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Poorer European Countries are Less Concerned about Biotechnology than Richer Countries*

Michael Siegrist**

Introduction

It is widely agreed among genetic engineers and scientists that attitudes held by the public will strongly affect the future development of genetic engineering.[1] In democratic societies, the public will have an impact on new laws regulating biotechnology, influencing, for example, decisions on the labeling of genetically modified products. Ultimately, consumer behavior will determine which new products will be accepted and economically successful.

There is no agreement among experts on how to address concerns about biotechnology applications. Some experts argue that the public should be informed about the risks and benefits of genetically engineered food to enable them to make rational choices.[2] Other experts contend that biotechnology food is no different from traditional food and that distinguishing labels would be misleading.[3] It is important, therefore, to identify the factors that influence people's perceptions of the risks and their acceptance or rejection of this new technology. Without such knowledge, there is no way to bridge the gap between the public and the scientists or biotechnology companies.

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1 *See* Isaac Rabino, *How European and U.S. Genetic Engineering Scientists View the Impact of Public Attention on Their Field: A Comparison*, 19 Sci. Tech. Human Values 23 (1994).

2 *See* Lynn J. Frewer, Chaya Howard & Richard Shepherd, *Effective Communication About Genetic Engineering and Food*, 98 Brit. Food J. 48 (1996).

3 *See* Henry I. Miller, *A Rational Approach to Labeling Biotech-derived Foods*, 284 Sci. 1471 (1999).

Perception of Gene Technology

Perception and acceptance of gene technology vary according to its type of application.[4] Surveys in both the United States and Europe have shown stronger support for medical applications than for agricultural applications. In a study conducted by Siegrist and Bühlmann, participants rated the similarity of all possible pairs among fifteen scenarios involving different applications of gene technology drawn from agricultural, food-related, and medical applications. Multidimensional scaling showed that two dimensions were relevant to the perception of gene technological applications. The first dimension was related to the nature of the application (food related/medical applications). Participants assessed medical applications as more beneficial and more acceptable than food applications. The second dimension was related to the organisms involved (animals, plants/micro-organisms). Participants judged applications involving animals or plants to be riskier than applications involving micro-organisms. Despite the observed mean differences among applications, strong correlations for perceived benefits, perceived risks and acceptance among different applications were observed.[5]

People who trusted public authorities perceived gene technology more positively than those who showed a low level of trust.[6] Using a structural modeling approach, it has been shown that trust in the institution or researchers involved in using or regulating biotechnology was positively related to perceived benefits and inversely related to

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4 *See* Lynn J. Frewer, Chaya Howard & Richard Shepherd, *Public Concerns in the United Kingdom About General and Specific Applications of Genetic Engineering: Risk, Benefit, and Ethics*, 22 Sci. Tech. Human Values 98 (1997); George Gaskell et al., *Worlds Apart? The Reception of Genetically Modified Foods in Europe and the U.S.*, 285 Sci. 384 (1999); Thomas J. Hoban, *Consumer Acceptance of Biotechnology in the United States and Japan*, 53 Food Tech. 50 (1999); Michael Siegrist & Renate Bühlmann, *Die Wahrnehmung verschiedener gentechnischer Anwendungen: Ergebnisse einer MDS-Analyse*, 30 Zeitschrift für Sozialpsychologie 32 (1999); Bernhard Zechendorf, *What the Public Thinks About Biotechnology*, 12 Bio/Tech. 870 (1994).

5 *See* Michael Siegrist, *A Causal Model Explaining the Perception and Acceptance of Gene Technology*, 29 J. Applied Soc. Psych. 2093 (1999) [hereinafter *A Causal Model*]; Michael Siegrist, *The Influence of Trust and Perceptions of Risks and Benefits on the Acceptance of Gene Technology*, 20 Risk Analysis 195 (2000) [hereinafter *The Influence of Trust*].

6 *See* Biotechnology and the European Public Concerted Action Group, *Europe Ambivalent on Biotechnology*, 387 Nature 845 (1997) [hereinafter Concerted Action Group]; Paul Sparks, Richard Shepherd & Lynn J. Frewer, *Gene Technology, Food Production, and Public Opinion: A UK Study*, 11 Agric. Hum. Values 19 (1994).

perceived risks of the technology.[7] Furthermore, acceptance of gene technology was strongly influenced by its perceived benefits and perceived risks.[8] In other words, social trust had an indirect influence on acceptance of biotechnology.[9] Most people do not possess detailed knowledge of gene technology.[10] Due to this lack of knowledge, people do not directly assess benefits and risks associated with biotechnology. Instead, lay people will base their assessments on information provided by sources they trust.

