BELIEFS SYSTEMS AND PERCEPTIONS OF RISK OF GENETICALLY MODIFIED FOOD

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1. Introduction

Issues surrounding the application of genetic engineering to food production have often occupied the front pages of newspapers. Should this technology be used in food production? Is it safe to eat such food? Consumer associations argue that consumers should have a choice in whether or not to buy genetically modified produce. Governments and industry need to decide on whether to continue investing in this area. The public increasingly has to make choices in their everyday life.

For the student of social representations this is a prime area of interest as it involves the interplay between scientific and common sense knowledge (Moscovici 1961/76). Genetic modification is a new technology that involves scientific knowledge. Moscovici (1988: 216) asks: "How can people understand things about which they neither have first hand knowledge nor experience?" Social Representations fulfil this function by articulating common sense and scientific knowledge to produce everyday understandings (Flick, 1998). Scientific discourse in the public arena circulates through communication and processes of social influence, where information is created and constructed as well as processed (Moscovici, 1988). Genetic modification can be considered as a new object that becomes familiar through its anchoring in different belief systems. It can be speculated that these belief systems are part of wider social representations that shape the relationship between Humans and Nature, or between Technology and Nature (also see the work done by Deconchy, 1999). Thus, scientific communication about genetic engineering does not take place in a vacuum.

Nevertheless, communication about genetic engineering goes beyond the distinction between scientific and common sense knowledge. Firstly there is a great deal of controversy within the scientific community concerning the risks and benefits of biotechnology. Secondly, the issue whether genetic engineering should be used or not is not a decision to be taken by the scientific community alone but a decision to be made at a societal level. Moscovici and Doise (1990) argue that people's beliefs systems and collective decisions are informed and orientated by tradition, science and consensus. Tradition represents the heritage of the past and produces norms to be followed. Science reflects the correspondence between its hypotheses and observations. Finally, consensus is the result of debates and represents the common perspective. In the past decisions were limited by how far science could go to produce solutions, today, in the case of genetic engineering, science has vastly extended the boundaries of what was considered possible. The question thus arises as to the extent to which these innovations are acceptable.

An idea of how the public is likely to view these innovations is to be found in the descriptions of genetic engineering in the media. In media discourse it is not unusual that, along with claims about the risk to human health, genetic modification is referred as "playing God" or "Tampering with Nature" (The Daily Telegraph, 1998). Science is expected to inform people about the risk to humans from the use of the technology. However, the moral aspect of this decision depends on beliefs about the relationship between humans, nature and technology**.** Different applications of biotechnology have been found to yield different attitudes, levels of support and objections (Zechendorf, 1994; Frewer & Shepherd, 1995; Grove-White et al, 1997). For example, analysing public perceptions of biotechnology in 1996 using the Eurobarometer survey, Gaskell et al (1998) observe that although morality rather than risk appears to be driving general public perceptions of biotechnology, in the case of food, risk perception still seems to shape attitudes and acceptance. Thus it is important to specify the particular application of biotechnology considered each time.

For example, reluctance to accept genetically modified food may stem from a perception of there being concrete health risks for human beings. Alternatively, it may be grounded within perceptions of more abstract risks for human species, such as modifying human DNA in the long term.

It appears that the issue of genetic engineering is multifaceted and involves a complex interaction of scientific and social issues informing decision-making. Societal acceptance of genetic engineering has to be investigated within wider beliefs about the relationship between humans and nature as well as in relation to perceptions of risk for the community. Furthermore, the investigation needs to focus in particular aspects of genetic engineering each time in order to be able to clarify the process of risk perception and acceptance of this technology.

In this process, scientific communication plays an active role in feeding the decision-making. The scientific community is expected to evaluate the risks associated with this technology and thus enable the decision-making processes concerning the continuation of the use of this technology. However, there is unease within the scientific community as research is still underway and scientific consensus has not been achieved as yet (Horning Priest, 1999). Furthermore, scientific messages about food safety were recently undermined in the UK after the BSE crisis.

Therefore, it is hypothesised here that the level of consensus (minority/majority) among scientists, in interaction with the type of risk (concrete/abstract) they advocate, will have an impact on public risk perception. In particular, it is hypothesised that when the message concerns a concrete risk such as a health risk, regardless of the level of consensus among the scientists, its impact on public perceptions of risk will be the same. This is because this type of risk is familiar, with imaginable consequences and therefore, whether few or many scientists warn about it (the consensus of the source) should not make any difference in public perceptions of risk. However, when the risk advocated is abstract, such as a possible modification of human DNA, with unclear consequences, a high consensus among the source will be more convincing and thus would yield higher levels of risk perception than when the same message is presented only by a few scientists.

