Factors underlying support or opposition to biotechnology among Australian food consumers and implications for retailer-led food regulation

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Abstract

Despite current findings that consumers, on average, have negative attitudes to biotechnologies such as cloning and genetic engineering, considerable variability can be found in the direction and strength of these attitudes. This paper presents a path analysis of attitudinal, motivational, demographic and behavioural variables that influence consumer dispositions towards biotechnology. Among these variables, those found to be most important were: consumers' level of motivation to find natural foods; the extent to which they were motivated by convenience; whether they did the shopping for their household on a regular basis; and their sex. In terms of direct effects on dispositions to biotechnology, motivation to find natural foods had a very strong negative effect while convenience had a very strong positive effect. Sex had a moderate direct effect with women less likely to be positively disposed towards biotechnology than men. In an apparent contradiction, taking responsibility for household shopping had an equally strong positive effect on both naturalness and convenience. However, sex also played a crucial role here with a very strong effect on motivation to find natural foods

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(women more motivated), a minor effect on convenience (women less motivated) and a strong effect on responsibility for household shopping (women more likely to shop). The policy implications of these findings are important, given the apparent oppositional trends of some sections of the food industry to endorse biotechnology, and of the supermarkets to deliver 'clean and green' non-GM foods to consumers.

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Introduction

While biotechnologies such as selective breeding, fermentation and enzyme production have been used for centuries to produce foods and medicines, new biotechnologies such as genetic engineering and cloning that allow direct transfer of genetic material between species, and accelerated reproduction within them, suggest the possibility of more revolutionary change (Norton, 2001). With the benefits of the new biotechnologies considered by proponents to range from reduced environmental damage to improvements in animal welfare, farm productivity, product quality and human health, it seems little wonder that adoption of such technologies by farmers and by food companies has been rapid. By 2003, an estimated 68 million hectares of land worldwide – or 25 percent of the total cropped area – was sown to GM crops (Pew Initiative on Food and Biotechnology, 2004). This represented a nearly 40-fold increase over the area planted to GM crops in 1996 (Pew Initiative on Food and Biotechnology, 2004). The enthusiasm of consumers to purchase and feed themselves and their families transgenic produce has, however, been rather more muted.

A great many studies from around the world have demonstrated considerable reluctance among consumers to embrace the new biotechnologies (INRA, 1991, 2000; Decima Research, 1993; Lemkow, 1993; Florkowski et al., 1994; Frewer and Shepherd, 1995; Norton, 1999; Marris et al., 2001; Grice and Lawrence, 2003). These studies suggest that concern is greatest in relation to products that are destined for human ingestion, that offer no tangible benefits to the consumer, and that are applied to animals. By contrast, the use of the new biotechnologies to produce novel medicines and to enhance production of fibre and ornamental plants is rather less controversial. Contrary to claims by biotech proponents that resistance to genetic engineering is based on ignorance, a number of studies have shown that the more people know about biotechnologically derived foods the more likely they are, in fact, to reject them (see discussions in Lawrence et al., 2001 and Grice and Lawrence, 2003). Overall, women are more opposed to application of the new biotechnologies than are men (Norton, 1999).

Unlike the work of those involved in the above studies, we are not concerned here with determining the level of consumer support or opposition to biotechnologies, nor, the types of biotechnological applications to which they are more or less averse. Rather, we are concerned with exploring how a range of attitudinal, motivational, behavioural, and demographic variables interact to influence

consumers' overall dispositions towards biotechnology and the implications of these findings for food policy. The paper attempts, therefore, to identify the key values and attributes that are likely to underlie choices made by Australian consumers about novel foods irrespective of the characteristics and claims of specific biotechnology applications. To this end, over 1200 Australian consumers were surveyed on their attitudes to biotechnology; the motivations that affected their food choices in general (using the scales developed by [Steptoe et al. \(1995\)](#) and [Lindeman and Väänänen \(2000\)](#)); and their involvement in so-called green consumption activities such as recycling. Before turning to the survey we will explore briefly the policy and regulatory context in which consumption of biotech foods must be located.

The governance of food biotechnologies

Some policy analysts have argued that the regulation of the new biotechnologies might more adequately be described as regulation *for* industry than as regulation *of* industry ([Newell, 2001](#)). While genetic engineering and other biotechnologies are subject to a plethora of legal regulations, non-legal rules and codes, international conventions and so on ([Black, 1998](#)), the over-riding principles behind these are the inter-related concepts of 'risk management' and 'substantial equivalence' ([Levidow and Carr, 2000](#); [Newell, 2002](#)). Under this regime, where genetically modified foods are determined to have similar physical and chemical properties as conventional foods they are deemed suitable for treatment in the same manner with regard to health and safety and subjected to little, if any, additional testing. This facilitates rapid approval of genetically modified foods by shifting the onus of responsibility away from the biotechnology industry to establish the safety of such foods and onto its opponents to establish their riskiness ([Levidow and Carr, 2000](#)). Further, questions regarding the purpose and social implications of genetic engineering are ruled out as legitimate concerns and the public accorded little role beyond the choices they may make as consumers within food markets ([Black, 1998](#); [Levidow and Tait, 1995](#); [Newell, 2002](#)).