Most of the past research has focused on individual differences in either perception of the technology[11] or on perception of different applications of the technology.[12] For example, surveys conducted in several European countries indicate that there are differences in the perception and the support of biotechnology across Europe.[13] It is still an open question, however, why people in some countries are concerned about gene technology while people in other countries are not.

Economics and Risk Perception

Some researchers have emphasized the influence of cultural variables in risk perception and acceptance.[14] According to this view, differences in risk perceptions can be explained by specific cultural biases. Empirical studies have shown low correlations between such cultural biases or worldviews and the risks that people were concerned

7 *See A Causal Model* & *The Influence of Trust*, *supra* note 5.

8 *See A Causal Model* & *The Influence of Trust*, *supra* note 5.

9 *See* Timothy C. Earle & George T. Cvetkovich, Social Trust: Toward a Cosmopolitan Society (1995).

10 *See* Biotechnology in the Public Sphere (John Durant et al. eds., 1998) [hereinafter Durant et al.].

11 *See* Michael Siegrist, *Belief in Gene Technology: The Influence of Environmental Attitudes and Gender*, 24 Pers. Ind. Diff. 861 (1998); *A Causal Model* & *The Influence of Trust*, *supra* note 5; Sparks et al. *supra* note 6; Paul Sparks, Richard Shepherd & Lynn J. Frewer, *Assessing and Structuring Attitudes Toward the Use of Gene Technology in Food Production: The Role of Perceived Ethical Obligation*, 16 Basic App. Soc. Psych. 267 (1995).

12 *See* Frewer et al., *supra* note 4; Siegrist & Bühlmann, *supra* note 4.

13 *See* Concerted Action Group, *supra* note 6; Durant et al., *supra* note 10; European Commission Eurobarometer Unit, *The Europeans and Modern Biotechnology*, Eurobarometer 46.1 (1997).

14 *See* Mary Douglas & Aaron Wildavsky, Risk and Culture: An Essay on the Selection of Technological and Environmental Dangers (1982); Aaron Wildavsky, *No Risk is the Highest Risk of All*, 67 Am. Scientist 32 (1979); Aaron Wildavsky & Karl Dake, *Theories of Risk Perception: Who Fears What and Why?*, 119 Daedalus 41 (1990).

about.[15] One possible explanation for differences in risk perception across countries is that countries may differ in respect to differences in prevalent cultural biases. Another view is that economic factors determine risk perception and acceptance.[16] One possible explanation for differing perceptions of gene technology may be variations in economic development. It has been suggested that acceptance of biotechnology may be higher in poorer than in richer European countries.[17] This hypothesis, however, has yet to be tested.

People in poorer countries may be more willing to accept technological risks because the relative gain associated with technological developments is higher there than for people in richer countries. There is a diminishing marginal utility of the benefits of new technologies. Therefore, people in richer countries may perceive less benefits in a technology than people in poorer countries.

Sokolowska and Tyszka recently addressed this hypothesis.[18] They predicted that, in comparison with Sweden, technologies in Poland would be viewed as more beneficial and less risky. Contrary to this hypothesis, however, respondents in Poland assessed the risks connected with the hazards as higher than respondents in Sweden. In both countries actual levels of risks associated with the hazards are different. Based on the data provided by Sokolowska and Tyszka, it is not possible to decide whether Poles overestimated or underestimated the risks associated with the hazards.[19] Personal benefits associated with different technologies were judged to be higher in Sweden than in Poland. However, participants in Poland showed less negative attitudes towards the technological hazards than participants in Sweden. This suggests, according to the authors, that acceptance of risky technologies is not solely determined by perceived risks and benefits.

15 *See* Jean Brenot, Sylviane Bonnefous & Claire Marris, *Testing the Cultural Theory of Risk in France*, 18 Risk Analysis 729 (1998); Claire Marris, Ian H. Langford & Timothy O'Riordan, *A Quantitative Test of the Cultural Theory of Risk Perceptions: Comparison with the Psychometric Paradigm*, 18 Risk Analysis 635 (1998); Lennart Sjöberg, *Factors in Risk Perception*, 20 Risk Analysis 1 (2000).