Furthermore, according to Social Representations Theory, the way scientific knowledge will influence perceptions depends upon how new information is anchored in pre-existing frameworks of knowledge and beliefs. Following Doise's (1992) suggestion concerning psychological anchoring (when new information is anchored on pre-exiting beliefs), it can be hypothesised that risk about genetic modification in food production will be influenced by people's beliefs before exposure to any new scientific message. Thus, any impact of scientific information on risk perception will be over and above people's existing beliefs and worries about genetic technology. Therefore, it is important to investigate the impact of the content of scientific messages in relation to pre-existing beliefs about this particular technology.

The present study aims to investigate public perceptions of risk from genetic modification after scientific communication has taken place on this issue. To fulfil the requirement of specificity in the investigation, the present study will be focused on genetic modification in food production. Two issues will be investigated:

- the impact of people's pre-existing beliefs about bio-technology on perceptions of risk from consumption of genetically modified food;
- the interaction between the content of the scientific message claiming either concrete risks (health) or abstract risks (modification of the human DNA) and the consensus (majority versus minority of scientists) of the scientific community claiming this message.

As argued earlier the following hypothesis is formulated.

People's previous beliefs on biotechnology will influence risk perceptions regarding GM food. The impact on any scientific message will depend on the level of consensus of the scientific source (majority/minority) in interaction with the type of risk claims made (concrete/abstract).

In particular, the level of consensus of the source is expected to have a differential impact on risk perception when it concerns an abstract type of risk (more risk is expected when the claim comes from a majority of experts than from a minority). However, the level of consensus among scientists is not expected to affect the risk perception when it comes to a concrete risk.

2. Method

2.1. Participants

First year Psychology undergraduates from the School of Human Sciences at Surrey University took part in the study (n=84). Participants were mainly women (90.5%) and their age ranged from 17 to 52 years (median 23).

2.2. Procedure

Participants were told that they were taking part in a study on attitudes to food. They were assured that all their responses were anonymous and confidential. They were given by the researcher a short booklet to complete during lecture time. After completion the participants were debriefed and thanked for their time and efforts.

2.3. Questionnaire

The questionnaire had five sections.

Section 1: attitudes and beliefs towards Genetic Modification in food production.

The participants first read a short statement defining genetically modified food. They were asked whether they would buy GM food in the supermarket and whether they had taken any actions in relation to GM food. Following this, the respondents were asked to indicate on a 7 point Likert-type scale (1=not at all; 7=extremely) their thoughts and feelings about GM food in general, on various dimensions (16 items) previously identified by Frewer et al (1997) to be associated with genetic engineering of food.

Section 2: Introduction of the independent variables.

The independent variables were introduced in the form of a text, supposedly from expert scientists that warned about the long-term effects of eating GM food. In order to manipulate the type of risk associated with genetic modification, in one condition it was claimed that the consumption of GM food would result in an outburst of serious diseases (concrete risk) that would be fatal to those consuming such food. In another condition, it was said that consumption of GM food would modify human DNA (abstract risk) causing genetic changes that would be transmitted from generation to generation. Further, in order to manipulate the level of consensus of the source, the messages were attributed to either a majority (79%) or a minority (21%) of expert scientists. Thus, there were four different versions of messages to which participants were randomly allocated.

The message read as follows (the modifications according to the experimental conditions are in parenthesis):

> 79% (or 21%) of expert scientists issued warnings that consumption of GM food would have long term effects on humans because it would provoke an outburst of serious diseases which would be fatal to individuals consuming such food; (or because it would modify their DNA causing genetic changes which would be passed on to their children, grand-children and future generations).

Section 3: Perceptions of the credibility of the source and the message provided.

Following the text, there were six items relating to the message itself and five relating to the message source. Participants indicated, on a seven-point Likert scale, the extent to what they thought that the message just given was accurate, factual, distorted, truthful, trustworthy and biased. Further, participants were asked whether the source was knowledgeable, expert, accountable, concerned and whether they were in favour of using this source for information in the future.

Section 4: Measuring perceptions of risk from GM food.

