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Psychosocial and cultural factors affecting the perceived risk of genetically modified food: an overview of the literature

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Abstract

The rapid globalization of the world economy has increased the need for an astute understanding of cultural differences in perceptions, values, and ways of thinking about new food technologies. In this paper, we describe how socio-psychological and cultural factors may affect public perceptions of the risk of genetically modified (GM) food. We present psychological, sociological, and anthropological research on risk perception as a framework for understanding cross-national differences in reactions to GM food. Differences in the cultural values and circumstances of people in the US, European countries, and the developing world are examined. The implications of cultural theory for risk communication and decision making about GM food are discussed and directions for future research highlighted.

Keywords: Genetically modified food; Risk perception; Psychosocial and cultural factors; Genetic engineering

Introduction

As global trade increases and international governance policies are developed, an astute understanding of cross-cultural differences in risk perceptions is important. Different cultural groups may address the risks and benefits of new technologies such as genetic engineering (GE) in disparate ways and these cross-cultural differences[1] can create conflict when these groups try to reconcile the complex array of health, environmental, and social benefits and risks faced in the international exchange of genetically modified (GM) foods. As Hofstede (1984) stresses: "The survival of mankind will depend to a large extent on the ability of people who think differently to act together. International collaboration presupposes some understanding of where others' thinking differs from ours." The purpose of this paper is to provide an overview of the socio-psychological and cultural factors that play an important role in public perceptions of the risk of GM food. We examine

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[1]Cross-cultural comparisons typically presume that different cultural contexts influence individuals' cognitions and behaviors. Commonly, "cultural differences" are viewed as attitudinal or behavioral divergences associated with differences in stable social structures, processes, and/or values. That is, cultural differences relate to individual and collective behavior shaped by a set of common characteristics, including geography, climate, history, economics, politics, and psychology (Tse, Lee, Vertinsky, & Wehrung, 1988; Weber & Hsee, 1999). Cultural differences often follow national boundaries, although, this is not always the case, as exemplified by scientists and lay people often acting as different cultural groups. While nations often proxy for cultures, this belies the complex mix of intra-national cultures that contribute to policy development.

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cross-national differences in reactions to GE and discuss the implications of cultural theory for risk communication and decision making about GM food.

We present psychological, sociological, and anthropological research on risk perception as a framework for anticipating socio-cultural differences in cognition and behavior. This framework can help address knowledge gaps about other people's cultural values—especially values underlying perceptions of risk—and thereby help to improve the effectiveness of communication and decision making in the complex risk scenarios posed by GM foods. Providing such a framework is important because many people involved in policy development, decision making, and risk communication about GE come from backgrounds of biological science rather than social science.

Accurately understanding cultural differences facilitates economic and social development in a way that appropriately balances the costs and benefits of new technologies in the unique environmental and human health contexts of different countries. The goal in this paper is simply to describe and explicate cultural differences in risk perceptions and behaviors, rather than prescribing specific policy options for any particular regions or groups.

Understanding risk

Traditional definitions of risk have focused typically on the chance (probability) of injury, damage, or loss (Webster, 1983). Consequently, traditional solutions to conflicts over the risks of new technologies have involved frequent calls for better technical analysis and expert oversight via small, centralized groups. These groups are charged with creating uniformity and rationality—based on "sound science"—in highly technical areas of risk management. However, some agencies suggest that because science cannot provide definitive answers, "the policy of relying on claims of 'sound science' may itself be unsound" (ESRC Global Environmental Change Programme, 1999), particularly in cases where uncertainty remains.

Recently, social scientists have rejected the notion of "real" or "objective" risk, arguing instead that risk is inherently subjective (Krimsky & Golding, 1992; Slovic, 1992). That is, risk is a social construct, meaning different things to different people, and cannot be measured independent of our minds and cultures (Slovic & Gregory, 1999). What is appropriate or inappropriate, good or bad, or dangerous or not, is constantly being negotiated and redefined (Fleising, 1991). Of course, technical analysis is vital for informed and accountable risk decisions, but the social scientific perspective suggests that trying to address risk controversies purely with more science that fails to account for the context-dependent and culturally dependent nature of risk is likely to exacerbate conflict (Slovic & Gregory, 1999). Beck (1992) describes the situation well, referring to "fissures and gaps" between scientific and social rationality in dealing with hazards, where the two sides talk past each other: social movements raise questions that are not answered by the risk technicians, and the technicians provide answers that miss the point of what was asked and what is feeding public anxiety.

Several decades of psychometric research have shown that public conceptions of risk are complex and guided by the "personality" characteristics of hazards (Slovic, 1987). In essence, two main qualitative features seem to drive risk perceptions: unknown risk (known vs. unknown) and dread risk (not dreaded vs. dreaded). The unknown risk factor reflects the extent to which a hazard is unknown, unobservable, unfamiliar, and has delayed consequences. The dread risk factor reflects the extent to which a hazardous activity or technology is seen as dreaded, uncontrollable, fatal, not equitable, high risk to future generations, not easily reduced, involuntary, and potentially catastrophic. In the domain of food risks, this two-dimensional structure has been revealed through psychometric work (e.g., Fife-Schaw & Rowe, 1996) showing that public perceptions are related primarily to awareness and severity.

The importance of the unknown and dread risk characteristics in perception of food risks can explain, in part, public opposition to GM foods. First, GM foods present unknown risk because they are based on relatively new science (thus, scientists do not know enough to estimate the risks accurately); the inadvertent introduction of harmful changes in DNA structure is not immediately obvious (the effects are delayed); and consumers do not necessarily know when they are exposed because GE is not obvious to the casual observer and they are not well informed about which products contain GM ingredients (Marris, 2000). A good example is GM soy, the first transgenic product launched in the European market, which is present in many foods and thus difficult to avoid. GM soy is perceived by some to be a concealed ingredient whose use in processed food is often not understood by the public (Moses, 1999).

