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*The Importance of Having a Different Opinion Europeans and GM foods**

Abstract

Objectives. The article examines the opinions of Europeans concerning genetically modified (GM) foods. It first deals with the socio-cultural variables that favour acceptance of such products. It then analyses the minority of respondents who exhibit greater openness towards GM foods. Methods. Mokken Scale Analysis (MSA) is applied to 2002 Eurobarometer 58.0 data to construct an index of acceptance of GM foods. Results. The acceptance of GM foods is associated positively with trust in biotechnologies and negatively with concerns about the environment. The minority consisting of respondents in favour of GM foods possesses specific characteristics. Unlike the rest of the respondents, these principally consider the opportunity to spend less, the absence of fats, and the taste of foods. Conclusions. The analysis confirms that high education level does not favour acceptance of GM foods.

BIOTECHNOLOGY is indubitably one of the most innovative scientific-technological areas in which scientists and public and private enterprises have worked in the past decade. Nevertheless, although discoveries in genetics have been widely reported by the mass media and raised hopes for the solution of many of mankind's problems (hunger, disease, pollution of the planet), the goods produced are regarded with great suspicion by Europeans (Gaskell *et al*. 2000, 2002; Bauer and Gaskell 2002; Midden *et al*. 2002; Nielsen *et al*. 2002; Bucchi and Neresini 2002, 2004; Bonny 2003; Gaskell *et al*. 2003; Loner 2006). The data available, most notably those collected by the Eurobarometer work group, have repeatedly evidenced attitudes towards this type of technological innovation (INRA, EB 35.1 of 1991; EB 39.1 of 1993; EB 46.1 of 1996; EB 52.1 of 2000; EB 58.0 of

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2002). Numerous surveys have considered, among other things, public policy, media coverage, and public perception. All such analyses have confirmed the distrust of Europeans in biotechnology (Bauer and Gaskell 2002). Similar results have been obtained in regard to GM foods (Grunert *et al*. 2001, 2003; Frewer *et al*. 2003, 2004; Gaskell *et al*. 2004; Poortinga and Pidgeon 2005; Scholderer 2005; Cook *et al*. 2006). As Scholderer notes, ''attitudes towards GM foods appear to be utterly resistant to persuasion'' (2005, p. 270).

This study contributes to the debate on the possible introduction of GM foods by investigating how the attitudes of Europeans towards such foods are shaped. The article examines the data of Eurobarometer 58.0 of 2002, paying particular attention to the opinion of respondents who evinced specific attitudes. It is important, in fact, to observe the characteristics of those individuals who differ from the majority of Europeans by being less mistrustful of GM foods. Is suspicion generalized, or are some categories of people more willing to accept the new foods?

Research studies have stressed that the causes of rejection are manifold. The hypothesis that the possession of greater information favours acceptance, and that the matter can be thus explained in terms of information deficit has not been confirmed. This has been shown by various studies reporting that acceptance of the new biosciences by no means increases with the amount of information possessed (Loner 2006). Other analyses have emphasised the importance of the type of education, and in particular of interest in scientific subjects. For instance, in a survey of young Finns, Saher *et al*. (2006) note that students enrolled on degree courses in science or technology are more favourable towards GM foods.

Some authors stress that people assess biotechnology products by giving great weight to socio-cultural factors. On this view, it may be that the fear of dangers to humanity and the environment, and the scant transparency of decision-making processes concerning innovative technologies, have created a certain alarm in regard to genetics (Gaskell *et al*. 2002; Bucchi and Neresini 2002, 2004; Grunert *et al*. 2003; Verbeke *et al*. 2007). This seems mainly due to the fact that the innovations introduced by genetics, for instance in the agro-food sector, may have unexpected and harmful consequences (Scholderer 2005).

These fears have been fuelled by the failure of the European (and national) public institutions to manage the crises caused by technology-connected risks (Frewer *et al*. 2004; Scholderer 2005). For instance, Torgersen *et al*. (2002) recall the Bovine Spongiform Enchephalitis

(BSE) crisis, which although not imputable to biotechnology, notably eroded public trust in experts. In this regard, Bonny (2003, p. 58-59) notes that genetically modified organisms have assumed the role of ''scapegoats'' symbolizing the harmful effects of globalization in the collective imagination.

Moreover, some surveys have shown that the attitudes of Europeans towards GM foods is associated with a general image of technologies, more than with a judgment on the actual properties of such foods (Bredahl 2001; Midden *et al*. 2002). It is, in fact, necessary to bear in mind that Europeans at-large have never had direct experience of such products because of the *de facto* moratorium imposed by the European Union on their importing in application of the so-called one ''precautionary principle''[1].

An interpretation of the effect of the media on public opinion put forward by Bauer (2005a; 2005b) centres on the differences between ''red'' and ''green'' biotechnologies. Bauer's analysis concentrates on the distinction drawn in the 1990s between medical and agro-food biotechnology. According to Bauer, there is an association between media coverage – and therefore the emphasis on biotechnology's possible health benefits or risks – and the medium-period trend in public opinion. Green biotechnology, in fact, is largely described by the media in terms of its harmful aspects, and this has fostered the public's negative attitude towards it. Media reports on red applications of biotechnology have instead extolled its possible positive impact on human health and well-being, thus helping to create a positive image of it. To this can be added that medical applications are perceived as more controllable – because they are restricted to a small section of the population – and as more acceptable because the patient's survival is at stake. This hypothesis has been partially confirmed by other studies (Bonfadelli 2005; Gutteling 2005), which, however, stress the need to clarify the theoretical framework in which to insert the role of the media and that of associations campaigning

[1] The moratorium was imposed in 1998. The precautionary principle is a set of rules adopted to prevent possible future damage due to risks which have not yet been completely ascertained. More than a moral principle, it is a series of procedures to support the taking of decisions when information about a possible harmful effect that may ensue in the future – usually as result of the spread of a new technology – is not available or is insufficient. Precaution is an aspect of prudence and is mainly a concern of decision-makers. Application of the principle involves several aspects: devising procedures which attribute specific responsibilities, the codification of routines to assess and to manage the potential risks, and the development of information and communication initiatives designed to involve the public in management of the risk. For further information see Foster *et al*. (2000).

against the negative effects of genetics. Gaskell moreover, emphasises that opposition is stronger against GM foods and animal cloning, while the production of seeds and the cloning of human cells for therapeutic purposes instead receive moderate support (Gaskell *et al*. 2000). This therefore seems to bear out Bauer's thesis.

This study divides into three parts which analyse the attitudes of Europeans towards GM foods and the mechanisms that shape opinions on the issue. The first part considers the opinions of Europeans on transgenic foods. It does so also by constructing an index showing the extent of acceptance (or rejection) of this technological innovation. The second part examines the index of openness to GM foods, paying particular attention to the factors that favour their acceptance. It is, in fact, of interest to determine whether distrust varies according to the characteristics of respondents, or to other attitudes such as fears (and hopes) in regard to the consequences of biotechnologies for the health, trust in the ability of science to improve human well-being, or broader aspects like political orientations or fears for the health of the planet. The third part further deepens the analysis by applying a non-standard technique (Guttman's error analysis). To investigate the phenomenon more thoroughly, this perspective assumes that it is necessary to focus mainly on respondents who judge GM foods from points of view different from – and at times opposed to – those of the majority. It is, in fact, important for sociological search to seek to identify the mechanisms that shape people's opinions. In this specific case, this entails analysing the features and the motivations of those who, contrary to the general pattern, would accept GM foods.

Constructing an index of acceptance of GM foods

The first part of this study examines the propensity of Europeans to purchase GM foods. The analysis considers data from the Eurobarometer 58.0 survey of 2002, which covered the main European countries (Austria, Belgium, Denmark, Finland, France, West and East Germany, Great Britain, Greece, Ireland, Northern Ireland, Italy, Luxembourg, Holland, Portugal, Spain and Sweden), with a total of 16040 cases[2].

[2] Around 1,000 interviews were conducted for each country. Fieldwork: September-October 2002. For further information: http://ec.europa.eu/public_opinion/standard_en.htm.

The following questions were used for the analysis:

Q. 14. For each of the following statements, please tell me if you tend to agree or tend to disagree? (Possible answers: ''Tend to Agree'', ''Tend to Disagree'').

