer all the questions. If you are uncertain about a particular question just give your best guess.

Please return this questionnaire in the FREEPOST envelope - you do not need to put a stamp on it.

Thank you for taking your time to help with this research.

~~HARM~~ LIKELY

1) **How likely is it that your health will ever be harmed by the following things?**

	Not Likely At all	Very Unlikely	Moderately Likely	Very Likely	Extremely Likely	
Food containing **saturated fats**	☐	☐	☐	☐	☐	1
Food containing **nitrates** from the soil (e.g. some lettuce)	☐	☐	☐	☐	☐	2
Food containing **sugar**	☐	☐	☐	☐	☐	3
Food containing **Salmonella** bacteria	☐	☐	☐	☐	☐	4
Food containing added **colourings**	☐	☐	☐	☐	☐	5
Food containing **Clostridium botulinum** (Botulism)	☐	☐	☐	☐	☐	6
Food that is **organically grown** (e.g. some apples)	☐	☐	☐	☐	☐	7
Food that has been **genetically altered** (e.g. Flavr Savr tomatoes)	☐	☐	☐	☐	☐	8
Food containing the prion that causes **B.S.E.** ('Mad Cow' Disease)	☐	☐	☐	☐	☐	9
Food containing **growth hormone residues**	☐	☐	☐	☐	☐	10
Food containing **pesticide residues**	☐	☐	☐	☐	☐	11

WORRY

2) **How worried are you about potential risks associated with the following things?**

		Not worried At all	Slightly Worried	Fairly Worried	Very Worried	Extremely Worried
1	Food containing **saturated fats**	☐	☐	☐	☐	☐
2	Food containing **nitrates** from the soil (e.g. some lettuce)	☐	☐	☐	☐	☐
3	Food containing **sugar**	☐	☐	☐	☐	☐
4	Food containing **Salmonella** bacteria	☐	☐	☐	☐	☐
5	Food containing added **colourings**	☐	☐	☐	☐	☐
6	Food containing **Clostridium botulinum** (Botulism)	☐	☐	☐	☐	☐
7	Food that is **organically grown** (e.g. some apples)	☐	☐	☐	☐	☐
8	Food that has been **genetically altered** (e.g. Flavr Savr tomatoes)	☐	☐	☐	☐	☐
9	Food containing the **prion that causes** B.S.E. ('Mad Cow' Disease)	☐	☐	☐	☐	☐
10	Food containing **growth hormone residues**	☐	☐	☐	☐	☐
11	Food containing **pesticide residues**	☐	☐	☐	☐	☐

SCIKNOW

3) **How much do you think scientists know about any potential risks from eating or drinking the following things?**

	Nothing At All	A Little	A Fair Amount	A Lot	Everything	
Food containing **saturated fats**	☐	☐	☐	☐	☐	1
Food containing **nitrates** from the soil (e.g. some lettuce)	☐	☐	☐	☐	☐	2
Food containing **sugar**	☐	☐	☐	☐	☐	3
Food containing **Salmonella** bacteria	☐	☐	☐	☐	☐	4
Food containing added **colourings**	☐	☐	☐	☐	☐	5
Food containing **Clostridium botulinum** (Botulism)	☐	☐	☐	☐	☐	6
Food that is **organically grown** (e.g. some apples)	☐	☐	☐	☐	☐	7
Food that has been **genetically altered** (e.g. Flavr Savr tomatoes)	☐	☐	☐	☐	☐	8
Food containing the prion that causes **B.S.E.** ('Mad Cow' Disease)	☐	☐	☐	☐	☐	9
Food containing **growth hormone residues**	☐	☐	☐	☐	☐	10
Food containing **pesticide residues**	☐	☐	☐	☐	☐	11

EASYTELL

4) **How easy is it** *for you* **to tell if a food you are about to eat:**

	You Can Never Tell	You Can Occasionally Tell	You Can Sometimes Tell	You Can Usually Tell	You Can Always Tell
Contains **saturated fats**	☐	☐	☐	☐	☐
Contains **nitrates** from the soil	☐	☐	☐	☐	☐
Contains **sugar**	☐	☐	☐	☐	☐
Contains **Salmonella** bacteria	☐	☐	☐	☐	☐
Contains added **colourings**	☐	☐	☐	☐	☐
Contains **Clostridium botulinum** (Botulism)	☐	☐	☐	☐	☐
Is **organically grown**	☐	☐	☐	☐	☐
Has been **genetically altered**	☐	☐	☐	☐	☐
Contains the prion that causes **B.S.E.** ('Mad Cow' Disease)	☐	☐	☐	☐	☐
Contains **growth hormone residues**	☐	☐	☐	☐	☐
Contains **pesticide residues**	☐	☐	☐	☐	☐

OTHRESP

5) **To what extent is it your responsibility, or the responsibility of the Government, to protect you from harm to your health from the following things?**