Evidence of Europeans' perception of their own lack of knowledge or understanding about GM products was apparent in the 1996 Eurobarometer, in which a large percentage answered "Don't Know" to questions about the applications of biotechnologies. Fifty-one percent said they had never talked with anyone about biotechnology before. Around 80% of respondents to the 1999 Eurobarometer said they were "insufficiently informed" about biotechnology (Gaskell et al., 2000). European respondents' perceptions that they were unknowledgeable occurred despite a significant increase in media coverage of biotechnology following key events in

Europe during 1996–1997, including the arrival of shipments of Monsanto GM soybeans in 1996 that resulted in massive protests in most of western and northern Europe (Bauer, Kohring, Allansdottir, & Gutteling, 2001; Grabner, Hampel, Lindsey, & Torgersen, 2001). After 1996, media representation of the consequences of biotechnology shifted toward a more "risk-oriented" discourse (vs. "benefit-oriented") (Bauer et al., 2001) and this may have contributed to public feelings of being inadequately informed. Frewer, Miles, and Marsh (2002) provide support for this explanation, suggesting that sudden changes in the volume and content of risk reporting about a particular hazard may produce attitude changes consistent with what is deemed "the social amplification of risk" (see Kasperson & Kasperson, 1996; Pidgeon, Kasperson, & Slovic, 2003).

Non-European surveys also point to unknown risk as an important element of perceptions of GM food. A Food Market Institute survey conducted in 1995–1996 found US consumers less aware of biotechnology than in 1992 (Hoban, 1997). Awareness of biotechnology is also relatively low among Japanese consumers, with 21% answering "no" to a question about "foods produced through biotechnology are in the grocery store now" and 39% saying they "did not know". Furthermore, compared with US consumers, Japanese consumers are less likely to have talked with anyone about biotechnology (Hoban, 1999).

Importantly, GM foods also have features of dread risk: food growers are the ones who decide whether to use GM seeds or other products; as a result, consumers do not necessarily have a choice (involuntary exposure). For example, focus groups in Austria showed fear that the spread of GM food across the supermarket shelves would occur without their consent (Torgersen et al., 2001). Many people are exposed to GM foods (signaling global catastrophic potential) and the risks and benefits are not fairly distributed (currently, the benefits go to farmers and GM food manufacturers rather than consumers). Furthermore, children are heavy consumers of some products from transgenic animals (e.g., milk), making parents especially sensitive to potential harm to future generations. Theoretical work by Beck (1992) underscores the importance of dread risk in concerns about the involuntary nature of new food technologies: For the consumer, the invisibility of GE in foodstuffs hardly leaves a decision open as they are "piggy-back products" acting as "stowaways of normal consumption" (p. 40).

A considerable body of qualitative sociological work on understandings of risk is also informative regarding factors influencing people's perceptions of food risks. For instance, using interviews, focus groups, and mass media analyses, Macintyre and colleagues (Macintyre, Reilly, Miller, & Eldridge, 1998) have described how individuals use different contexts and experiences to inform their decision making under conditions of uncertainty. They report that age, gender, income, personal experience, national and other aspects of identity are associated with decisions about diet and health. Women in the UK, for instance, were found to be more concerned about food safety than men, particularly if they were pregnant or had young children. Similarly, research in other parts of Europe has found greater support for GE among males than females (Gaskell et al., 2000; Jelsoe, Lassen, Mortensen, & Kamara, 2001; Siegrist, 2000; Torgersen & Seifert, 1997). Macintyre et al. conclude that public understanding of, and reactions to, messages regarding food safety appear to be context dependent, being actively constructed through social interactions within the structure and culture of the news and entertainment media.

Focus group research in the UK has also uncovered consumers' use of "rules of thumb" where safety scales were based on geographical region. Foods of local origin were seen as safer than those of more distant origin, with home- or garden-produced food deemed safest and imported food deemed most risky (Draper & Green, 2002; Green, Draper, & Dowler, 2003.) (Similar preferences have been found in the Philippines, see Aerni, 1999). Clearly, while scientists may measure risk primarily as a function of probability, social scientific research has shown that public perceptions of food risks incorporate many other non-technical factors (Slovic, 1987).

Benefits, risks, trust, and decisions in different countries

The trans-Atlantic debate

Sharp policy conflicts and differences in public opinions about GE have occurred across the Atlantic, between the US and European countries. Initially, American consumers and farmers embraced GM foods and European countries had (in the early 1990s) relatively permissive policies regarding the development of GM products. The use of GE in agriculture was perceived at first as having several distinct benefits, including enhanced farming productivity, reduced pesticide use and run-off, tailored micronutrient enrichment of food, and reduced food costs. That perception changed dramatically, however, when a study published in the prestigious journal *Nature* suggested that GE may have harmful effects (Losey, Rayor, & Carter, 1999). In addition, European concerns were dramatically amplified by multiple food scandals (e.g., mad cow disease), which in turn contributed to a climate of widespread distrust of GM food.

The Food Market Institute survey in 1995 found that in the majority of European countries, one-third to one-half of respondents rated the risk of GE as a serious health hazard, in contrast to the same rating from only one-fifth of US respondents (Hoban, 1997). Similarly, surveys in 1995–1997 found that 30% of European respondents (but only 13% of US respondents) were opposed to GM foods (Gaskell, Bauer, Durant, & Allum, 1999). A study reported by Ezzell (1987) indicated that 67% of US respondents said that they would either approve or not care if a genetically engineered product were field-tested in their community. More recent surveys, however, show substantial opposition in both the US and Europe (Priest, 2000). One explanation for the increasing opposition in the US may be that American export markets diminished dramatically as European consumers started boycotting GM foods. The late 1990s also witnessed a similar drop in support in Canada, where the media became less positive; surveys conducted in 1997 and 2000 show an 11% drop (from 60% to 49%) among Canadians who would encourage using biotechnology for food and drinks (Einsiedel & Medlock, 2001).