16 *See* Joanna Sokolowska & Tadeusz Tyszka, *Perception and Acceptance of Technological and Environmental Risks: Why are Poor Countries Less Concerned?*, 15 Risk Analysis 733 (1995).

17 *See* Durant et al., *supra* note 10.

18 *See* Sokolowska & Tyszka, *supra* note 16.

19 *Id.*

Rationale of the Present Study

Few studies have investigated the relationship between economic wealth and perception of hazards. The present study tested the hypothesis that acceptance of biotechnology in Europe is negatively related to the wealth of a country. The same relationship was expected for perceived benefits of gene technology. In addition, it was expected that people in richer countries perceive greater risks associated with gene technology than people in poorer countries. Finally, it was hypothesized that in richer countries the news media focus more on risks and less on benefits associated with biotechnology than in poorer countries. In other words, the new technology is portrayed in a more positive way in poorer countries than in richer countries.

Method

Data drawn from a European survey of public perception of biotechnology were used for a secondary analysis.[20] The survey was conducted in all fifteen member states of the European Union (Belgium, Denmark, Germany, Greece, Italy, Spain, France, Ireland, Luxembourg, Netherlands, Portugal, United Kingdom, Finland, Sweden, and Austria), Norway, and Switzerland. A multi-stage, random sampling procedure was used. The sample size varied between 610 (Luxembourg) and 2,032 (Germany). Only persons aged fifteen and over participated in the survey. Interviews were carried out face-to-face in November 1996 (except Switzerland, June 1997).

Participants were asked whether they perceived six gene technology applications as useful for society, risky, and morally acceptable; they were also asked whether applications should be encouraged. Of the six gene technology applications, two were related to food[21] and four were related to medical applications.[22] Four-point Likert scales were

20 *See* Concerted Action Group, *supra* note 6; Durant et al., *supra* note 10; European Commission Eurobarometer Unit, *supra* note 13.

21 The two items measuring usefulness of food applications read: "Useful for society to use modern biotechnology in the production of foods, for example to make them higher in protein, keep longer or change taste?" and "Useful for society to take genes from plant species and transfer them into crop plants, to make them more resistant to insect pests?"

22 The four items measuring usefulness of medical applications read: "Useful for society to introduce human genes into bacteria to produce medicines or vaccines, for example to produce insulin for diabetics?"; "Useful for society to develop genetically modified animals for laboratory research studies, such as a mouse that has genes which cause it to develop cancer?"; "Useful for society to introduce human genes into animals to produce organs for human

used to measure the four constructs ("definitely agree" coded as 2 to "definitely disagree" coded as -2).[23] The "don't know" category was coded as 0. In the present study, mean scores across the two food applications and across the four medical applications were used.[24] Past research suggests that medical applications are viewed more positively than food applications, so the two categories were analyzed separately.[25]

Results of a content analysis of articles about biotechnology between 1973 and 1996 were presented by Durant et al.[26] In the twelve participating countries (United Kingdom, France, Germany, Netherlands, Austria, Sweden, Greece, Denmark, Italy, Finland, Switzerland, Poland), one or up to three print media with opinion leader functions were analyzed. A sample of articles was selected for a content analysis.[27] The authors report for each country the percentage of articles that mentioned risks only, benefits only, risks as well as benefits, and neither risks nor benefits. For the present study, the relevant data consists of the percentage of articles reporting the risks but not benefits associated with biotechnology and the percentage of articles reporting the benefits but not risks associated with gene technology.[28]

The Gross National Product (GNP) per capita for 1997, in dollars, was used as an indicator of each country's wealth.[29] The GNP per capita reflects a country's average income per person. It may be

transplants, such as into pigs for human heart transplants?"; and "Useful for society to use genetic testing to detect diseases we might have inherited from our parents such as cystic fibrosis, mucoviscidosis or thalassaemia?"

23 The question measuring the four constructs read: "Do you definitely agree, tend to agree, tend to disagree or definitely disagree that it is useful for society to (...)"; "(...) that it is risky to (...)"; "(...) that it is morally acceptable to (...)" and "(...) that society should be encouraged to (...)."

24 *See* Durant et al., *supra* note 10, at 259-260, Tables 8a to 8d.

25 *See* Siegrist & Bühlmann, *supra* note 4.

26 *See* Durant et al., *supra* note 10.

27 See *id.* at 276-298, Appendix 3 to Appendix 7, for a detailed description of the procedure. The sample consisted of 5,404 articles published in nineteen newspapers or magazines. The average intercoder agreement was 68% for benefit and 77% for risk.