None of this is to suggest that the risk management regime is interpreted and applied uniformly across national boundaries, nor that it has not been subject to considerable contestation and debate. Moves, for example, by the European Union to introduce the 'precautionary principle' by extending risk assessment to cover the entire food production process and introducing stricter labelling of genetically modified foods ([FSA, 2003](#)) have been criticised by the US and others as non-tariff barriers to trade that are not based on 'sound science' ([Levidow and Carr, 2000](#)). At the same time, social movements opposed to genetic engineering on a range of grounds have won a series of concessions from regulatory agencies and biotech firms alike ([Tokar, 2001](#)). However, arguably the most significant challenge to continued expansion of the new food biotechnologies lies in the increasing role of large retailers in private sector regulation of food production, processing and distribution ([Marsden et al., 2000](#)).

Marsden et al. (2000) argue that a key feature of retailer-led food industry self-regulation is likely to be the imposition of progressively more stringent food quality standards designed both to enhance positive food attributes and to avoid food 'hazards'. While there can be little doubt that much of the motivation for food quality standards and associated quality assurance regimes lies in the minimisation of liability for food-borne hazards (Pearce and Hansson, 2000), such standards also provide retailers with opportunities to represent themselves as champions of consumer interest and demands (Lockie, 2002). At the same time, therefore, that self-regulatory regimes based on risk minimisation have been promoted by the food biotech industries as strategies to ensure their own growth, application of the same principles by retailers may have very different results. Understanding better the basis of food consumer dispositions towards the new biotechnologies is thus of as much relevance to the future of self-regulatory practices in the food industry as it is to democratic institutions and social movement politics.

Methodology

Sampling and survey design

The study was undertaken in three stages. First, 13 focus group interviews were conducted to identify those issues of concern to consumers and to assist later in survey data interpretation. To ensure a degree of representativeness the groups were conducted in both metropolitan and regional centres in Queensland and Victoria and with a variety of socio-economic and ethnic groups.

Second, a preliminary set of questions on attitudes related to food was developed and pre-tested with 77 students from Central Queensland and Griffith Universities. Scales were then developed for the issues of primary concern; namely, disposition towards biotechnologies; perceived risks from industrial food production and processing methods such as chemical use, irradiation, artificial additives and genetic engineering; attitudes towards certified organic foods; and willingness to pay more for food that has been produced in an environmentally friendly manner. The scale on risks from industrialised foods included five four-point items taking the form: "*How high would you consider the risk posed to food consumers by regular consumption of foods grown or treated with pesticides and other chemicals?*" where 1 = very low risk and 4 = very high risk. The remaining scales comprised 19 five-point items taking the form: "*How strongly do you agree or disagree with the statement, scientists are going too far with cloning and other biotechnologies?*" where 1 = strongly disagree and 5 = strongly agree. Each scale was tested for validity following the survey and four items deleted. The final attitudinal scales are shown in Table 1.

Third, 1212 Australian consumers were surveyed using computer-assisted telephone interviewing facilities at the Centre for Social Science Research, Central Queensland University. The target population designated for telephone interviewing was all persons 18 years of age or older who, at the time of the survey, were living in

Table 1
Attitudinal scales

Scale	Item	Mean item score ^a	Standard deviation	Scale reliability (Cronbach's alpha) ^b
Disposition towards biotechnology	Scientists are going too far with cloning and other biotechnologies	2.21	1.307	0.63
	Biotechnologies like cloning and genetic engineering are against the laws of nature	2.53	1.368	
	Releasing genetically modified organisms into the environment is too risky. We just don't know what will happen	2.18	1.352	
	All foods containing genetically modified ingredients should be labelled so that consumers can make their own choice	1.61	0.833	
Risks from industrialised foods	Pesticides and other chemicals	1.91	0.992	0.74
	Genetically modified organisms	2.38	1.388	
	Food irradiation	1.98	1.266	
	Preservatives and artificial colouring	2.41	0.927	
	Hormones and antibiotics in meat	1.98	1.091	
Healthiness of organic foods	Organic foods have lower chemical residues than conventional foods	2.52	1.551	0.72
	Organic foods have no more vitamins and minerals than conventional foods	3.87	1.417	
	Organic foods are safer to eat than conventional foods	2.69	1.404	
	Organic food is healthier to eat than conventionally grown food	2.69	1.400	
Quality of organic foods	Organic food tastes better than conventional food	3.13	1.553	0.56
	Organic food looks inferior to conventional food	3.50	1.312	
	Organic food has a shortened shelf life	3.37	1.705	
Fairness of premium for environment-friendly food	The prices received by Australian farmers are not high enough for them to address environmental problems	2.60	1.570	0.70
	I think it is fair to pay farmers more for producing food in an environmentally friendly way	2.13	0.968	