To some extent, the trans-Atlantic debate seems to have been about economic, environmental, and health risks. For instance, the debate has included discussion of food safety, trade restrictions, labeling requirements, and patent protection. But a closer look suggests that the opposition in Europe to American GM exports is determined also by cultural values that reflect sensitivities to dread and unknown risk, personal experience, and socio-cultural context. Among European nations, levels of support for biotechnology vary, with Spain, the Netherlands, and Finland having high levels of support, and Austria, Denmark, Greece, and France heavily opposed, possibly reflecting distinct cultural values. These differences are explored thoroughly elsewhere (see Gaskell & Bauer, 2001), although some examples here are illustrative.

France, for example, is reasserting "culinary sovereignty" in response to the erosion of traditional food and eating habits due to the invasion of America's fast food culture (Klee, 1999). If one culture is feeling invaded by another, a sense of dread risk reflects the extent that the invasion is uncontrollable, involuntary, a threat to future generations, and inequitable (in that the risks are incurred by the invaded and the benefits are incurred by the invader). The preference for local foods may also relate to a preference for organic foods. Such preferences may be less about the risks of biotechnology than about the perceived quality of GM food. GM produce is seen as the opposite of regional products from organic agriculture which appear much more favorable (Grabner et al., 2001). Local organic produce is deemed "slow food" as opposed to "fast food," accompanied by a resistance to additives, hormones, and the idea of a globalized menu of fast food where the origins of ingredients are not well documented and may be interpreted as a sign of US domination (Wagner et al., 2001).

In Austria there are comparatively low levels of support for GE, with only 13% of Austrians surveyed in 1999 willing to buy GM fruits compared with 21% in all of Europe (Torgersen et al., 2001). However, their response patterns are somewhat unique in that they also exhibit comparably low levels of perceived risks and factual knowledge. These factors usually correlate inversely with support in most European countries, but not in Austria. Torgersen and Seifert (1997) suggest that low GE acceptance in Austria may be related to a conservative attitude to (reluctant optimism about) new technologies that may be explained by historical experiences.

Germany has exhibited high levels of resistance to transgenic food in studies using examples such as GM yogurt and beer (Bredahl, 1999). A number of theories have been proposed by Moses (1999) to explain Germany's high resistance, including: residue of a rejection of Nazi racial policy that rejects anything to do with genetics; a history of using a marketing strategy that has discussed food in terms of "100% security;" a tradition of strong anti-industry feeling toward chemical and pharmaceutical sectors which may now extend to biotechnology; a conservative attitude toward novelty that asks "I have perfectly good food already; why try anything remotely doubtful?" (p. 673).

In Spain—one of the nations said to have the highest levels of overall acceptance—there is a strong contrast between the population's general valuation of GE as a process and the population's attitudes toward applications related to food consumption. Spaniards may rank GM of plants high in terms of general benefit, but a clear majority say they would not consume fruit with flavor improved through GM (Lujan & Todt, 2000).

Differing views on the application of biotechnology to plants versus animals have been found among respondents in the UK (Frewer, Howard, & Shepherd, 1997), and among students in the UK and Taiwan, where GE for growth enhancement was judged more negatively than GE for the purpose of disease or pest resistance (Chen & Raffan, 1999). In Europe generally, views toward the application of biotechnology to produce transgenic animals are far less supportive than toward plant modification; among bioindustry association sources surveyed in 1997, none saw the possibility of any involvement of transgenic animals in food production (Moses, 1999).

Other groups have expressed significant concerns that the idea of GE is contrary to their belief systems. Several religious bodies are worried that transgenesis is inherently wrong, even blasphemous in the sense of "playing God," and will upset the natural order of things, unleashing unknown consequences (Bruce & Eldridge, 2000). For instance, GM foods are considered morally disgusting by people from the Scottish Anglican church: moving genes between species that could never breed normally is "not natural" and likened to "playing God" (Paarlberg, 2000; Shepherd, Manaras, & Sparks, 2000).

In short, the reasons underlying objections to GM foods may vary, but often can be traced to important socio-cultural beliefs, values, customs, and histories that orient and inform people making decisions in the face of uncertainty.

Developing countries

Intense debate and public opinion polling typically addressed the benefits and risks of GM organisms in the rich industrial world (Boutler, 1995; Brill, 1985; Zechendorf, 1994), because this is primarily where biotechnology has been developed and commercialized. More recently, however, some authors have argued for a broader debate because the greatest human and environmental impacts (good and bad) may occur in the developing world (Levidow, 1999).

For instance, Levidow (1999) has outlined how the use of GM foods and crops may present several distinct benefits to developing countries. For instance, remote rural areas with poor soil, water, topography, or labor endowments may benefit from GM crops because they depend less on the hard to get, hard to manage "packages" of purchased chemical inputs. In addition, the spread of herbicide-resistant and pest-resistant GM crops may reduce pesticide runoff into surface and groundwater and reduce the need for tillage. Natural rural ecosystems could also benefit from less population-linked expansion of land area devoted to low-productivity crop farming and livestock grazing. Benefits for human health might come from the availability of micronutrient rich crops (e.g., rice can be enhanced with vitamin A to counter eye damage among the poor) (Levidow, 1999).