1. I would buy genetically modified food if it contained less fat than ordinary food (LESSFAT)

2. I would buy genetically modified food if it were cheaper than ordinary food (CHEAPER)

3. I would buy genetically modified food if it contained less pesticide residues than ordinary food (NOPESTIC)

4. I would buy genetically modified food if it were grown in a more environmentally friendly way than ordinary food (ENVFRIEND)

5. I would buy genetically modified foods if it tasted better than ordinary food (TASTEBET)

Preliminary examination of the replies to these questions showed that GM foods are disliked by Europeans. Fully two-thirds of respondents would not purchase them if they were cheaper, and around the same proportion would not do so if they contained less fat (CHEAPER = 66.2 %, LESSFAT = 65.2 %, table 1).

TABLE I

Acceptance of GM Foods (Column %, Eurobarometer 58.0 *of* 2002, *n.* =16040)

	LESSFAT	NOPESTIC	ENVFRIEND	TASTEBET	CHEAPER
Tend to agree	23.6	39.1	37.2	30.7	22.5
Tend to disagree	65.2	46.6	48.0	56.3	66.2
Don't know	11.2	14.3	14.8	13.0	11.3
Diff. agree–disagree	**-41.6**	**-7.5**	**-10.8**	**-25.2**	**-43.7**

Nor would superior quality persuade the most reluctant respondents (TASTEBET = 56.3 %). The difference between those subjects for and against purchasing GM foods would only decrease if they were produced without pesticides (-7.5 %)[3].

Mokken Scale Analysis (MSA), a nonparametric probabilistic IRT model, derived from Guttman's cumulative scale analysis (Guttman

[3] To be noted is that the number of respondents who did not express an opinion was rather high (over 10 % for each items in the battery). This would require specific analysis, in that it is indicative of the semantic complexity of the topic. A first analysis (not reported in the main text for reasons of space but available from the author on request) identified the more ''disadvantaged'' categories of respondents – i.e. the elderly, the lower-educated, and women – as those who had most difficulties in expressing an opinion, while particular differences did not emerge among countries.

TABLE II
Scale analysis of acceptance of GM foods (%; n. =11647; Eurobarometer 58.0 of 2002).

Item	Mean Score	H-Item
Cheaper (CHEAPER)	26	0.75
Fewer fats (LESSFAT)	27	0.74
Better quality and taste (TASTEBET)	34	0.76
Environmentally friendly (ENVFRIEND)	41	0.76
Fewer pesticides (NOPESTIC)	42	0.78
H–scale		**0.76**
Cronbach's α		**0.91**

1950; Mokken 1971; Giampaglia 1990; Molenaar *et al*. 2000; Sijtsma and Molenaar 2002; Van Schuur 2003; for a parametric counterpart, see Andrich 1988; Embretson and Reise 2000; Bond and Fox 2001), performed on all the questions, revealed the existence of a ''strong'' one-dimensional scale (H-scale = 0.76, table 2)[4]. The result of the analysis enabled the items to be ordered according to decreasing difficulties: CHEAPER was the most difficult item and its average score was 26 (table 2, column 2). Since all the items had been dichotomized, this value also indicated the percentage of respondents who replied to the question in the affirmative[5]. This signifies that only just over one respondent in every four would purchase GM products if they cost less than other foods. There then followed in order: LESSFAT (27), TASTEBET (34), ENVFRIEND (41) and NOPESTIC (42), which was the easiest (i.e. popular) step of the scale.

As predictable, the reasons that would induce the majority of respondents to purchase GM foods were the absence of pesticides and environmental friendliness. The positive replies obtained – from well below half of the respondents – on these items nevertheless indicate the unpopularity of GM foods.

[4] For two items, *i* and *j*, this measure can be defined as: $Hij = 1 - E(obs) / E(exp)$, where $E(obs)$ denotes the number of violations in the deterministic model observed in the sample, and $E(exp)$ the ratio between the violations expected in the case of stochastic independence. The coefficient of the entire scale is defined as the sum of the single errors. For further information see Van Schuur (2003, p. 147-149) and Mokken (1971, p. 148). Analysis was performed using the MSP5 program (Molenaar *et al*. 2000) after dichotomizing all the items and excluding those respondents who did not express an opinion. As a further control, the MSA was also performed codifying the option ''I don't know'' as a negative reply, obtaining analogous results: H-scale = 0.69.

[5] It consequently also represents the probability of obtaining a positive reply (Mokken 1971).

Since the values of the coefficients of scalability (H-item, table 2, last column) were very high[6], and analysis did not show violations of the model's assumptions of monotonicity, the instrument was one-dimensional according to the requirements established by Mokken (1971)[7].

On the basis of these results it was therefore possible to construct an additive index representing, by and large, the degree of acceptance of genetically modified foods. Summing the responses to the five items (with values equal to zero if the interviewee agreed [*tend to agree*] and to one if s/he disagreed [*tend to disagree*]), each respondent received a score ranging from five, for those who always gave positive replies, to zero for those who, conversely, would not in any circumstances purchase GM foods. The index confirmed the hostility of Europeans to these types of foods. Only 16.4 % of the interviewees, in fact, obtained the highest score and the 8.2 % recorded four, while almost half (48.6 %) achieved the lowest score (fig. 1).

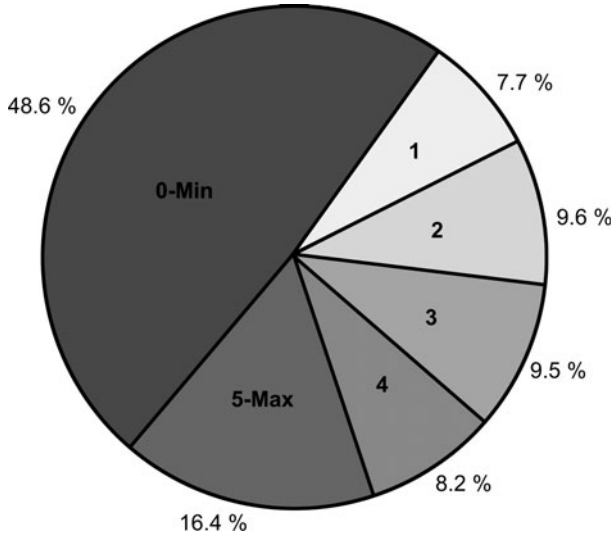
The factors influencing the opinions of Europeans on GM foods

The second part of this study analyses the mechanisms that shape opinions on GM foods. To frame the problem more precisely, it is necessary to maintain control over both the structural and ''measurement'' levels of the attitude to GM foods. A technique useful for this purpose is structural equation modelling (SEM) and, in particular, Lisrel (Jöreskog and Sörbom 1993). These tools make it possible simultaneously to consider covariations among the model's variables of the model and to include possible latent dimensions. For these reasons, the model constructed is called MIMIC, *i.e.* Multiple Indicator–Multiple Cause. In the specific case reported here, the model estimated the parameters of the relations between the latent

[6] Mokken suggested using the coefficient of homogeneity (H) to establish violations of the scale's monotonicity and sets 0.30 as the minimum limit of acceptability for the coefficient of homogeneity of the individual items (1971, p. 190-194). As suggested by Mokken (1971) and by Sijtsma and Molenaar (2002), the one-dimensionality of the scale was checked within various subgroups for: country, gender, age, education level, and political orientation, without finding violations. The results of this analysis are not reported for reasons of space but can be obtained from the author on request.

[7] Further confirmation of the one-dimensionality of the scale formed by CHEAPER, LESSFAT, TASTEBET, ENVFRIEND and NOPESTIC was obtained by verifying its conformity with Rasch's 1PL model. The 1PL model is known as the one-parameter Rasch logistic model. Analysis conducted with the Rumm 2020 program established that the five items constituted a ''good'' Rasch scale and confirmed the same order of difficulty of the items as found with the MSA. The results of this analysis are not reported for reasons of space but are available from the author on request.