The participants were then asked how much risk GM food presented to different targets: to themselves, to future generations in general, to the ecosystem, to animals and to the average person. They were also asked how risky they perceived the technology to be. These measures constitute the dependent variables.

Section 5: Demographic Information.

The final part of the questionnaire consisted of a section on biographic details such as age, gender and year of study.

2.4. Design

The study followed a 2 (types of risk) x 2 (levels of consensus) design with both factors entered as between subjects factors.

3. Results

3.1. Perceptions of GM food measured before the introduction of the message and perceptions of credibility of message and the source

All items measuring attitudes towards GM food prior to the introduction of the message were subjected to one-way analysis of variance with the experimental conditions as a between subject factor, in order to make sure that the four experimental groups did not differ significantly in their initial perceptions of risk. Indeed, none of these analyses revealed significant differences in the participants' attitudes prior to the introduction of the message. Of particular interest was the response of the participants to the item “how risky is GM food”. The one-way analysis of variance did not reveal any significant difference among the experimental groups ($M_{dna79\%}$=2.35 SD=1.46; $M_{dna21\%}$=2.66 SD=1.32; $M_{dis79\%}$=2.90 SD=1.31; $M_{dis21\%}$=2.48 SD=1.63; F(3,80)=1.25 ns). Thus, we can be confident that the random allocation of the participants into the four groups was effective as far as their attitudes and beliefs were concerned.

Furthermore, it was important to make sure that the message and the source were perceived to be equally credible and reliable by the participants in the different conditions. All items relating to the source and message quality were subjected to one-way analysis of variance with the experimental conditions as a between subject variable. None of these analyses revealed significant differences between perceptions of either the message itself or the source. Thus, it can be assumed that in all conditions the message and the source were perceived as equally credible and reliable.

3. 2. Perception of risk from GM food after the introduction of the message: The effect of people’s beliefs

One of the main arguments of the study is that risk communication does not happen in a social vacuum, and that a new message is anchored to the set of beliefs and representations already held about the “object” of risk. Thus, the first step of the analysis was to look at the part of the variance in participants’ risk perception after they read the message that could be explained by the beliefs people had before reading the text. A multiple regression analysis of participants’ initial beliefs was performed on their perception of risk to humans after reading the message.

As the messages presented here related to risks to humans, only the items measuring risk to humans were considered as the outcome variable. These items were perceptions of risk to oneself, to the average person, to future generations. These items were combined into a single factor (Crombach’s alpha=.92) named thereafter *Human Risk*, which was used as the dependent measure on the analysis.

Further, the messages presented concerned risks associated specifically either with human health (outburst of diseases) or with alterations to the human species (altering human DNA). Therefore, the two items measuring attitudes on related issues prior to the introduction of the message (*GM food has negative consequences for human health, GM food is tampering with nature*) were entered in the analysis as predictors. Other predictors were participants' perceptions of *overall risk* evaluated again before the introduction of the message and items on how much the participants *worried* about and how much they *objected* to GM technology in food production. Table 1 reports the effects of participant's beliefs on their perceptions of risk to humans.

Table 1 - Multiple regression analysis of participants' beliefs on perceptions of risk for humans

Adj. R^2=.506 F(5-77)=17.90 p<.001	Std Beta weights	t	p level
Personally Worried	-.276	-2.661	.009
Personally Object	.136	.958	ns
Negative consequences for human health	-.570	-4.279	.000
Risky	-.228	-2.076	.041
Tampering with nature	.094	.959	ns

The analysis revealed that 50% of the variance in perceptions of risk to humans could be accounted by the previous beliefs of the participants. This result supports the argument that a message on risk communication is not received in a vacuum. Further, only three predictors had significant relationships with perceptions of risk to humans. The more participants believe that GM technology in food production *has negative effects for human health* the more risk they perceive. Furthermore *general perceptions of risk* correlate positively with perceptions of risks to humans. Finally the more people *worry* in general about the use of this technology in food production the more risk they perceive from GM food consumption by humans. It is important to notice that risk perception is not related to general levels of objection to the use of the technology in food production or to beliefs that GM technology is tampering with nature.

3.3. Perception of risk from GM food after the introduction of the message: the effect of the Message

The messages given were differentiated at two levels: the type of risk advocated (outburst of diseases or alteration of the DNA) and the level of consensus within the scientific community (Majority or minority of experts). It was predicted that the level of risk perceived will depend on an interaction between the type of risk advocated and the level of consensus within the source. More specifically, it was hypothesised that the level of consensus of the source will not influence the perception of risk when a "concrete" type of risk (outburst of diseases) was presented. However, an "abstract" type of risk (Alteration of the DNA) was predicted to provoke a greater perception of risk when presented by a highly consensual source (majority of experts) than a low consensual one (minority of experts).