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Table 1 (continued)

Scale	Item	Mean item score ^a	Standard deviation	Scale reliability (Cronbach's alpha) ^b
Willingness to buy more organic food if available	I would gladly buy more organic food if I could find it	2.59	1.212	0.64
	I would buy more organic food if it was available as convenience, packaged and pre-prepared food	2.86	1.235	
Environmental behaviours	How often do you recycle paper, glass and other household waste products?	1.47	0.953	0.32
	How often do you purchase environmentally friendly cleaning products such as phosphate-free laundry powder or detergent?	2.80	1.279	
	How often do you compost your food scraps at home?	2.51	1.430	
	Are you a member, or do you participate, in an environmental organisation (such as Landcare, Greenpeace, the Wilderness Society, a local community group)?	1.86	0.358	
	Have you ever written a letter or made a phone call to a member of parliament, government department or your local council on an environmental matter?	1.77	0.423	

^a Risks from industrialised foods based on four point scale where 1 = very high risk and 4 = very low risk. All other variables based on five point scale where 1 = strongly agree and 5 = strongly disagree.

^b Cronbach's alpha is a statistic used to test the reliability of a multi-item scale by measuring the average inter-item correlation. High values (between 0.5 and 1.0) indicate a satisfactory scale.

a dwelling unit anywhere in Australia that could be contacted by a direct-dialled, land-based telephone service. A random selection approach was used to ensure that all potential participants had an equal chance of being contacted. The survey itself was designed to gather data on: motivational factors such as environmental and health concerns likely to influence food choice; attitudes towards contemporary food-related issues such as food safety, biotechnology and organics; and demographic characteristics.

Items on motivations affecting food consumption were drawn from Steptoe et al.'s (1995) food choice questionnaire with the addition of Lindeman and Väänänen's (2000) expanded range of items on ethical food choice motives. This instrument is designed to provide a multidimensional measure of motives related to food choice including health, weight control, ethical concerns, familiarity, sensory appeal, mood, convenience, natural content and price. Minor changes were made to the wording of several questions to reflect terminology with which Australian consumers were more likely to be familiar and two items added were directed more specifically to physical fitness. Each item took the form: "*how important is it to you that the food you eat on a typical day contains a lot of vitamins and minerals?*" Table 2 shows the scales, items and scale reliability.

Data analysis procedures

The factors behind food choice are too complex to be explained with a single motivation, attitude or other variable. Path analysis is thus used here as a multivariate tool to illustrate proposed causal relationships between multiple variables (De Vaus, 1991). Path analysis requires the prior construction of a path diagram based on theoretical reasoning. The path diagram consists of variables and the possible relationships between them. Relationships are denoted by directional arrows with the causal variable at the base of the arrow and the dependent variable at the arrowhead. Each variable may have an effect on several other variables and direct and indirect effects also are possible. Thus sex could influence an attitude directly or indirectly through an intervening variable such as education. While the idea of causality may be controversial (Mueller, 1996), path analysis provides a way of determining the inter-relationships of multiple variables in determining a particular outcome. The path diagram gives a pictorial representation of this relationship. Analysis of the path diagram produces the values of the path coefficients (the standardised partial regression coefficients). The path coefficients are "interpreted as absolute measures of direct causal influence" (Kotz et al., 1982, p. 636). The total causal effect of any variable on another variable may be calculated using the path coefficients. The direct effect of one variable on another is equal to the path coefficient. The indirect effect is calculated by multiplying the path coefficients along the desired path. The total effect is the sum of the direct and indirect effects (De Vaus, 1991).

Steptoe et al. (1995) note that while the scales developed in their food choice questionnaire have high internal reliability there are also strong enough correlations