FIG. 1
Index of acceptance of GM foods for all countries (Eurobarometer 58.0 of 2002; %; n. = 11647)



dependent variable, consisting of the likelihood of purchasing genetically modified foods, and certain exogenous variables. Openness to GM foods, termed FOOD, was indicated by the following five items: LESFATT, CHEAPER, TASTEBET, NOPESTIC AND ENVFRIEND[8].

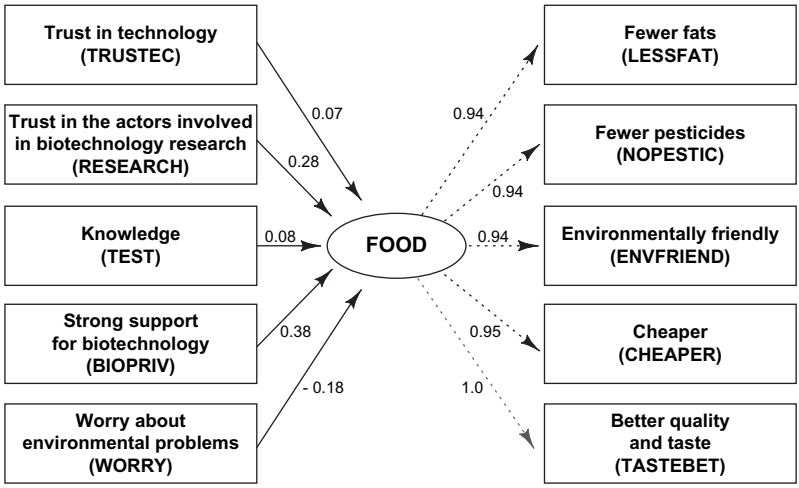
Initially considered as independent variables were nine demographic and socio-cultural dimensions (fig. 2):

1. The gender of the interviewee (SEX)
2. Age expressed in years (AGE).
3. Education level (EDU), obtained by considering the respondent's age at the time when s/he completed formal education. For greater simplicity, this value was recoded into three levels: ''low'' (aged up to 15), ''medium'' (16-19) and ''high'' (20 or over)[9].
4. The interviewee's political orientation (POLITIC) on the left/right continuum (1 = Left, 10 = Right).

[8] This part of the model is the ''measurement'' side of the latent construct. This construct can be considered the factor analysis of the latent concept of acceptance of GM foods included in the model.

[9] Thus excluded from analysis were subjects who had not yet completed their formal educations, i.e. 1746 respondents. It was decided to analyse only subjects who had completed their educations in order to control the effect of education level, and this enabled analysis of how acceptance of GM foods varied with educational qualification.

FIG. 2
The model of acceptance of genetically modified foods (Eurobarometer 58.0 of 2002, n. = 5028)



Chi-Square = 17.17, df = 14, P. = 0.25, RMSEA = 0.007, AGFI = 1.0, RMR 0.0071

5. Strong support for biotechnology (BIOPRIV). This dimension concerned agreement with applications of this science in situations involving the use of private genetic information. The contexts considered were particularly delicate and connected with health (for instance, the possibility of undergoing genetic tests to detect illnesses in advance), social security and insurance. Approval of such applications meant having great faith in the possibilities offered by biotechnology. Looking with more favour on the benefits to health and well-being (more than the negative aspects) also indicated a favourable attitude towards this type of innovation. For these reasons, it likely that individuals generally more in support of biotechnology will also be more willing to purchase GM foods. The additive index used to ''measure'' this attitude consisted of values ranging from 0 (no support) to 6 (maximum support)[10].

[10] The MSA showed that these variables constituted a one-dimensional scale (H-scale = 0.47). The reliability analysis confirmed this result because the value of the Cronbach's alpha was sufficiently high (0.75). The additive index of strong support for biotechnology was constructed by adding the scored obtained by every respondent for each of the following questions: *Q*14.14. *I would support private insurance companies having access to people's genetic information*. *Q*14.13. *I would support the public agency handling social security and pensions having access to people's genetic information*. *Q*14.11. *I would support the cloning of embryos to help infertile couples have children*. *Q*14.9. *I would take a genetic test to detect any serious diseases that I might get when I am older*. *Q*14.10. *I would support the testing of unborn babies for any serious diseases they might get in later life*. *Q*14.12. *I would support doctors and surgeons having access to a patient's genetic information*. The possible replies were: ''*Tend to agree*'' (1) and ''*Tend to disagree*'' (0).

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6. Trust in the public and private actors involved in biotechnology research (RESEARCH). Because trust is the main basis of social relationships, it is likely that greater trust in the genetic researchers will be associated with greater openness towards GM foods. This dimension considers the role of certain specific actors: private companies, scientists, and universities. By summing the positive replies. it was possible to obtain an additive index representing the degree of trust in actors involved in biotechnology research. This index could assume values between 0 (trust in none of the research actors) and 3 (trust in all three)[11].
7. Knowledge of biotechnology (TEST). It was said in the introduction that the relation between knowledge and support for biotechnology is unclear, so that it was also of interest to verify its extent in this analysis. Knowledge was obtained by summing the exact replies given to a series of questions:

   ''Q. 11. For each of the following statements, please tell me whether you think it is true or false? [True, False]'' and, in particular: ''1. There are bacteria which live from waste water; 2. Ordinary tomatoes do not contain genes, while genetically modified tomatoes do. 3. The cloning of living things produces genetically identical copies; 4. By eating a genetically modified fruit, a person's genes could also become modified; 5. It is the mother's genes that determine whether a child is a girl (M); 6. Yeast for brewing beer consists of living organisms; 7. It is possible to find out in the first few months of pregnancy whether a child will have Down's Syndrome, Trisomy, Mongolism; 8. Genetically modified animals are always bigger than ordinary ones; 9. More than half of human genes are identical to those of a chimpanzee; 10. It is not possible to transfer animal genes into plants; 11. Criminal tendencies are mainly genetically inherited; 12. Musical abilities are mainly learned''.

   Each respondent was given a score between 0 and 12 corresponding to the number of correct answers[12].
8. Trust in technology in general (TRUSTEC). This dimension was included in the model in order to verify whether, as seemed likely, a favourable view of certain technological innovations (not closely connected with biotechnology) was associated with greater acceptance of GM foods. Trust in technology was as obtained as an additive index, which was constructed by examining opinions on the effects for society of certain innovative technologies [possible answers: ''*Will Improve*'' (3); ''*No Effect*'' (2); ''*Will Make Things Worse*'' (1)]. The list was: computer and information technology; telecommunications; exploration of space, nuclear energy, mobile telephones. The sum of

[11] Used for the analysis were questions 2, 3 and 9 of battery 15 of the questionnaire (Q.15. *Now I am going to ask you about different people and groups involved in various applications of modern biotechnology and genetic engineering. Do you think they are doing a good job for society?*). Principal components analysis showed that the three items were correlated to only one factor (variance explained by the component extracted: 61.6 %). Also the MSA revealed the existence of a one-dimensional scale: H-scale = 0.47. For each question the possible options were ''*Doing a good job for society*'' (value 1) and ''*Not doing a good job for society*'' (value 0). The scores of the replies for each modality were summed so as to obtain a value between 0 (minim value) and 3 (maximum value).

[12] These questions formed a standard battery also used in other editions of the Eurobarometers on biotechnology. The possible replies were ''true'', ''false'' and ''don't know''. Non-replies were treated as wrong answers. The index was constructed following Bauer and Bonfadelli (2002), which should be consulted for further information.

the scores for every question enabled a score between 0 (minimum) and 10 (maximum) to be assigned to each respondent[13].