28 *See id.* at 294, Table 8.

29 *See* http://www.worldbank.org/data/databytopic/GNPPC97.pdf. It was assumed that the economic development of the near future is more important than past developments. Therefore, the GNP 1997 was used. This assumption is not critical, however, because the GNPs of different years are highly correlated.

problematic to compare GNP per capita across countries because the purchasing power of the dollar may differ. Purchasing power parity (PPP), on the other hand, reflects the actual purchasing power per capita. However, GNP and PPP were highly correlated ($r_s = .92$, $p < .001$);[30] therefore, analyses using PPP instead of GNP yielded virtually identical results. In the present article only results of the analyses using GNP per capita are presented.

Results

Due to the small number of data points, possible outliers could have a strong influence on correlation coefficients. Therefore, rank correlation coefficients were computed. Rank correlations between GNP and risk, usefulness, moral acceptability and encouragement of gene technology for food and medical applications are shown in Table 1. A significant correlation between GNP and perceived risks was observed for food applications but not for medical applications. People in richer countries perceived more risks associated with genetically modified food than people in poorer countries. No such differences were found for medical applications, which are generally assessed more positively. GNP correlated negatively with perceived usefulness, moral acceptability, and encouragement. Food related applications had a somewhat higher correlation than medical applications. Altogether, people in poorer countries assessed biotechnology more positively than people in more developed countries.

Table 1
Rank Correlations Between GNP per Capita, Risk, Usefulness, Moral Acceptability, and Encouragement for Food and Medical Applications (N=17)

	Applications	
	Food	*Medical*
Risk	.47*	-.18
Usefulness	-.66***	-.50**
Acceptability	-.61***	-.58**
Encouragement	-.73***	-.66***

* $p < .06$ ** $p < .05$ *** $p \leq .01$

30 See *id.* for source of PPP values. For Luxembourg, the PPP was not available. The analyses were, therefore, based on sixteen instead of seventeen countries.

Rank correlations between mean assessments of risk, usefulness, moral acceptability and encouragement for food and medical applications are shown in Table 2. Perceived risks of food applications were negatively correlated with usefulness, moral acceptability and encouragement. However, no significant correlations between risk and any other variable were found for medical applications. The strong intercorrelations between usefulness, moral acceptability and encouragement suggest that these three items measured the same latent construct. Further support for this interpretation stems from results found on the level of the individual subjects, which also yielded high correlations among the three variables.[31]

Table 2
Rank Correlations Between Risk, Usefulness, Moral Acceptability, and Encouragement for Food and Medical Applications (N=17)

		1 Risk Food	*2 Risk Med.*	*3 Useful Food*	*4 Useful Med.*	*5 Moral Accep. Food*	*6 Moral Accep. Med.*	*7 Encour. Food*	*8 Encour. Med.*
1	Risk food	x							
2	Risk medicine	.42*	x						
3	Usefulness food	-.44*	.26	x					
4	Usefulness medicine	-.27	-.07	.55**	x				
5	Moral acceptability food	-.55**	.26	.90***	.51**	x			
6	Moral acceptability medicine	-.27	.16	.47*	.76***	.58**	x		
7	Encouragement food	-.65***	.16	.91***	.59**	.97***	.61**	x	
8	Encouragement medicine	-.49**	.02	.59**	.87***	.67***	.89***	.73***	x

*p < .10 **p < .05 ***p ≤ .01

Rank correlations between GNP per capita and the percentage of the articles reporting either risks or benefits were computed to test the hypothesis that the wealth of a country influences how newspapers cover gene technology. Data from a content analysis were available for twelve European countries. The expected association was observed between GNP and the percentage of articles in which risks but not benefits were reported, rs = .79, p < .005 (N = 12). A negative association was found between GNP and the percentage of articles in which benefits but not risks were reported, rs = -.70, p < .02 (N = 12). The two indices, percentage of risk-related articles and percentage of benefit-related

31 *See* Durant et al., *supra* note 10.

articles, were significantly correlated, rs = -.86, $p < .001$ (N = 12). In other words, these results show that, in richer countries, newspapers reported more critical stories about biotechnology than in poorer countries.

Conclusion

The wealth of a country had an influence on perceived risks associated with genetically modified food. However, no such association was observed for medical applications. Results only partially support the hypothesis that economic wealth influences risk perception. GNP was strongly negatively correlated to perceived usefulness and acceptability of gene technology. This inverse relationship was observed for food-related applications as well as for medical applications. Altogether, people in poorer countries were more inclined to neglect possible risks and to focus on benefits associated with the new technology.