In contrast, other authors (e.g., Paarlberg, 2000) argue that despite the potential benefits of GM foods and crops, there is also potential for environmental and health risks. For instance, developing countries without appropriate risk regulation frameworks may become testing grounds for novel and potentially risky substances. The rich natural biological endowments of many developing countries (especially in the Asia-Pacific region) leads to concerns about the potential of GM seeds to increase the genetic uniformity of crops and/or of native flora. Cultural diversity also may be threatened as current risk analysis procedures are inadequate for integrating the concerns of marginalized groups. In addition, the capacity for field testing under closely monitored conditions is potentially poorer in developing countries than in industrialized countries, increasing the potential for uncontrolled biohazards, such as herbicide-resistant "superweeds." Finally, poorer countries may be excluded from lucrative world markets for GM products due to technically unattainable or unaffordable labeling requirements (Paarlberg, 2000).

So a complex decision scenario remains. Industrialized countries may be able to afford a precautionary approach, but the greater levels of poverty and need in developing countries may make too much precaution inappropriate. Furthermore, the scientific/industry-friendly approach may be acceptable where there is the capacity to manage the tangible and non-tangible impacts of GE, but poorer technical and political capacities may make it more difficult for developing countries to pursue the benefits of GE safely and equitably (Tutangata, 1999). The debate highlights how the highly precautionary European policies and the industry-friendly US policies for GE may be inappropriate for the unique circumstances of developing countries. The formation of policy in developing nations needs to be guided by each nation's needs and values (Finucane, 2002). Importantly, very little work has explored the intangible cultural values unique to groups in the developing world that are likely to influence perceptions of GM food risks. Key values need to be identified and incorporated into policy debates and decision making in developing nations.

Trust

Numerous studies have cited lack of trust as a critical factor in the gap between expert and lay assessments of risk and research suggests a direct relationship between distrust in regulatory agencies and risk perceptions (Slovic, 1997). Indeed, the willingness to rely on the policies and decisions of agencies and their employees, or social trust, has been found to be important to environmental risk perception and to accepting emerging technologies and environmental management (Earle & Cvetkovich, 1995). For example, Grobe, Douthitt, and Zepeda (1999) found that greater trust in the US Food and Drug Administration was related to less concern about the adverse health effects from the use of recombinant bovine growth hormone. There are clear national differences in this regard, however, as shown by a 1998 survey of Japanese consumers, in which government endorsement of safety did not increase acceptance of GM soybeans (Hoban, 1999).

Research by Frewer, Howard, Hedderley, and Shepherd (1999) has shown that trust in information sources is an important determinant of the way people respond to information about GE. Similarly, Siegrist's structural equation modeling work among students (Siegrist, 1999) and in a random quota Swiss sample (2000) has confirmed that trust in institutions or persons doing genetic modification research or using modified products is the most important factor influencing perception of gene technology. Siegrist has shown that trust has an influence on perceived risk as well as benefit and therefore an indirect impact on the acceptance of biotechnology. Importantly, Frewer and colleagues (Frewer, Howard, Hedderley, & Shepherd, 1996) have found that information sources are associated with different characteristics that differentiate the extent to which they are trusted by the public. Expertise does not lead to trust unless accompanied by other characteristics, such as accountability. Sources with a moderate amount of accountability rather than complete freedom tend to be the most trusted.

The public's general skepticism of politicians, scientists, "experts," and the media has been found in both qualitative research in the UK (Macintyre et al., 1998) and surveys in the US (Zechendorf, 1994). In some European countries, government and official agencies are the least trusted of all information sources, even less so than industry sources (Moses, 1999). Focus group participants were routinely skeptical of statements of politicians and policy-makers on food safety in Great Britain (Draper & Green, 2002; Green et al., 2003). The cross-nation average responses in the Eurobarometer survey ranked consumer organizations as the most reliable source of information on biotechnology, followed by environmental protection organizations, schools/universities, public authorities, and industry (Barling et al., 1999). However, views can sometimes differ between supporters and opponents of biotechnology. Regarding environmental groups, for instance, more opponents (75%) than supporters (49%) think environmental organizations are "doing a good job for society on biotechnology." This difference does not hold for consumer groups, as both supporters and opponents generally agree that they are doing a good job for society (Gaskell et al., 2000).

Consumer organizations in the UK are generally trusted sources of information, seen as both knowledgeable and proactive in providing information, having a primary concern with public welfare (Frewer et al., 1999) and being less tied to commercial interests (Green et al., 2003). Qualitative research by Moses (1999) in Belgium, Germany, France, Italy, the Netherlands, Norway, Sweden, and the UK found that a primary objective of consumer organizations is to ensure that consumers are informed and have choice.

An important dimension of agency/public interaction is public trust in regulatory and industry officials (Tait, 1992). An example is the very different response of the public to GM products in the US and Europe. Discussions among scientists, regulators, farmers, and environmentalists led to US field tests in the mid-1980s, which produced shared data, and further experiments addressed concerns raised by the discussants (Beachy, 1999). In 1992, the US Food and Drug Administration issued a key ruling that brought foods containing GM ingredients to market quickly in the US, and without labels. US regulators did not see biotechnology as posing special risks and regulation was contained within existing laws addressing known physical risks of new products. Canada followed a similar path to the US in terms of how biotechnology was to be regulated and managed (Einsiedel & Medlock, 2001).