	Totally My Responsibility	Mainly My Responsibility	Partly My Responsibility	Mainly the Responsibility Of Government	Totally the Responsibility Of Government	
Food containing **saturated fats**	☐	☐	☐	☐	☐	1
Food containing **nitrates** from the soil (e.g. some lettuce)	☐	☐	☐	☐	☐	2
Food containing **sugar**	☐	☐	☐	☐	☐	3
Food containing **Salmonella** bacteria	☐	☐	☐	☐	☐	4
Food containing added **colourings**	☐	☐	☐	☐	☐	5
Food containing **Clostridium botulinum** (Botulism)	☐	☐	☐	☐	☐	6
Food that is **organically grown** (e.g. some apples)	☐	☐	☐	☐	☐	7
Food that has been **genetically altered** (e.g. Flavr Savr tomatoes)	☐	☐	☐	☐	☐	8
Food containing the prion that causes **B.S.E.** ('Mad Cow' Disease)	☐	☐	☐	☐	☐	9
Food containing **growth hormone residues**	☐	☐	☐	☐	☐	10
Food containing **pesticide residues**	☐	☐	☐	☐	☐	11

COMMON

6) **How common are the following things in Britain?**

	Extremely Rare	Quite Rare	Moderately Common	Quite Common	Extremely Common
Food containing **saturated fats**	☐	☐	☐	☐	☐
Food containing **nitrates** from the soil (e.g. some lettuce)	☐	☐	☐	☐	☐
Food containing **sugar**	☐	☐	☐	☐	☐
Food containing **Salmonella** bacteria	☐	☐	☐	☐	☐
Food containing added **colourings**	☐	☐	☐	☐	☐
Food containing **Clostridium botulinum** (Botulism)	☐	☐	☐	☐	☐
Food that is **organically grown** (e.g. some apples)	☐	☐	☐	☐	☐
Food that has been **genetically altered** (e.g. Flavr Savr tomatoes)	☐	☐	☐	☐	☐
Food containing the prion that causes **B.S.E.** ('Mad Cow' Disease)	☐	☐	☐	☐	☐
Food containing **growth hormone residues**	☐	☐	☐	☐	☐
Food containing **pesticide residues**	☐	☐	☐	☐	☐

BIGQTY

7) **Is the potential harm to your health from the following things dependent upon how much of them you eat or drink?**

	Harmful In Very Small Quantities	Harmful In Fairly Small Quantities	Harmful In Moderate Quantities	Only Harmful In Very Large Quantities	Not Harmful At All	
Food containing **saturated fats**	☐	☐	☐	☐	☐	1
Food containing **nitrates** from the soil (e.g. some lettuce)	☐	☐	☐	☐	☐	2
Food containing **sugar**	☐	☐	☐	☐	☐	3
Food containing **Salmonella** bacteria	☐	☐	☐	☐	☐	4
Food containing added **colourings**	☐	☐	☐	☐	☐	5
Food containing **Clostridium botulinum** (Botulism)	☐	☐	☐	☐	☐	6
Food that is **organically grown** (e.g. some apples)	☐	☐	☐	☐	☐	7
Food that has been **genetically altered** (e.g. Flavr Savr tomatoes)	☐	☐	☐	☐	☐	8
Food containing the prion that causes **B.S.E.** ('Mad Cow' Disease)	☐	☐	☐	☐	☐	9
Food containing **growth hormone residues**	☐	☐	☐	☐	☐	10
Food containing **pesticide residues**	☐	☐	☐	☐	☐	11

CONTROL

8) **How much control do people have over whether they eat or drink the following?**

	No Control	A Little Control	A Fair Amount of Control	A Lot of Control	Total Control
Food containing **saturated fats**	☐	☐	☐	☐	☐
Food containing **nitrates** from the soil (e.g. some lettuce)	☐	☐	☐	☐	☐
Food containing **sugar**	☐	☐	☐	☐	☐
Food containing **Salmonella** bacteria	☐	☐	☐	☐	☐
Food containin added **colourings**	☐	☐	☐	☐	☐
Food containing **Clostridium botulinum** (Botulism)	☐	☐	☐	☐	☐
Food that is **organically grown** (e.g. some apples)	☐	☐	☐	☐	☐
Food that has been **genetically altered** (e.g. Flavr Savr tomatoes)	☐	☐	☐	☐	☐
Food containing the prion that causes **B.S.E.** ('Mad Cow' Disease)	☐	☐	☐	☐	☐
Food containing **growth hormone residues**	☐	☐	☐	☐	☐
Food containing **pesticide residues**	☐	☐	☐	☐	☐

MAN BLAME

9) **To what extent are the risks to your health from the following things natural or the fault of mankind?**