9. Worry about various environmental problems (WORRY). GM foods may be ambivalently associated with fear about the future of the environment (Tait 2001; Bruce 2002; Cooley 2002; Toke 2002). On the one hand, they may diminish if they fuel hope that pesticide-free and environment-friendly foods can be developed. On the other, the introduction of genetics into the agro-food system may have unpredictable long-term consequences. Since such effects may not yet have been determined by scientists, fear of the possible risks may reduce acceptance of GM foods. Another question often raised by environmentalists concerns the legitimacy for humans to manipulate other living beings. This worry was ''measured'' by means of the following question:

   ''Q.39. At present, are you very worried, fairly worried, not very worried or not at all worried about the following topics?: 1. Destruction of the ozone layer; 2. Climate change; ; 3. Acid rain; 4. The extinction of animals and plants species; 5. The progressive elimination of tropical rain forests; 6. Hunting and shooting; 7. Natural disasters; 8. Disasters caused by industrial activities; 9. Pollution of tap water; 10. Pollution of the seas and coasts; 11. Pollution of rivers and lakes; 12. Pollution of underground water; 13. Pollution from farming; 14. Damage caused by tourism; 15. The use of genetically modified organisms; 16. The use of pesticides; 17. The use of other chemical products; 18. Air pollution; 19. Nuclear power and radioactive waste; 20. Noise; 21. Urban problems (traffic, public transport, green spaces, etc.); 22. Using up natural resources that cannot be easily replaced; 23. Environmentally friendly consumption habits; 24. Domestic and urban waste management; 25. Industrial waste management''.

   Each respondent was given a score between 0 (never worried) and 25 (always worried) which, for greater simplicity, was recoded into 9 levels on the base of the distribution of frequency of the variable[14].

Since an exploratory analysis (see appendix, table A1) had shown that the attitude towards GM foods was largely unconnected with education, gender, age, and political orientation, these variables were eliminated in order to obtain a more parsimonious solution[15].

The new model obtained after such simplification provided a fairly accurate ''snapshot'' of the situation. Firstly, greater openness to GM foods was associated, as hypothesized, with support for the use of

[13] The index was obtained by considering questions 2, 4, 5, 7 and 9 of battery 9 of the questionnaire. The one-dimensionality of this index was checked by means of reliability analysis, which showed a sufficiently high value for the Cronbach alpha statistic (0.68). The MSA also showed the presence of a one-dimensional scale (H-scale = 0.47).

[14] The one-dimensionality of worry about environmental problems was checked by means of reliability analysis, which yielded a very high value for the Cronbach alpha statistic: 0.93. The possible replies were dichotomized (''*Very worried*'' and ''*Fairly worried*'' = 1; ''*Not very worried*'' and ''*Not at all worried*'' = 0).

[15] Education was significantly associated only with the amount of information possessed (TEST). The models were estimated using the WLS (Weighted Least Squares) method with listwise elimination of the missing cases. The estimates of the parameters of the preliminary model are reported in the appendix (table A1). The complete output of the model is available from the author on request.

personal genetic information (BIOPRIV = 0.38, fig. 2)[16]. Obviously this result was not surprising, since it denotes cognitive convergence between the representations of the two fields of biotechnology application (red and green). Subjects who saw above all the usefulness for health (or for social security) of biotechnology also more easily accepted its applications in the agro-food industry.

Also trust in the actors actively involved in genetic research was positively associated with acceptance of GM foods (RESEARCH = 0.28). To this should be added that this factor was also connected with BIOPRIV (0.32[17]) and can therefore be seen as an attitude of generalized trust in biotechnology.

Thirdly place, fear of environmental problems was the main obstacle against acceptance of GM foods (WORRY = -0.18). This result indicates that the greater the worry about degradation of the planet, the greater the fear that biotechnology may increase pollution. Although this hypothesis is difficult to demonstrate with the data available, and require further investigation, it may explain why campaigns by movements opposed to the development of these technologies are more successful when they emphasise the possible damage to the health of people and to that of the planet (Tait 2001).

Another point concerns the fact that fears acted as an ''irrational'' component because they were negatively associated with the level of knowledge about the biotechnology[18] but positively with the use of private genetic information (BIOPRIV = 0.11). This perhaps unexpected result can be explained by considering that BIOPRIV concerned personal safety (for instance health, tests on unborn babies, help for sterile couples, access to information by doctors). When the health (and often the survival) of people was at stake, the result of the judgment depended mainly on the possibility of saving lives. This highlights the difference in public opinion when biotechnology is applied in the medical or agro-food sectors. In the former case, biotechnology is seen as an additional cause for hope, while in the latter it is seen as a possible threat.

Fourthly, knowledge was moderately associated with acceptance of GM foods (TEST = 0.08). However, as already noted by other

[16] The value indicates estimation of the model's gamma parameter between the latent variable (FOOD) and BIOPRIV. For further information see JÖRESKOG and SÖRBOM (1993).

[17] Std. Err. = 0.02, T-value = 19.11. The complete estimates of the model's parameters are not reported in the main text but are available from the author on request.

[18] The Lisrel estimate of the parameter between TEST and WORRY was -0.14 (Std. Err. = 0.02, T-value = -8.35), that between TEST and WORRY was 0.11 (Std. Err. = 0.02, T-value = 6.69).

studies (Loner 2006), the relation is modest. Although this aspect should be investigated more thoroughly, one may argue that, contrary to information deficit theory, the amount of information possessed does not greatly increase trust in biotechnology products.

Finally, support for such innovative technologies as computer technology or mobile telephony was associated, albeit modestly, with acceptance of transgenic foods (TRUSTEC = 0.07). Interestingly, this ''measure'' was more closely associated with approval of research actors and with support for the use of information in the medical or social fields (BIOPRIV = 0.19; RESEARCH = 0.26[19]), as found by other studies (Loner, 2006).

Although the model described above produced a first picture of the phenomenon, it was important to deepen the analysis by also introducing as an independent variable the country of the interviewee. Acceptance, or conversely rejection, of GM foods may in fact change in relation to factors connected with the national context, such as coverage by the media, policies adopted in regard to these new technology products, the culture in relation to food quality, etc.

A Lisrel (MIMIC) Multisample model was used to determine the presence of variations in the national groups: a model of this kind shows whether the impact of the factors are the same, or whether differences emerge among groups.

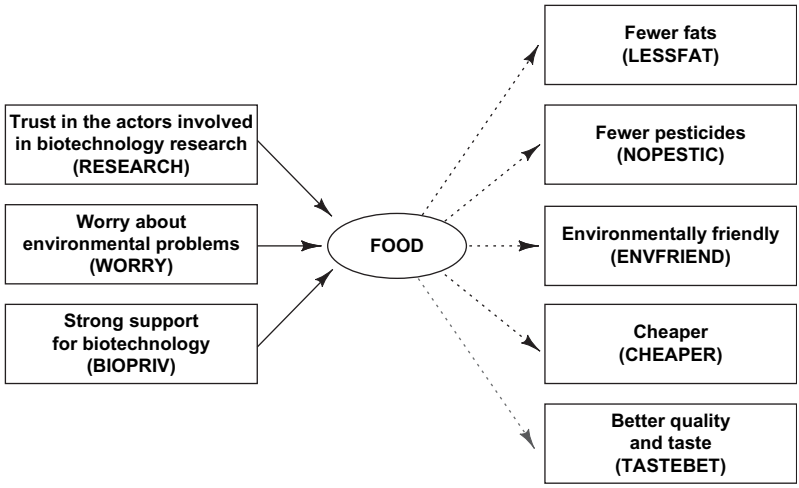
Since the previous model showed that the main factors associated with genetically modified foods were BIOPRIV, RESEARCH and WORRY, it was of interest to test a more parsimonious model which included only these three variables (fig. 3)[20].

The results confirmed a certain amount of variability among the groups according to the country concerned (table 3). Moreover, trust in biotechnology and in its positive effects on health (BIOPRIV) was very closely associated with acceptance of GM foods in all countries. The estimate of the parameter between BIOPRIV and FOOD was not the highest only in Belgium, Denmark, Western Germany and Finland: in those countries the largest weight was again assumed by trust in research actors (RESEARCH = 0.41, 0.42, 0.41 and 0.46, respectively). Worries about the environment reduced acceptance of GM foods in

[19] TRUSTEC-RESEARCH: Std. Err. = 0.02, T-value = 14.64; TRUSTEC-BIOPRIV: Std. Err. = 0.02, T-value = 11.74.

[20] The models were estimated using the WLS (Weighted Least Squares) method with listwise elimination of the missing cases. The parameters were allowed to vary among the groups so as to bring out differences among countries. The complete list of the estimates of the model's parameters are available from the author on request.