In contrast, Europe had no central regulator to green-light the technology and allay public fears and biotechnology was dealt with as a novel process requiring novel regulatory provisions (Gaskell et al., 1999). European field tests in the early 1990s failed to engage discussions between the public and governmental agencies. The European public were not convinced by the US system of regulation and approval (Beachy, 1999). Public trust in food safety processes was tainted by concerns such as mad-cow disease and dioxin contamination in animal feeds. In Great Britain, for instance, the government's attempt to play down the mad-cow disease crisis in the early 1990s led to plummeting trust and skyrocketing risk perceptions. Subsequently, the government was criticized for a paternalistic approach, a criticism that culminated in the establishment of the Food Standards Agency, which is separate from the government ministry responsible for agriculture. This represented a public policy shift that viewed consumers as subjects of policy in their own right, having separate interests from producers (Draper & Green, 2002).

Beyond Great Britain, the mad-cow disease scare also sensitized large sections of the European public to the lack of effective regulatory oversight in industrial farming practices (ESRC Global Environmental Change Programme, 1999; Gaskell et al., 1999; Green et al., 2003; Lujan & Todt, 2000; Moses, 1999), paving the way for more generalized fear of food safety. Following this and other scares, the European Union established a new scientific body charged with providing independent and objective advice on food safety issues associated with the food chain. The result was the European Food Safety Authority (EFSA), established on 28 January 2002. EFSA's primary objective is to "…contribute to a high level of consumer health protection in the area of food safety, through which consumer confidence can be restored and maintained…" (European Food Safety Authority, 2004).

Overall, biotechnology has represented a threat rather than an opportunity for the European public and the European Union has made explicit reference to the precautionary principle in dealing with the threat (Grabner et al., 2001). This principle implies that "preventive action may be taken in the absence of full scientific demonstration of the existence of a risk" (p. 29). The debate about GM foods has often pitted the US perspective that there must be a demonstration of a cause–effect relationship against the precautionary principle that acknowledges that action may be taken in the face of uncertainty.

Cultural theory

In the literature reviewed above, we have focused on various social and cultural factors influencing the perceived risk of GM foods. Our focus is consistent with the modern perspective of risk as a social construct, dependent on cultural context and constantly being redefined (Beck, 1992; Fleising, 1991; Slovic & Gregory, 1999). Understanding the socio-cultural construction of risk is important for improving risk communication and policy development about GM foods. To improve our understanding of risk construction, systematic examination into the socio-cultural basis of different risk perceptions is needed and we suggest that Douglas and Wildavsky's (1982) cultural theory is a useful starting point for structuring examinations of socio-cultural factors that orient and motivate individuals. Cultural theory has been highly influential in the debate on risk perception, providing a parsimonious account of the complexities underlying what people fear and why. To the extent that judgments of risk are influenced by such "non-technical" factors as cultural values and belief systems, attempts to communicate about risk will be improved by models that describe how people use socially embedded worldviews to navigate a complex, uncertain, and sometimes dangerous world (Slovic & Peters, 1998).

According to Douglas and Wildavsky (1982), perceived risk is influenced by a "way of life" derived from a combination of cultural bias (shared values and beliefs) and social (interpersonal) relations. Perceived risk is seen as a collective phenomenon in that every cultural group chooses to attend to some risks and ignore others to maintain their particular way of life. Cultural theory is based on Douglas' grid-group model of society that identifies several cosmological types, including: egalitarianism, which distrusts institutions and experts; hierarchy, which supports the establishment, promotes trust in expertise and detests social deviance; and individualism, which gives priority to individual achievement and stresses that people should have material reward for their work (see Douglas, 1982). Extending cultural theory, Dake (1991) identified associations between distinct cultural worldviews (beliefs about how the world and its social structure should be organized) and particular trends in risk perceptions. For instance, groups endorsing an egalitarian worldview (supporting broad distribution of power and wealth and detesting ranked role differentiation) tend to focus on threats to their social structure. In contrast, groups endorsing a hierarchical worldview (supporting superior/subordinate social relations and detesting civil disobedience) tend to focus on the opportunities offered by industrial and technological risks. Two large American surveys have shown that individuals who are more likely to endorse statements reflecting hierarchical views tend to perceive less risk from genetically engineered bacteria and crops (Finucane, Slovic, Mertz, Flynn, & Satterfield, 2000; Flynn, Slovic, & Mertz, 1994).

Individual differences in worldviews have important implications for which approach to safety standards will be supported. For example, a study by Sheehy and colleagues (Sheehy, Legault, & Ireland, 1996) suggested that hierarchists feel that the complexity of biotechnology and genetic information undermines their ability to make informed personal decisions. They would prefer mechanisms that draw on the experience of experts to make decisions, rather than rely on their own incomplete knowledge.

On the other hand, egalitarians have a strong desire to have information provided to them on which they can base their own personal choices in the marketplace. These people want to be able to make a risk assessment based on their individual beliefs and preferences. Part of public skepticism about dietary admonitions of experts may stem from the certainty with which experts' dietary views are expressed (Macintyre et al., 1998). In adapting to contexts of uncertainty, the public utilizes short-cuts or "rules of thumb" that allowed for the routinization of food choices and everyday life (Draper & Green, 2002), using sensory and aesthetic judgments or "common sense." For egalitarians then, such lay knowledge may even "trump" expert knowledge (Green et al., 2003), such that industry and government assertions that the key to public acceptance of biotechnology is a matter of education is false (Fleising, 1991; Urban & Hoban, 1997). For many consumers, the judgments they are willing to trust refer mostly to safety standards; for others this trust could be extended to include judgments about ethical considerations of product availability. In short, things like food choices are framed by cultural, social, and material circumstances (Draper & Green, 2002).