The results of the present study suggest that the economic context may have an impact on the level of risks tolerated in a society. These findings are in line with the conclusion of Sokolowska and Tyszka that poorer societies are more willing to accept risks associated with technologies than are richer societies.[32] This may be a rational response; there is a diminishing marginal utility of the benefits associated with economic progress. In relative terms, people in poorer countries may benefit more from technological and economical developments than people in richer countries.

Furthermore, the results of the present study suggest that the wealth of a country shapes the discussions about new technologies. In poorer countries, newspaper articles focused more on benefits than on possible risks; in richer countries, risks were emphasized. Poorer countries may gain more from additional economic growth, whereas in richer countries, side effects of additional growth may outweigh positive effects.

Perception of gene technology varies according to the type of application. Genetically modified food is less accepted than genetically altered drugs.[33] Results of the present study further emphasize that

32 *See* Sokolowska & Tyszka, *supra* note 16.

reactions towards gene technology depend on the application. The wealth of a country explains attitudes towards food-related applications much better than attitudes towards medical applications. One possible explanation is that people in richer countries profit less from lower food production costs than do people in poorer countries; breakthroughs in drugs, at least in principle, may be equally beneficial for all people.

Each survey provides only a snapshot of prevalent attitudes and opinions. Research suggesting that genetically modified food could be potentially harmful, or suggesting that there are unwanted ecological side effects, may influence public perception of gene technology.[34] The theoretical framework of "social amplification of risk" suggests that social systems may influence the impact new information has on public perception and responses.[35] Data used in the present study were collected in 1996. Since that time, public discussions about risks and benefits associated with gene technology have increased in some European countries. It may well be that this process has weakened the observed correlations between GNP and attitudes towards biotechnology.

GNP may explain different levels of acceptance of gene technology in European countries; it cannot explain, however, why the technology is more accepted in the United States than in Europe. Other variables are crucial for the observed cross-national differences regarding attitudes towards biotechnology. Europe and the United States differ, for example, in how the technology is regulated and the level of confidence people have in the regulators.[36] On an individual level, social trust had a strong impact on perception of gene technology.[37] It seems plausible that differences across countries in the level of social trust in authorities regulating gene technology could be another explanation for the different levels of acceptance of biotechnology

33 *See* Siegrist & Bühlmann, *supra* note 4.

34 *See* Stanley W. B. Ewen & Arpad Pusztai, *Effect of Diets Containing Genetically Modified Potatoes Expressing Galanthus Nivalis Lectin on Rat Small Intestine*, 354 Lancet 1353 (1999); John E. Losey, Linda S. Rayor & Maureen E. Carter, *Transgenic Pollen Harms Monarch Larvae*, 399 Nature 214 (1999).

35 *See* Roger E. Kasperson et al., *The Social Amplification of Risk: A Conceptual Framework*, 8 Risk Analysis 177 (1988).

36 *See* Gaskell et al., *supra* note 4.

37 *See A Causal Model* & *The Influence of Trust*, *supra* note 5.

across Europe and the United States. There are, unfortunately, no data available for testing this hypothesis.

Some limitations of the present study should be mentioned. Correlations were used for testing the hypotheses presented; thus we cannot rule out alternative explanations for the strong association between wealth and perception of gene technology. One possible explanation could be that cultural factors and not wealth caused different attitudes towards biotechnology across Europe. Postmaterialist values were negatively correlated with perceived benefits and positively correlated with perceived risks of gene technology.[38] Inglehart and Abramson found a strong association between GNP and postmaterialist values.[39] Therefore, differences in postmaterialist values, and not GNP, may explain the different attitudes towards biotechnology across Europe.

The association between wealth of a country and media content was tested using data provided by Durant et al.[40] For this content analysis only higher quality newspapers were analyzed. Other newspapers, news magazines, radio or TV may report differently about new technologies than do higher quality newspapers. Furthermore, the analysis was restricted to European countries. Results of the present study may not be generalized to other parts of the world.

38 *See A Causal Model*, *supra* note 5.

39 Ronald Inglehart & Paul R. Abramson, *Economic Security and Value Change*, 88 Am. Pol. Sci. Rev. 336 (1994).

40 *See* Durant et al., *supra* note 10.