FIG. 3
The multisample model of acceptance of GM foods



Denmark, Italy and Austria, where they obtained rather higher values (WORRY = -0.26, -0.20 and 0.20, respectively). This seemingly confirms the results obtained by Gutteling *et al*. (2002)[21], who found that in Denmark, Austria and Italy the media gave great prominence to articles which emphasise the risks but not the benefits of biotechnology. In regard to Italy, for instance, Mini (2005, p. 10) notes that ''no concession is made to GMOs, unattractive, useless, poor-quality hybrids. Risks always seem superior to benefits and superior to legislative guarantees''.

Overall, variations in acceptance of GM foods could be attributed to BIOPRIV and RESEARCH, while the role of fears was important in only a few countries.

Since the national groups were not particularly numerous, it may also be that the different patterns recorded in the countries considered were also due, besides actual lifestyles and habits, to the structural composition of the groups[22].

[21] The study covered the years between 1973 and 1996.

[22] This statement is obviously not empirically verifiable with the data available. It should be remembered, however, that the sizes of the samples processed by the model, after listwise treatment of the missing data, were between a minimum of 236 cases (FINLAND, Table III last column) and a maximum of 577 (Greece), so that the samples can hardly be considered representative of the national population. Also the distribution of frequency according to the main stratification variables (not reported here but available from the author on request) shows differences among the samples, which further complicates comparison among countries.

TABLE III

Lisrel standardized estimates of the parameters of the Mimic Multisample Model of the Acceptance of GM Foods (X^2 = 584.85; df = 317; p. = 0.000; RMSEA = 0.049; RMR = 0.04; GFI = 0.99; missing = listwise; WLS estimates)

	Estimation of the parameters of the structural equation (FOOD = b_1*RESEARCH				**Estimation of the parameters of the latent dimension (FOOD)**					
	RESEARCH	**BIOPRIV**	**WORRY**	**VARIANCE EXPLAINED (R^2)**	**LESSFAT**	**NOPESTIC**	**ENVFRIEND**	**CHEAPER**	**TASTEBET**	***N.***
Austria	0.32***	0.37***	−0.20***	0.37	0.94	0.96	0.94	0.93	1.00	356
	(0.05)	(0.04)	(0.04)		(0.04)	(0.03)	(0.04)	(0.03)		
Belgium	0.41***	0.31***	0.07	0.38	0.94	0.95	0.94	0.94	1.00	429
	(0.05)	(0.05)	(0.05)		(0.03)	(0.02)	(0.03)	(0.03)		
Denmark	0.42***	0.25***	−0.26***	0.41	0.92	0.94	0.92	0.95	1.00	415
	(0.05)	(0.05)	(0.05)		(0.03)	(0.03)	(0.03)	(0.03)		
Finland	0.46***	0.22***	−0.14***	0.39	0.94	0.93	0.97	0.94	1.00	539
	(0.04)	(0.05)	(0.04)		(0.03)	(0.03)	(0.03)	(0.02)		
France	0.29***	0.41***	−0.07	0.39	0.94	0.96	0.95	0.94	1.00	408
East	0.34***	0.39***	−0.05	0.42	0.92	0.95	0.97	0.97	1.00	290
Germany	(0.07)	(0.06)	(0.05)		(0.03)	(0.02)	(0.02)	(0.02)		
West	0.41***	0.34***	−0.03	0.42	0.97	0.96	0.96	0.98	1.00	336
Germany	(0.06)	(0.06)	(0.05)		(0.03)	(0.02)	(0.02)	(0.02)		
Greece	0.34***	0.36***	0.05	0.37	0.96	0.97	0.98	0.99	1.00	577
	(0.04)	(0.05)	(0.05)		(0.02)	(0.02)	(0.02)	(0.02)		

Italy	0.29***	0.33***	−0.20***	0.36	0.97	0.98	0.97	0.94	1.00	295
	(0.06)	(0.06)	(0.06)		(0.04)	(0.03)	(0.04)	(0.03)		
Ireland	0.28***	0.52***	−0.09	0.44	0.92	0.96	0.97	0.93	1.00	236
	(0.08)	(0.06)	(0.07)		(0.02)	(0.02)	(0.02)	(0.02)		
Luxembourg	0.34***	0.37***	−0.07	0.40	0.94	0.98	0.96	0.93	1.00	303
	(0.06)	(0.06)	(0.06)		(0.04)	(0.03)	(0.03)	(0.03)		
Netherlands	0.35***	0.36***	−0.18***	0.42	0.92	0.93	0.90	0.93	1.00	387
	(0.06)	(0.06)	(0.05)		(0.03)	(0.03)	(0.03)	(0.03)		
Great Britain	0.32***	0.38***	−0.10	0.40	0.95	0.96	0.97	0.91	1.00	346
	(0.06)	(0.06)	(0.05)		(0.03)	(0.03)	(0.03)	(0.03)		
Portugal	0.28***	0.51***	−0.11	0.44	0.91	0.93	0.95	0.95	1.00	244
	(0.07)	(0.07)	(0.06)		(0.03)	(0.03)	(0.03)	(0.03)		
Spain	0.30***	0.49***	−0.06	0.43	0.92	0.94	0.96	0.96	1.00	369
	(0.05)	(0.04)	(0.05)		(0.03)	(0.02)	(0.02)	(0.02)		
Sweden	0.29***	0.44***	−0.14***	0.40	0.93	0.94	0.96	0.94	1.00	424
	(0.05)	(0.04)	(0.05)		(0.03)	(0.03)	(0.03)	(0.02)		

Note: Significance levels of the parameters: *** = 99%; ** = 95%; * = 90%; standard error of the parameter estimated in brackets

Also to be stressed is the role of trust. This aspect, as hypothesised, was associated with a positive view of the subject to whom it was directed. In confirmation of this, in the model developed, the estimate of the parameter between acceptance of GM foods and trust in the actors involved in genetic research (RESEARCH) was greater than that of the obstacle raised by fear in each national group (table 3).

The attitude towards GM foods was therefore closely connected with public trust in the social actors involved in the development of such products and hopes that they would improve the life (and the health) of citizens. The fear of negative consequences instead acted as a brake; but, as said, this effect was significant in only a few countries. In this regard, it is useful to bear in mind the role performed by the mass media in heightening fears. The main hypothesis on this matter (''media coverage hypothesis'') was formulated some ten years ago by Alan Mazur (1975, 1981). It states that, regardless of the type of news reported, as media coverage increases, so does public distrust in technology (thereby inducing an evaluation error). Research results do not agree on the impact of the media on conflicts concerning biotechnology: Gutteling (2005) and Neresini (2005), for instance, have not corroborated Mazur's thesis.

Moreover, comparative analyses have emphasised the importance of distinguishing among general evaluations, which are often value-loaded, and attitudes toward specific products, which are evaluated mainly in terms of their usefulness (on Spain see Lujàn and Todt 2000).

The causes of the distrust by Europeans in GM foods are therefore manifold, and as Gaskell *et al*. have written:

> In conclusion, no single explanation accounts for the greater resistance to food biotechnology in Europe. Media intensity, knowledge of biotechnology and trust in the regulatory process are implicated and interrelate. Different histories of media coverage and regulation go together with different patterns of public perceptions; and these in turn reflect deeper cultural sensitivities, not only towards food and novel food technologies but also towards agriculture and the environment. (Gaskell *et al*. 2002, p. 373-374)

Subsequent studies should therefore clarify the effect of media coverage, especially in relation to the fears that may be aroused by the application of scientific innovations in the absence of clear rules on their use, and on who should reap the benefits (economic and for health) of new discoveries.

The analysis reported in the first part of this study has identified the factors associated with the phenomenon under examination.

However, it is incomplete, because it is unable to shed full light on the mechanisms involved in acceptance of GM foods. The variance in acceptance of GM foods explained by its association with RESEARCH, BIOPRIV and WORRY ranges, in fact, from 36 % (Italy) to 44 % (Ireland and Portugal), and it is likely that at the moment of evaluation the subjects were considering other factors as well (table 3).