Although the examples above point to cultural theory's ability to explain perceived risk, not all research has concluded similarly. Sjöberg (1997) claims to have found little support for cultural theory in research conducted in Brazil and Sweden and concludes that cultural theory has often explained only a very minor share of variance in perceived risk ratings. However, reliance on variance to assess the strength of the relationship between cultural worldviews and risk perceptions is problematic because it is a misleading indicator of the importance of the relationship (D'Andrade & Dart, 1990; Ozer, 1985; Rosenthal, 1990; Slovic & Peters, 1998). Other critiques of cultural theory (e.g., Bellaby, 1990) question the theory's ability to account for life-course and group transitions and the context dependence of socio-cultural views and values. These critiques suggest a dynamic view of social values, which is consistent with the constructed nature of risk perception and human judgment processes described by other authors (Finucane & Satterfield (in press); Gregory & Slovic, 1997; Payne, Bettman, & Johnson, 1992; Slovic, 1995). Examining changes in worldviews over time and across contexts is an important area for future research. Alternative versions of cultural theory have been proposed (see Boholm, 1996; Thompson, Ellis, & Wildavsky, 1990) and the extent to which these versions account for diverse perceptions of GM food risks (and point to effective value-based communication strategies) is an empirical question.

Conclusions and future directions

The rapid globalization of the world economy has increased the need for a more comprehensive understanding of cultural differences in perceptions, values, and ways of thinking about new food technologies. Both qualitative and quantitative methods (from psychological, sociological, anthropological, and other disciplines) have pointed to several socio-cultural factors as important determinants of GM food risk perceptions. However, research is still needed to improve our understanding of the context-dependent and constructed nature of cultural values that affect the uptake of complex new technologies and their products.

Government or industry policy developers and decision makers should take advantage of diverse social science methods to better understand what is important to individuals from different cultures and why it is important to them. Although there has been much public opinion polling about GE in the US and European countries, surveys can be rather blunt instruments for exploring such complex issues (Davison, Barns, & Schibeci, 1997) and cultural values in the developing world have been largely ignored. A more sophisticated framework than currently exists is needed for understanding cross-cultural differences in ways of dealing with the complex array of technical and ethical issues raised by GE. International agreements should minimize national differences and bring predictability to international trade, but they should also still allow for legitimate national differences in concerns and priorities (Finucane, 2002).

Overall, a systematic assessment of reliable cross-cultural differences in perceptions, values, attitudes, and behaviors regarding GM food will help to fill in current knowledge gaps and to respond to conflicts encountered in international negotiations over GM foods. Decision making and communication about GM food risks will only be successful if it is based on a thorough understanding of the psychological and socio-cultural determinants of risk.

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References

Aerni, P. (1999). Public acceptance of transgenic rice and its potential impact on future rice markets in Southeast Asian countries. Unpublished Doctoral Dissertation, Swiss Federal Institute of Technology.

Barling, D., de Vriend, H., Cornelese, J., Ekstrand, B., Hecker, E., Howlett, J., Jensen, J. L., Lang, T., Mayer, S., Staer, K., & Top, R. (1999). The social aspects of food biotechnology: a European view. *Environmental Toxicology and Pharmacology*, *7*, 85–93.

Bauer, M. W., Kohring, M., Allansdottir, A., & Gutteling, J. (2001). The dramatisation of biotechnology in elite mass media. In Gaskell, G., & Bauer, M. W. (Eds.), *Biotechnology 1996–2000: the years of controversy* (pp. 35–52). London: Science Museum.

Beachy, R. N. (1999). Facing fear of biotechnology. *Science*, *285*, 335.

Beck, U. (1992). *Risk society: towards a new modernity*. London: Sage.

Bellaby, P. (1990). To risk or not to risk? Uses and limitations of Mary Douglas on risk-acceptability for understanding health and safety at work and road accidents. *Sociological Review*, *38*(3), 465–483.

Boholm, A. (1996). Risk perception and social anthropology: critique of cultural theory. *Ethnos*, *61*, 64–84.

Boutler, D. (1995). Plant biotechnology: facts and public perception. *Phytochemistry*, *40*(1), 1–9.

Bredahl, L. (1999). Consumers' cognitions with regard to genetically modified foods: results of a qualitative study in four countries. *Appetite*, *33*, 343–360.

Brill, W. (1985). Safety concerns and genetic engineering in agriculture. *Science*, *227*, 381–384.

Bruce, D. M., & Eldridge, J. (2000). The role of values in risk perception in the GM debate. In Cottam, M. P., Harvey, D. W., Pape, R. P., & Tait, J. (Eds.), *Foresight and precaution* (pp. 855–862). Rotterdam, The Netherlands: A. A. Balkema.

Chen, S., & Raffan, J. (1999). Biotechnology: student's knowledge and attitudes in the UK and Taiwan. *Journal of Biological Education*, *34*(1), 17–23.

Dake, K. (1991). Orienting dispositions in the perception of risk: an analysis of contemporary worldviews and cultural biases. *Journal of Cross-Cultural Psychology*, *22*, 61–82.

D'Andrade, R., & Dart, J. (1990). The interpretation of r versus r^2 or why percent of variance accounted for is a poor measure of size of effect. *Journal of Quantitative Anthropology*, *2*, 47–59.

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

Douglas, M. (Ed.). (1982). *Essays in the Sociology of Perception*. London: Routledge and Kegan Paul.

Douglas, M., & Wildavsky, A. (1982). *Risk and culture: an essay on the selection of technological and environmental dangers*. Berkeley: University of California Press.

Draper, A., & Green, J. (2002). Food safety and consumers: constructions of choice and risk. *Social Policy & Administration*, *36*(6), 610–625.

Earle, T. C., & Cvetkovich, G. T. (1995). *Social trust: toward a cosmopolitan society*. Westport, CT: Praeger.

Einsiedel, E., & Medlock, J. (2001). Canada on the gene trail. In Gaskell, G., & Bauer, M. W. (Eds.), *Biotechnology 1996–2000: the years of controversy* (pp. 145–156). London: Science Museum.