To test this hypothesis a 2 (levels of consensus) x 2 (types of risk) univariate analysis of variance was performed with both factors entered as between subject variables.

Having hypothesised that the impact of the scientific message on risk perception will be over and above initial beliefs about GM food, it was important to establish its effect after partialing out the effects of the prior beliefs. Thus, the unstandardized residuals of the multiple regression were saved and used as the dependent variable for the analysis of variance.

Table 2 - Univariate Analysis of Variance (N, Means, Standard Deviations)

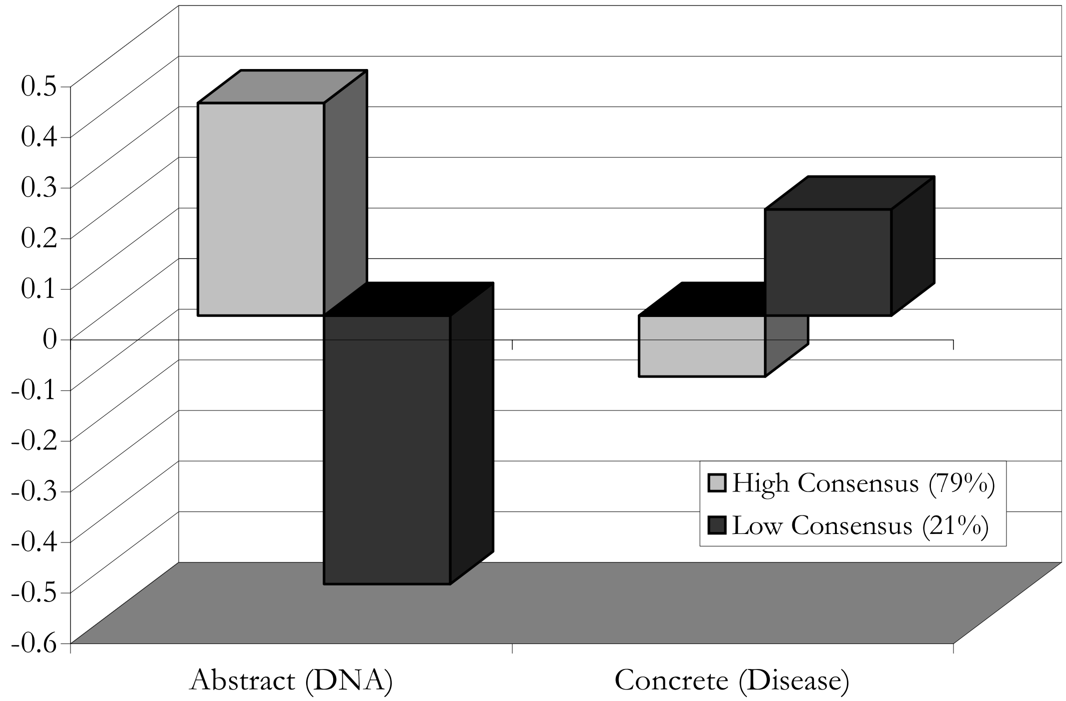
	DNA 79%	Disease 79%	DNA 21%	Disease 21%
Means	.42	-.12	-.53	.21
SD	.65	.82	.96	.98
N	21	22	20	20

As expected, none of the independent factors yielded significant main effects (Levels of Consensus $F(1\text{-}79)=2.66$ ns; Type of Risk $F(1\text{-}79)=.273$ ns). However, the interaction between "levels of consensus" and "types of risks" was highly significant ($F(1\text{-}79)=11.59$ $p=.001$ $\eta^2=.128$).

These results suggest that there is a significant difference on the levels of risk perceived from GM food according to the type of risk made salient in the message in interaction with the level of consensus among the experts (source) advocating the risk. These differences are significant after taking into account people's prior beliefs about the negative consequences of GM food for human health, their overall perceptions of risk concerning the use of this technology in food production and how much people generally worry about GM food.