A variation on the theme: those who think differently from the majority

In order to obtain more detailed knowledge about the mechanisms that shape opinions on GM foods, the perspective of analysis was changed by focusing on those subjects who ''diverged'' from the general pattern. Although, as said, the analysis that follows may appear at odds with the rest of the study, it seeks to combine reflections of a substantial and methodological kind. From the substantial point of view, it is important to take account of the attitudes of those subjects who constituted the ''minority'' who were in favour of GM foods. These respondents may in fact have represented the vanguard of a new tendency likely to exert great influence on the rest of public opinion[23]. It was therefore important to examine those respondents favourable towards GM foods: did they possess characteristics very similar to the other respondents? If they did not, how did they differ from the others? From the methodological point of view, it was interesting to ''reverse'' the principles underlying the technique used to construct the index of openness to GM foods – i.e. Mokken's (1971) scale analysis procedure[24]. To understand the type of analysis which follows, it is useful to remember that the Mokken Scale Analysis is based on analysis of deviations from the perfect cumulative scale devised by Guttman (1950). According to Mokken, if the scale is sufficiently ''strong'', it is possible to consider ''deviations'' from the ''perfect'' scale as due to chance (Mokken 1971, pp. 41-48)[25]. Such

[23] As Moscovici *et al*. (1994) have shown when studying attitudes to the death penalty, abortion, pollution, and the rights of homosexuals or women, the opinion of the minority may exert very high persuasive force until it becomes the majority public opinion.

[24] Note that Rasch models are based on the same principles as the technique developed by Mokken (i.e. deviations from the perfect Guttman scale). The principal difference between the two procedures is that, whilst Mokken's technique is non-parametric, so that the function expressing the probability of a positive reply can assume any form whatever, Rasch scales are instead parametric.

[25] Mokken uses Loevinger's H coefficient to measure the goodness of the scale and establishes (as a rule of thumb) 0.50 as the value of the coefficient which defines the entire scale as ''strong'' (1971, p. 190-194).

deviations are called ''Guttman errors''. To clarify this concept, it is sufficient to point out that Guttman's model entails the dominance of each (more difficult) item over the easier ones, and no exceptions are admitted once the order of difficulty of the questions has been identified. In this way, in order to establish a subject's position on the continuum (or rather on the straight line along which the subjects and the items are ordered), it is only necessary to know the highest step (i.e. question, item) to which the subject has replied positively. An ''error'', or violation of the model, is thus defined according to the order that a subject gives to two items. More precisely, an ''error'' occurs when the subject gives a positive reply to the more difficult of the two items, not to the easier one (Van Schuur 2003)[26]. Although the term ''error'' has a negative connotation in everyday language, in this context it refers only to the interviewee's choice of a pattern of replies at odds with those of the majority, i.e. with the ''perfect'' scale.

According to an alternative interpretation, ''deviations'' are not due to pure chance, but depend on the presence of one or more additional dimensions connected to the phenomenon (see e.g. Bart and Krus, Dalton and MacReady, Shye *et al*., cited in Van Schuur 2003, p. 141). This hypothesis can be verified by examining the attitude of subjects who think differently. As Van Schuur (2003, p. 150) points out: ''subjects' numbers of Guttman errors can be regarded as their values on a new variable''. It is thus possible to use this information for further analysis. In the case of the scale of acceptance of GM foods, this meant analysing the ''Guttman errors'' in relation to the index of openness to GM foods. The analysis now described sought to identify the presence of systematic patterns in the replies of respondents who did not match the ''perfect'' model (i.e. the Guttman scale). The analysis concentrated on those subjects who ordered the items differently and examined their attitudes towards GM foods. Specifically, this part of the study seeks to show that violations of the ''perfect'' model were not random but denoted specific and particular patterns of thought.

In this case, to determine whether these were systematic patterns, it was sufficient to observe the variations from the scale of acceptance of GM foods previously identified. The latter, as described earlier, was

[26] This consequence derives from the model's MH (Monotonous Homogeneity) property whereby the probability of a positive reply to an item increases (or at least does not decrease) with the value (ability) of the subject (θ). As Van Schuur (2003, p. 145) writes: ''for all items $i \in I$ and for all values $\theta_s \leq \theta_t$ we therefore assume that $pi(\theta_s) \leq p_i(\theta_t)$''.

TABLE IV
Number of Guttman errors in the whole sample
(Eurobarometer 58.0 of 2002; row %; n. = 11643)

	0	1	2	3	4	5	6
n.	9362	916	557	414	262	61	71
%	80.3	7.9	4.8	3.6	2.3	0.5	0.6

composed, in decreasing order of difficulty, of: LESFATT->CHEAPER->TASTEBET->NOPESTIC->ENVFRIEND.

Guttman errors can be verified in two steps. The first consists of identifying the respondents who order the items in a different way, while the second concentrates on these individuals in order to determine their distinctive characteristics.

As regards the distribution of the Guttman errors, more than four-fifths of the interviewees did not commit even one ''error'' in the ordering. This obviously indicated that the great majority matched the ''perfect'' scale (80.3 %, table 4). It was therefore sufficient to know the scores obtained by these individuals to establish the replies that they gave to all the questions. Since they perfectly matched the deterministic scale, it was possible to know the replies given to each question. That ''errors'' were relatively rare is also shown by the fact that, conversely, only seven out of one hundred respondents committed more than two ''errors'' (table 4)[27].

Those respondents that matched the perfect scale (no ''errors'') on average obtained lower scores (on the index of acceptance of GM foods) than did the other respondents: indeed, six out of ten scored zero (60.3 %, table 5). This pattern once against highlights the great resistance of the majority of respondents against the introduction of GM foods. Moreover, fewer than three out of ten of them exceeded two points (29.8 % summing those who obtained three, four or five points). On examining those who committed at least one ''error'', one notes that none of them obtained the maximum score (as predictable, since this was a cumulative scale). Instead, on considering a score equal to or above three – which indicates a percentage of subjects favourable to GM foods well above the average – one finds that in all groups with at least one ''error'' the score is higher than that of subjects who matched the perfect scale.

[27] In total, groups with 3, 4, 5 or 6 ''errors'' comprises, respectively, 3.6 %, 2.3 %, 0.5 % and 0.6 % of respondents (Table IV, bottom row). The sum of these percentages is 7.0 %.

TABLE V
Acceptance of GM foods according to the number of Guttman errors (Row %; N. = 11643; Eurobarometer 58.0 of 2002)

	Index of acceptance of GM foods						
Number of Guttman errors	**0 Min**	**1**	**2**	**3**	**4**	**5 Max**	***Sum* 3–5**
0	60.3	3.7	6.2	5.4	4.1	20.3	29.8
1	0.0	32.5	13.4	18.2	35.9	0.0	54.1
2	0.0	22.8	33.0	23.9	20.3	0.0	44.2
3	0.0	19.8	22.7	38.7	18.8	0.0	57.5
4	0.0	19.0	26.0	32.1	22.9	0.0	55.0
5	0.0	0.0	67.2	32.8	0.0	0.0	32.8
6	0.0	0.0	46.5	53.5	0.0	0.0	53.5

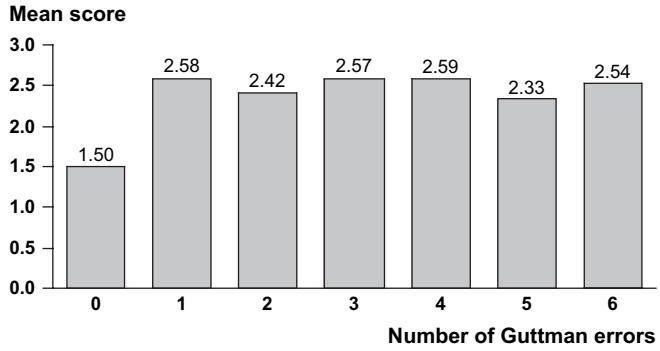
In four groups, therefore, over half the respondents would purchase GM foods: these were the groups with 1, 3, 4 and 6 ''errors'' (last column of Table 5) in which the share of interviewees who reached or exceeded three points was well over 50 %. It should be pointed out, however, that these groups all together made up less than 20 % of respondents.

Although the pattern resulted from the analytical procedure used, and was therefore largely predictable (gives the model's conformity with the requirements established by Mokken), one may wonder whether the ''deviations'' from the majority did not also derive from the specific views and attitudes of these respondents. This hypothesis can be verified by observing the differences in the average scores of the index of acceptance of GM foods according to the number of Guttman errors (fig. 4).