ESRC Global Environmental Change Programme (1999). *The politics of GM food: risk, science, and public trust*. Special Briefing No.5: University of Sussex.

European Food Safety Authority. (2004). Moving towards full strength. Retrieved 4/29/2004, from the World Wide Web: http://www.efsa.eu.int/about_efsa/catindex_en.html

Ezzell, C. (1987). US attitudes to biotechnology show qualified support. *Nature*, *327*, 453.

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

Finucane, M. L. (2002). Mad cows, mad corn and mad communities: the role of socio-cultural factors in the perceived risk of genetically-modified food. *Proceedings of the Nutrition Society*, *61*, 31–37.

Finucane, M. L., & Satterfield, T. (in press). Risk as narrative values: a theoretical framework for facilitating the biotechnology debate. *International Journal of Biotechnology*.

Finucane, M. L., Slovic, P., Mertz, C. K., Flynn, J., & Satterfield, T. A. (2000). Gender, race, and perceived risk: the "white male" effect. *Health, Risk, & Society*, *2*(2), 159–172.

Fleising, U. (1991). Public perceptions of biotechnology. In Moses, V., & Cape, R. E. (Eds.), *Biotechnology: the science and the business* (pp. 89–102). Harwood Academic: Chur, Switzerland.

Flynn, J., Slovic, P., & Mertz, C. K. (1994). Gender, race, and perception of environmental health risks. *Risk Analysis*, *14*(6), 1101–1108.

Frewer, L. J., Howard, C., Hedderley, D., & Shepherd, R. (1996). What determines trust in information about food-related risks? Underlying psychological constructs. *Risk Analysis*, *16*(4), 473–486.

Frewer, L. J., Howard, C., Hedderley, D., & Shepherd, R. (1999). Reactions to information about genetic engineering: impact of source characteristics, perceived personal relevance, and persuasiveness. *Public Understanding of Science*, *8*, 35–50.

Frewer, L. J., Howard, C., & Shepherd, R. (1997). Public concerns about general and specific applications of genetic engineering: risk, benefit and ethics. *Science, Technology, & Human Values*, *22*, 98–124.

Frewer, L. J., Miles, S., & Marsh, R. (2002). The media and genetically modified foods: evidence in support of social amplification of risk. *Risk Analysis*, *22*(4), 701–711.

Gaskell, G., Allum, N., Bauer, M. W., Durant, J., Allansdottir, A., Bonfadelli, H., Boy, D., de Cheveigne, S., Fjaestad, B., Gutteling, J., Hampel, J., Jelsoe, E., Jesuino, J., Kohring, M., Kronberger, N., Midden, C., Nielsen, T. H., Przestalski, A., Rusanen, T., Sakellaris, G., Torgersen, H., Twardowski, T., & Wagner, W. (2000). Biotechnology and the European public. *Nature Biotechnology*, *18*(9), 935–938.

Gaskell, G., & Bauer, M. W. (Eds.). (2001). *Biotechnology 1996–2000: the years of controversy*. London: Science Museum.

Gaskell, G., Bauer, M. W., Durant, J., & Allum, N. C. (1999). Worlds apart? *The reception of genetically modified foods in Europe and the U.S. science*, *285*, 384–387.

Grabner, P., Hampel, J., Lindsey, N., & Torgersen, H. (2001). Biopolitical diversity: the challenge of multilevel policy-making. In Gaskell, G., & Bauer, M. W. (Eds.), *Biotechnology 1996–2000: the years of controversy* (pp. 15–34). London: Science Museum.

Green, J., Draper, A., & Dowler, E. (2003). Short cuts to safety: risk and 'rules of thumb' in accounts of food choice. *Health, Risk, & Society*, *5*(1), 33–52.

Gregory, R., & Slovic, P. (1997). A constructive approach to environmental valuation. *Ecological Economics*, *21*, 175–181.

Grobe, D., Douthitt, R., & Zepeda, L. (1999). A model of consumers' risk perceptions toward recombinant bovine growth hormone (rbGH): the impact of risk characteristics. *Risk Analysis*, *19*(4), 661–673.

Hoban, T. (1997). Consumer acceptance of biotechnology: an international perspective. *Nature Biotechnology*, *15*, 232–234.

Hoban, T. (1999). Consumer acceptance of biotechnology in the United States and Japan. *Food Technology*, *53*(5), 50–53.

Hofstede, G. (1984). *Culture's consequences*. Newbury Park, CA: Sage.

Jelsoe, E., Lassen, J., Mortensen, A., & Kamara, M. (2001). Denmark: the revival of national controversy over biotechnology. In Gaskell, G., & Bauer, M. W. (Eds.), *Biotechnology 1996–2000: The years of controversy* (pp. 157–171). London: Science Museum.

Kasperson, R. E., & Kasperson, J. X. (1996). The social amplification and attenuation of risk. *The Annals of the American Academy of Political and Social Science*, *545*, 95–105.

Klee, K. (1999). Frankenstein foods? *Newsweek*, *134*, 33–35.

Krimsky, S., & Golding, D. (1992). *Social theories of risk*. Westport, CT: Praeger Publishing Company.

Levidow, L. (1999). Regulating Bt maize in the United States and Europe: a scientific-cultural comparison. *Environment*, *41*(10), 10–22.

Losey, J. E., Rayor, L. S., & Carter, M. E. (1999). Transgenic pollen harms monarch larvae. *Nature*, *399*.

Lujan, J. L., & Todt, O. (2000). Perceptions, attitudes and ethical valuations: the ambivalence of the public image of biotechnology in Spain. *Public Understanding of Science*, *9*, 383–392.