Contrast t-test confirmed the direction of the hypothesised differences (see figure 1). A consensual source (majority of experts) yielded higher levels of risk than a less consensual source (minority of experts) in the case of an "abstract" (DNA) risk $t(79)=3.09$ $p<.01$ whereas in the case of a "concrete" (Disease) risk, the difference between levels of consensus was not significant $t(79)=-1.19$ ns (see table 2 for mean scores and standard deviations).

Figure 1 - Perceptions of Risk to humans as a function of the type of risk and the level of consensus among the source (means of unstandardized residuals)



Unexpectedly, it was found that it is the low consensus source (minority of experts) that produces higher levels of risk when it advocates a concrete message than an abstract one $t(79) = -2.44$ $p<.05$. Initially it was thought that when a message comes from a source with low consensus the type of risk advocated would not differently influence perceptions of risk. Regardless the type of message given, a low consensus source would be perceived as a minority and thus would yield, the same level of risk perception for both messages. This was not found to be the case in this data. Low consensus source provokes a higher level of risk perception in the case of a concrete message (disease) than in the case of an abstract one (DNA). Only tentative explanations can be given about this result and these will be discussed in the following section.

4. Discussion

This study aimed to put forward two major points. The first point argues that when people are faced with new scientific and technological advancements, the levels of risk they perceive depend on their general beliefs and representations about this technology. Therefore, scientific communication about specific new technologies does not take place in a vacuum. The second point developed here is the impact of scientific communication on people's risk perception over and above the pre-existing beliefs depends on the type of message it advocates in interaction with the source's level of consensus. Both points found support in this research.

Participants' beliefs and attitudes about genetic modification in food production were measured prior to the introduction of a message concerning long-term risks to humans. The message was attributed either to a majority (high consensus) or a minority (low consensus) of expert scientists and warned about health (concrete) or alteration of human DNA (abstract) risks.

The analysis of participants' perceptions of risk after reading the messages confirmed that their prior beliefs about biotechnology played a crucial role in their perceptions of risk. Indeed, about half of the variance in risk perception could be explained by people's prior beliefs. Further, participants' levels of risk perception differed according to the type of risk advocated and the level of consensus among the experts. In particular, people who read the message concerning abstract risks allegedly issued from a majority of scientists perceived more risk to humans than did those who read the same message but this time attributed to a minority of scientists.

Moreover, the level of source consensus did not have a differential effect on risk perception when the message concerned a concrete risk. As hypothesised, it seems that for risks that people can easily envisage and about which they worry, whether few or many scientists agree did not make a difference to the degree of risk perceived. However, when the risk is abstract and its consequences less concrete the degree of consensus among the scientists affects risk perception.

An unexpected result was that people seem to perceive higher levels of risk following a concrete risk message attributed to a minority of scientists than when the same source advocated an abstract risk. One can only speculate about this finding. It can be argued that, a message presented by a low consensus source is more likely to have a higher impact when it concerns a concrete risk, the nature of which is familiar (i.e. health related), than when it concerns an abstract risk of unclear nature. When an unfamiliar abstract risk is evoked the source issuing the warning is dismissed when it is a minority. Further research should confirm the strength of these results and clarify this last point.

Nevertheless, in light of these results it can be argued firstly that scientific discourse concerning a new technology is anchored within people's already constructed perceptions. Secondly, it can be argued that scientific discourse when circulating in the public arena, has a different impact depending on the type of message advocated and on the perceived level of consensus among the source. Acknowledging the importance of the representational framework in which the message makes sense and taking into account the interaction between the type of message and how consensual these messages are thought to be among the source, are important steps needed for understanding the impact of scientific communication.

In this study participants perceived high levels of risk of genetically modified food, held negative attitudes, worried about it, and objected to it. Thus, the messages advocating risks fed participant's beliefs because they were at the same direction. Further research should look at the arguments made here in a context where scientific communication goes against people's beliefs (i.e. advocating benefits) or with people who have more positive initial attitudes to genetically modified food. Moreover, this study would not allow us to answer the question as to why people object to genetic modification in food production. This part of the representation can be better studied through qualitative work.

To conclude, genetic engineering is a new technological advancement about which decisions have to be made. Further, as a representational object, genetic engineering is at the interface between scientific and common sense knowledge. Scientific communication provides information that can be used to enable decision-making. Social representational processes (i.e. anchoring) shape this decision-making process at a societal level in conjunction with communication and social influence processes. Studying risk perception of genetic engineering within this theoretical framework has important implications for the social debates around these issues. Further, such research can enrich the theory of social representations as it integrates within the study aspects of communication and social influence processes.

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