This analysis supports the hypothesis that acceptance of GM foods involved a different attitude towards them: for those subjects more in favour of such foods, the order of preference among the five items changed with respect to the majority. Those who committed at least one ''error'' obtained a score higher by around one point on average than the score of those who did not commit even one error[28].

[28] The data for the graph were obtained by means of the One-Way Anova procedure of Spss 12.1, which yielded significant parameters: df = 6, F = 88.460, Sig. 0.000. However, this result should be regarded as purely indicative because the groups differed considerably in size. In particular, the groups with five and six ''errors'' comprised, respectively, only 61 and 71 cases. The results of the analysis are available from the author on request.

FIG. 4
Index of acceptance of GM foods. Mean scores of respondents according to the number of Guttman errors (n. = 11643, Eurobarometer 58.0)



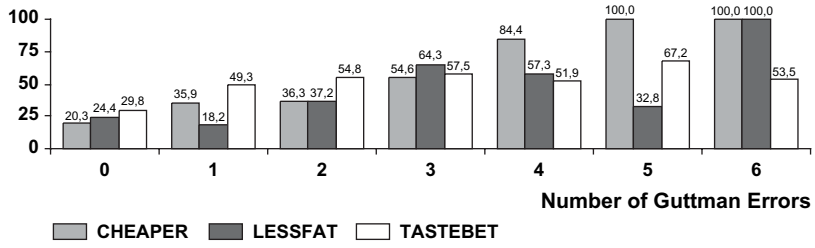
The general pattern can be interpreted by considering that, for some respondents, the order of importance of the items differed from the average pattern. Obviously, this should have occurred with greater frequency for the pairs of items ''closest'' in the scale, i.e. those with similar mean scores: CHEAPER-LESSFAT and ENVFRIEND-NOPESTIC[29].

In order to determine whether ''deviations'' from the ''perfect'' scale concealed one or more alternative attitudes towards GM foods, it is necessary to answer a further question. This concerns the aspects that distinguish the ''perception'' of GM foods by these respondents. To address the question it was sufficient to examine the distribution of the replies that respondents who committed at least one ''error'' gave to the individual items (fig. 5 and 6).

For those respondents who committed *one Guttman error*, the most convincing aspect of biotechnology concerned its ability to solve environmental problems: almost nine out of ten would purchase biotechnology products if they were produced in an environment-friendly manner (ENVFRIEND = 86.6 %, fig. 6). More than two-thirds, moreover, would make the same choice if such produces contained fewer pesticides – that is, were less harmful to the planet,

[29] This is not surprising, given that it was obviously more likely that inversions in the order of preference would occur between items with very similar ''popularity'' (i.e. a percentage of positive replies). CHEAPER, for instance, obtained 26 % positive replies, and LESSFAT obtained 27 %. The percentages for ENVFRIEND and NOPEST were, respectively, 41 % and 42 % (see Table 2).

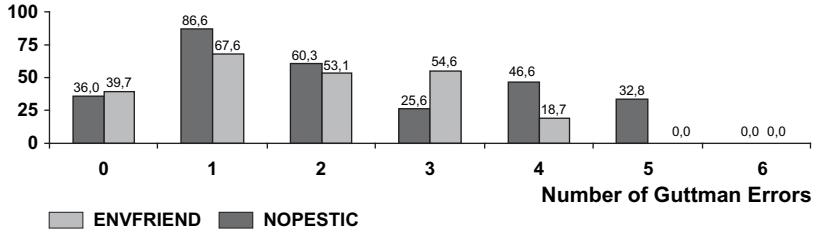
FIG. 5
Cheaper (CHEAPER), Fewer fats (LESSFAT) and Quality and better taste (TASTEBET) Positive responses according to the number of Guttman Errors (% of positive responses; n. = 11643; Eurobarometer 58.0 of 2002)



but also to health – considering that residues of the fertilizers and pesticides used in agriculture also contain substances dangerous to humans (NOPESTIC = 67.6 %). Because these respondents committed just one ''error'', it is likely that in the majority of cases the violation was due to an inversion (in the order of preferences) between ENVFRIEND and NOPESTIC, or between CHEAPER and LESSFAT, which as said, had very similar mean scores (see table 2). This is particularly important because it concerns the second largest group (7.9 % of respondents) and indicates an attitude that links environmentalism with personal health.

The second pattern was exhibited by respondents who committed *two ''errors''*, i. e. 5 % of the interviewees. This group had characteristics

FIG. 6
Environment-friendly (ENVFRIEND) and Fewer pesticides (NOPESTIC). Positive responses according to the number of Guttman errors (% of positive responses; n. = 11643; Eurobarometer 58.0 of 2002)



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similar to the previous category and consisted of subjects who appreciated the absence of pesticides (NOPESTIC = 53.1 %, fig. 6), ecosustainable farming (ENVFRIEND = 60.3 %), and the good taste of food (TASTEBET = 54.8 %, fig. 5). For these individuals, therefore, ecological reasons mixed with a concern for the quality of food.

Whilst the members of the group *with three ''errors''* also appreciated the absence of pesticides (NOPESTIC = 54.6 %, fig. 6), they placed particular importance on the taste of food, on price and, to a greater extent, on a lower fat content (LESSFAT = 64.3 %, fig. 5). Unlike the previous groups, therefore, the choices of these respondents were determined less by environmental worries than by concerns for personal well-being and the quality of food.

Although the *last three groups* comprised a very small number of respondents, they warrant close attention because they largely reversed the order of items made by the majority. The preferences of these respondents were dominated by economic aspects, which were indicated by 84.4 % in group four (CHEAPER, fig. 5) and by all (100.0 %) of those who committed five or six ''errors''. However, each group had distinctive features. In the one with six ''errors'', all respondents (100.0 %) also gave a positive response to the absence of fats (LESSFAT = 100.0 %). Those belonging to group five also gave great importance to better taste (TASTEBET = 67.2 %), while those subjects who committed four ''errors'' favourably evaluated the absence of fats, taste and, to some extent, environmental qualities. This pattern may have been due to the fact that lower-income earners attach greater importance to price, although the survey data unfortunately cannot be used to verify this hypothesis.

The group with four ''errors'' had interesting characteristics because its members ordered the items in the exact reverse of the ''perfect'' scale: for these subjects, as reported earlier, CHEAPER was the most popular item, and NOPESTIC was the most difficult. In other words, price mattered a great deal for these individuals, while the absence of pesticides was of little importance to them. At cognitive level, the ''yardstick'' which they use to evaluate GM foods was the reverse of that used by the majority. These were probably the most materialistic interviewees, because they were little concerned about health, but very much so about price.

Looking at the general pattern, it is possible to add that the number of positive responses for CHEAPER grow as the Guttman errors increased (from 20.3 % in the group with no ''errors' to 100 % in those with five or six: fig. 5), while it decreases for ENVFRIEND

and NOPESTIC (fig. 6). As regards ecological and health aspects (ENVFRIEND and NOPESTIC), the highest number of positive responses are instead made by subjects who committed one ''error'', while as ''violations'' increase, the weight of these factors decreases until it disappears in the groups with five or six violations (fig. 6).

Conclusions

As predictable, a positive judgement on transgenic foods is associated with trust in biotechnologies and in the actors involved in their development. Conversely, worries about the environment constitute a barrier against the introduction of GM foods. However, the analysis has shown that the deterrent represented by fears is strong in only some countries. The effect of the fears can be regarded as an ''irrational'' component, but, as other studies have argued, it also involves the management of decisions concerning applications of these technologies and the way in which information about them is transmitted to the public (Bucchi *et al*. 2003; Bucchi and Neresini 2004; Pellizzoni 2006).

Attitudes towards GM foods vary considerably according to the context. When interviewees were unable to identify a clear advantage (above all for health), the response was often negative. Not coincidentally, the reasons of those opposed to the innovations centred on uncertainty and on the dangers – i.e. fears – deriving from the new technologies. Only when the stakes were higher (that is, when people's lives and survival were at risk) was there a change in the conditions in which the choice was made and greater openness to medical applications. This highlights the usefulness of concentrating analysis on the mechanisms involved in interpretative frames.