Macintyre, S., Reilly, J., Miller, D., & Eldridge, J. (1998). Food choices, food scares, and health: the role of the media. In Murcott, A. (Ed.), *The nation's diet: the social science of food choice* (pp. 228–249). London: Addison Wesley Longman.

Marris, C. (2000). *Swings and roundabouts: French public policy on agricultural GMOs 1996–1999 (2000–2002)*. Guyancourt, France: Politeia.

Moses, V. (1999). Biotechnology products and European consumers. *Biotechnology Advances*, *17*(8), 647–678.

Ozer, D. J. (1985). Correlation and the coefficient of determination. *Psychological Bulletin*, *97*, 307–315.

Paarlberg, R. (2000). Genetically modified crops in developing countries: promise or peril? *Environment*, *42*(1), 19–27.

Payne, J. W., Bettman, J. R., & Johnson, E. J. (1992). Behavioral decision research: a constructive processing perspective. *Annual Review of Psychology*, *43*, 87–131.

Pidgeon, N., Kasperson, R., & Slovic, P. (Eds.). (2003). *The Social Amplification of Risk*. Cambridge: Cambridge University Press.

Priest, S. H. (2000). US public opinion divided over biotechnology? *Nature Biotechnology*, *18*(9), 939–942.

Rosenthal, R. (1990). How are we doing in soft psychology? *American Psychologist*, *45*(6), 775–777.

Sheehy, H., Legault, M., & Ireland, D. (1996). *Consumers and biotechnology: a synopsis of survey and focus group research*. Ottawa, ON: Office of Consumer Affairs, Industry Canada.

Shepherd, R., Manaras, I., & Sparks, P. (2000). Moral and ethical concerns on genetic modification of foods. In Cottam, M. P., Harvey, D. W., Pape, R. P., & Tait, J. (Eds.), *Foresight and precaution* (pp. 849–854). Rotterdam, The Netherlands: A. A. Balkema.

Siegrist, M. (1999). A causal model explaining the perception and acceptance of gene technology. *Journal of Applied Social Psychology*, *29*(10), 2093–2106.

Siegrist, M. (2000). The influence of trust and perceptions of risks and benefits on the acceptance of gene technology. *Risk Analysis*, *20*(2), 195–203.

Sjöberg, L. (1997). Explaining risk perception: an empirical evaluation of cultural theory. *Risk Decision and Policy*, *2*(2), 113–130.

Slovic, P. (1987). Perception of risk. *Science*, *236*, 280–285.

Slovic, P. (1992). Perception of risk: reflections on the psychometric paradigm. In Krimsky, S., & Golding, D. (Eds.), *Social theories of risk* (pp. 117–152). New York: Praeger Publishing Company.

Slovic, P. (1995). The construction of preference. *American Psychologist*, *50*, 364–371.

Slovic, P. (1997). Trust, emotion, sex, politics, and science: surveying the risk-assessment battlefield. In Bazerman, M. H., Messick, D. M., Tenbrunsel, A. E., & Wade-Benzoni, K. A. (Eds.), *Environment, ethics, and behavior. The psychology of environmental valuation & degradation* (pp. 277–313). San Francisco: New Lexington Press.

Slovic, P., & Gregory, R. (1999). Risk analysis, decision analysis, and the social context for risk decision making. In Shanteau, J., Mellers, B. A., & Schum, D. A. (Eds.), *Decision science and technology: reflections on the contributions of Ward Edwards* (pp. 353–365). Boston: Kluwer Academic.

Slovic, P., & Peters, E. (1998). The importance of worldviews in risk perception. *Risk Decision and Policy*, *3*(2), 165–170.

Tait, J. (1992). Who's afraid of biotechnology? *New Scientist*, *134*(1827), 49.

Thompson, M. R., Ellis, R., & Wildavsky, A. (1990). *Cultural theory*. Boulder, CO: Westview.

Torgersen, H., Egger, C., Grabner, P., Kronberger, N., Seifert, F., Weger, P., & Wagner, W. (2001). Austria: narrowing the gap with Europe. In Gaskell, G., & Bauer, M. W. (Eds.), *Biotechnology 1996–2000: the years of controversy* (pp. 131–144). London: Science Museum.

Torgersen, H., & Seifert, F. (1997). Aversion preceding rejection: results of the eurobarometer survey 39.1 on biotechnology and genetic engineering in Austria. *Public Understanding of Science*, *6*, 131–142.

Tse, D. K., Lee, K., Vertinsky, I., & Wehrung, D. A. (1988). Does culture matter? A cross-cultural study of executives' choice, decisiveness and risk adjustment in international marketing. *Journal of Marketing*, *52*, 181–195.

Tutangata, T. (1999). *Genetic engineering: The right to say no, the right to say*. Islands Business, 42.

Urban, D., & Hoban, T. (1997). Cognitive determinants of risk perceptions associated with biotechnology. *Scientometrics*, *40*(2), 299–331.

Wagner, W., Kronberger, N., Gaskell, G., Allansdottir, A., Allum, N., de Cheveigne, S., Dahinden, U., Diego, C., Montali, L., Mortensen, A., Pfenning, U., Rusanen, T., & Seger, N. (2001). Nature in disorder: the troubled public of biotechnology. In Gaskell, G., & Bauer, M. W. (Eds.), *Biotechnology 1996–2000: the years of controversy* (pp. 80–95). London: Science Museum.

Weber, E. U., & Hsee, C. K. (1999). Models and mosaics: investigating cross-cultural differences in risk perception and risk preference. *Psychonomic Bulletin & Review*, *6*(4), 611–617.

Webster, N. (1983). *Webster's New Twentieth Century Dictionary*. New York: Simon & Schuster.

Zechendorf, B. (1994). What the public thinks about biotechnology. *Bio/Technology*, *12*, 870–875.