	They Are Natural Risks	Man Is Rarely To Blame	Man Is Partly To Blame	Man Is Mainly To Blame	Man Is Entirely To Blame	
Food containing **saturated fats**	☐	☐	☐	☐	☐	1
Food containing **nitrates** from the soil (e.g. some lettuce)	☐	☐	☐	☐	☐	2
Food containing **sugar**	☐	☐	☐	☐	☐	3
Food containing **Salmonella** bacteria	☐	☐	☐	☐	☐	4
Food containing added **colourings**	☐	☐	☐	☐	☐	5
Food containing **Clostridium botulinum** (Botulism)	☐	☐	☐	☐	☐	6.
Food that is **organically grown** (e.g. some apples)	☐	☐	☐	☐	☐	7
Food that has been **genetically altered** (e.g. Flavr Savr tomatoes)	☐	☐	☐	☐	☐	8
Food containing the prion that causes **B.S.E.** ('Mad Cow' Disease)	☐	☐	☐	☐	☐	9
Food containing **growth hormone residues**	☐	☐	☐	☐	☐	10
Food containing **pesticide residues**	☐	☐	☐	☐	☐	11

SERIOUS

10) **How seriously do you think the following things may harm your health?**

	Not seriously At All	Not Very Seriously	Fairly Seriously	Very Seriously	Extremely Seriously
Food containing **saturated fats**	☐	☐	☐	☐	☐
Food containing **nitrates** from the soil (e.g. some lettuce)	☐	☐	☐	☐	☐
Food containing **sugar**	☐	☐	☐	☐	☐
Food containing **Salmonella** bacteria	☐	☐	☐	☐	☐
Food containing added **colourings**	☐	☐	☐	☐	☐
Food containing **Clostridium botulinum** (Botulism)	☐	☐	☐	☐	☐
Food that is **organically grown** (e.g. some apples)	☐	☐	☐	☐	☐
Food that has been **genetically altered** (e.g. Flavr Savr tomatoes)	☐	☐	☐	☐	☐
Food containing the prion that causes **B.S.E.** ('Mad Cow' Disease)	☐	☐	☐	☐	☐
Food containing **growth hormone residues**	☐	☐	☐	☐	☐
Food containing **pesticide residues**	☐	☐	☐	☐	☐

Personal Details

The following questions are intended to help us find out what backgrounds people come from. We need to ask these questions so that we can find out whather different groups of people hold different views about food and food-related risks.

1) **Are you male or female?** *(please tick one box)* Male ☐ Female ☐ SEX

2) **What is your age?** ____________ years AGE

3) **What is your marital status?** *(please tick as many as are right for you)*

Single ☐ Married ☐ Divorced ☐ (Asis)

Widowed ☐ Separated ☐

4) How many adults, including yourself, normally live in your home? ________ NADULTS

How many adults, including yourself, are over the age of 65? ________ ADULTS65

How many children normally live with you? ________ CHILDREN

If you live with children, how many are under the age of 5? ________ CHILDUS

5) **On average, how much does your household spend on food each week for all the people who live in your home?** FOODEXP

£________ per week

6) **What is your ethnic origin?** *(please tick as many as are right for you)*

CAUCASN Caucasian (white) ☐ AFROCARI Afro-Caribbean ☐ ASIAN Asian ☐

ORIENT Far-Eastern Asian/Oriental ☐ MIDEAST Middle Eastern ☐

Other *(please specify)* ______ OTHETHN ______

7) What is the highest academic qualification you have obtained? HIGHACAD

What is the highest professional or vocational qualification you have obtained? HIGHPVQ

What is the highest qualification (academic or professional) that you have obtained in a science or health-related topic? HIGHHLTH

8) **Do you like to watch any of the following types of TV and Radio programmes regularly?**

		YES	NO
CONSUM	Consumer Affairs programmes (e.g. Watchdog)	☐	☐
SCIDOCS	Science documentaries (e.g. Horizon, Science Today)	☐	☐
FARMINE	Farming programmes (e.g. Farming Today)	☐	☐
ARDENIN	Gardening programmes (e.g. Gardener's World)	☐	☐
FOOD COOK	Food/Cooking programmes (e.g. Food and Drink)	☐	☐
NEWSPROG	News Programmes (e.g. BBC 9 o'clock news)	☐	☐

9) **Do you, or any of your close family or friends, work in any of the following?**

		YES	NO
HOTEL	The hotel and/or catering industry	☐	☐
FARMHORT	The farming or horticultural industry	☐	☐
FOODPROC	Food maufacturing/processing industry	☐	☐
MEDICAL	Medical or health-related professions	☐	☐

10) **Please answer the following questions by placing a tick in the appropriate box.**

		YES	NO
VEGETARI	I am a vegetarian	☐	☐
VEGAN	I am a vegan	☐	☐
MEDCOND	I have a medical condition that prevents me from eating certain foods	☐	☐
ONDIET	I am on a diet to lose weight	☐	☐
SPECDIET	I am on a special diet for some other reason	☐	☐

If yes, please say what ______________________________

COMMENT

THANK YOU VERY MUCH FOR YOUR HELP

If there is anything else you would like to tell us about food or food-related hazards please write these on the front cover or on a separate sheet of paper. We shall be most interested in what you have to say.

QTYPE

Survey : 14

Page : 14

Confidential

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