The study has shown that both attitudes (openness or closure) were based on processes perceived as rational by the interviewees. According to the analytical perspective adopted, respondents who accepted GM foods could be regarded as ''deviant''. As said, this term should be taken, not in the ''negative'' sense, but relatively to the attitude shared by the great majority of respondents.

The method of analysis assumed that the minority of supporters of GM foods choose according to what they consider to be good reasons for responding positively. These individuals, in fact, found

strong justification and support for their judgement in two aspects which, in some respects, were the opposite of each other. On the one hand, they hoped that products containing fewer pesticide residues would create a cleaner world and healthier foods. On the other, their acceptance of GM foods depended on economic factors and on opportunities to spend less. One may presume that these latter individuals were more materialistic, or had lower incomes. In the former case, they may also have been people more worried about, or anyway more sensitive to, the environment. From the point of view of the rational reasons for supporting GM foods, anchorage in economic factors was comparable with that for worries about health. In both situations, the decision was conditional on external conditions over which the respondents had – and perceived that they had – little control (in the latter case, for instance, it may have been a serious illness, in the former economic hardship). For respondents in these circumstances, GM foods may have represented an additional resource. Both when life is at stake, and when poverty is a serious threat, any possible salvation is accepted. These actors perceived GM foods as an additional rationally-founded hope.

For a minority of respondents, therefore, their attitude towards GM foods was connected with factors different from those on which the opinion of the large majority was based. It was therefore useful to integrate ''measurement'' of the phenomenon – though effective in explaining the reasons underlying the choices of a large part of respondents – by seeking to understand the reasons for and the mechanism shaping the opinions of those who thought differently from the majority.

On the basis of the findings set out above, it is possible to group Europeans into five categories representing the same number of attitudes towards GM foods (table 6).

The *first* group (no Guttman errors) comprises the great majority of respondents (over 80 %). These individuals were distinguished by a closure determined by fear, and by the uncertainties surrounding possible negative effects of GM foods. As Verbekes *et al*. point out:

> in a typical food consumer decision-making process, safety is usually a non-negotiable product attribute. There is evidence to suggest that consumers expect all food to be intrinsically safe and a well-informed and rational consumer would never knowingly purchase or consume unsafe food. (Verbekes *et al*. 2007, p. 2)

TABLE VI
Division of Europeans according to their attitudes towards GM foods (Eurobarometer 58.0 data, N. = 11643)

'Errors' in the ordering	%	Result
0	80.3	Strong closure: fears predominate
1	7.9	Openness only if beneficial to environment and health
2	4.8	Partial openness only for environment, health and quality of food
3	3.6	Partial openness only for health and, lower prices
4–6	3.4	Openness only (almost solely) for lower prices and foods containing less fat (group 6)

Partial openness is apparent in the remaining categories, but the reasons for acceptance depend on different factors. These motivations to some extent override the fears raised by the potential risks of GM foods. For almost 8 % of Europeans (group with one Guttman error), a valid reason for approving these products is their benefit for the health of the planet or of people. Future research could analyse the characteristics of these individuals in order to determine whether they belong to organizations for defence of the environment. The attitude of environmentalists, in fact, lies at the centre of the cleavage between the hopes and fears raised by scientific discoveries and progress. As various commentators have pointed out, biotechnologies may be both a threat and an opportunity to defend the planet (albeit from different points of view: see Buttel 1998; Hoban 1998, 2003; Roller 2001; Loner 2006 or, for the opinion of agriculturists: Loop 1998).

In the second group (*two ''errors''*), which comprises around 5 % of respondents, health reasons overlap with those concerning the quality of food. For the remaining categories (*three ''errors'' and more*), composed of a small minority of respondents, openness largely depends on the hope of spending less.

According to Scholderer (2005), only direct experience of the benefits can break down the great resistance of Europeans to the revolution in dietary habits represented by GM foods. More than on information and education campaigns, changes in their attitudes will

depend closely on practical aspects: the quality of products, beneficial consequences for health and the environment, and competitive prices. As Bruce (2002) notes, the success of biotechnology will depend on attaining a shared public vision able to restore trust in the bio-industries, rules, and governments involved in recent technology-related crises (of which BSE has been the most striking example). Future research should seek to establish whether the categories comprising supporters of GM foods are still a small minority, or whether they reflect a growing attitude among Europeans.

From the methodological point of view, the analysis has demonstrated the importance of considering the presence of other dimensions which may be associated with the phenomenon. Specifically, observation of ''errors'' in ordering has revealed the reasoning of those respondents who gave priority to materialistic aspects (such as price) over more idealistic ones (such as protecting the environment), or the opposition between those who considered health benefits in terms of the absence of pesticide residues and those who instead considered lower fat content. The results have shown that study of human reality – often fleeting and complex – cannot ignore the opinion of the minority of citizens who think differently. Observation of the characteristics of ''deviants'' (in the non-negative sense with which the term has been used here) yields more profound knowledge on the mechanisms underlying social phenomena.

TABLE A1

Lisrel standardized estimates of the parameters of the Mimic Multisample Model of the acceptance of GM foods

	Estimation of the parameters of the structural equation									**Estimation of the parameters of the latent dimension (FOOD)**					
	Model 1: FOOD = b_1*RESEARCH + b_2*BIOPRIV + b_3*WORRY **Model 2: FOOD = b_1*RESEARCH + b_2*BIOPRIV + b_3*WORRY + b_4*TRUSTEC + b_5*TEST + b_6*POLITIC + b_7*EDU + b_8*AGE + b_9*EDU**														
	Research	**Biopriv**	**Worry**	**Trustec**	**Test**	**Politic**	**Edu**	**Age**	**Edu**	**Lessfat**	**No-pestic**	**Env-friend**	**Cheaper**	**Taste-bet**	**(n valids)**
Model **1**	0.28***	0.38***	−0.18***	0.07***	0.08***					0.94	0.94	0.94	0.95	1.00	4393
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)					(0.01)	(0.01)	(0.01)	(0.01)		
Model **2**	0.31***	0.38***	−0.19***	0.05***	0.05***	0.01	0.00***	−0.04***	0.00	0.93	0.94	0.93	0.92	1.00	3716
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)		

Significance levels of the parameters: *** = 99 %; ** = 95 %, * = 90 %, standard error of the parameter estimated in brackets

FIT:

Model 1 : Chi-Square = 17.25 ; df = 14; P = 0.25 ; RMSEA = 0.007 ; RMR = 0.007

Model 2 : Chi-Square = 38.56 ; df = 28; P = 0.09 ; RMSEA = 0.010 ; RMR = 0.001

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Résumé

L'article porte sur les opinions des européens vis à vis des OGM. Après avoir dégagé les variables associées aux opinions favorables, on s'intéresse aux attitudes, minoritaires, favorables. La méthode Mokken Scale Analysis est appliquée aux données Eurobaromètre de 2002. Un modèle Lisrel teste la qualité de l'indice obtenu. Il apparaît que l'acceptation des OGM est liée positivement à la confiance dans les biotechnologies et négativement à l'intérêt pour l'environnement.
Par ailleurs, la minorité favorable se distingue par un souci de dépenser moins, d'éviter les graisses et pour le goût des aliments. En revanche un haut niveau d'éducation n'est nullement favorable à l'acceptation des OGM.

Zuzammenfassung

Aufgabenstellung. Dieser Beitrag erörtert die Einstellung der europäischen Öffentlichkeit zu genetisch veränderten Lebensmitteln : welche soziokulturellen Aspekte fließen positiv mit ein, wer sind die Gegner. Methode. Die Mokken Scale Analysis wird auf den Eurobarometer 2002 angewandt, um Raster bei der Beurteilung von genetisch veränderten Lebensmitteln aufzustellen. Das Lisrel Modell überprüft die Verwendbarkeit dieses Rasters. Ergebnis. Vertrauen in die Biotechnologien führt zu einer positiven Einstellung, Angst vor Umweltschäden zur Ablehnung. Die Minderheit der Befürworter sieht Vorteile in puncto Zeitersparnis, fettarme und geschmacklich bessere Produkte.
Schlußfolgerung. Laut dieser Studie führt eine höhere Ausbildung nicht grundsätzlich zur Anerkennung genetisch veränderter Lebensmittel.

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