Table 2
Food choice scales

Scale	Item How important is it to you that the food you eat on a typical day ...?	Mean item score	Standard deviation	Scale reliability (Cronbach's alpha)
Health	Contains a lot of vitamins and minerals	4.08	1.034	0.82
	Keeps you healthy	4.44	0.841	
	Is nutritious	4.43	0.870	
	Is high in protein	3.39	1.225	
	Is good for your skin/teeth/hair/nails, etc.	3.66	1.336	
	Is high in fibre and roughage	3.89	1.078	
Weight control	Is low in calories	3.20	1.307	0.84
	Helps you control your weight	3.27	1.403	
	Is low in fat	3.81	1.248	
Fitness	Provides enough energy to get through your physical exercise program	3.69	1.308	0.54
	Does not compromise your sporting and exercise goals	2.58	1.460	
Mood	Helps you cope with stress	2.56	1.507	0.80
	Helps you relax	2.88	1.407	
	Keeps you awake/alert	2.38	1.442	
	Cheers you up	2.87	1.479	
	Makes you feel good	3.83	1.218	
Convenience	Is quick and easy to prepare	3.82	1.102	0.73
	Can be cooked very simply	4.01	1.095	
	Can be bought in shops close to where you live	3.82	1.341	
	Is easily available in shops and supermarkets	4.23	0.980	
	Is not messy to eat	2.93	1.423	
Sensory appeal	Smells nice	4.13	0.998	0.67
	Looks nice	3.53	1.215	
	Has a pleasant texture	3.66	1.180	

Natural content	Contains no additives	3.61	1.234	0.86
	Contains natural ingredients	4.19	0.994	
	Contains no artificial ingredients	3.62	1.207	
	Certified free of chemical and hormone residues	3.63	1.413	
	Is as unprocessed as possible	3.73	1.206	
	Is prepared in a way that preserves its natural goodness	4.29	0.873	
Price	Is not expensive	3.53	1.174	0.58
	Is good value for money	4.33	0.825	
Familiarity	Is what you usually eat	3.63	1.128	0.61
	Is familiar	3.44	1.240	
	Is like the food you ate when you were a child	2.59	1.380	
Animal welfare	Has been produced in a ways that animals have not experienced pain	3.59	1.425	0.86
	Has been produced in a way that animals' rights have been respected	3.64	1.375	
Environmental protection	Is prepared in an environmentally friendly way	3.78	1.237	0.79
	Is produced in a way that has not shaken the balance of nature	3.47	1.372	
	Is packaged in an environmentally friendly way	3.18	1.360	
	Is grown locally to reduce transportation	3.42	1.380	
Political values	Comes from a country that you approve of politically	2.99	1.603	0.78
	Comes from a country in which human rights are respected	2.90	1.598	
	Has the country of origin clearly marked	3.80	1.370	
	Has been prepared in a way that does not conflict with your political values	2.46	1.497	
Religion	Is not forbidden by your religion	1.59	1.217	0.66
	Is in harmony with your religious views	1.50	1.133	

between a number of the scales to suggest that collapsing them into a smaller number of factors may be appropriate. While Steptoe et al. (1995) justify the maintenance of the full nine scales on the basis that investigating a wide range of specific motives of food choice is likely to be more useful than assessment of a small number of broad dimensions, the use here of path analysis to describe the causal relationships between multiple variables necessitated assimilation of scale items into the smallest number of variables practicable. Factor analysis was, therefore, conducted prior to undertaking the path analysis and a revised set of scales developed. Factor analysis is a statistical technique used to describe data using a smaller set of underlying variables (De Vaus, 1991).

Results

The attitudes of consumers towards biotechnologies were, on average, more negative than positive (see Table 1). Similarly, consumers were generally concerned about the long term riskiness of industrialised food production and processing techniques (see Table 1) and professed to be highly motivated by the health, naturalness, animal welfare and environmental attributes of foods. However, there also were considerable levels of variability in the direction and strength of consumer attitudes and motivations towards a number of scales including disposition towards biotechnology. While the broad thrust of community opinion would appear to be cautious regarding biotechnology, enough variability was evident to suggest that underlying food choice motives and behaviours may have some ability to account for differing levels of opposition and support for biotechnologies.

Factor analysis of all items included in Tables 1 and 2 resulted in assimilation of these items into seven underlying factors that explained a large amount of the variance, had good reliability analysis and could sensibly be interpreted. These underlying factors included *green consumption behaviours*, *willingness to pay a premium* for environmental values, *convenience*, *sensory and emotional appeal*, *natural foods*, *political and ecological values*, *healthy food values*, and *acceptance of biotechnology* (see Table 3).

These factors, together with the demographic variables age, sex, income and education level, as well as responsibility for household shopping, were used to conduct a path analysis predicting acceptance of biotechnology. The resultant path can be seen in Fig. 1. The path coefficients are shown in Table 4. The *green consumption behaviours* and *willingness to pay a premium* scales did not have a significant impact on *acceptance of biotechnology* and were removed from the resultant analysis. All other variables were significant at the 95% confidence level. Further examination showed that the coefficients related to *healthy food values* were contradictory to the intuitive relationships between *healthy food values* and education and with other observed relationships between these variables, gender and *acceptance of biotechnology*. This factor consequently was deleted from the analysis.

Table 3
Revised scales – motives, attitudes, beliefs and behaviours affecting food choice

Scale	Abbreviated questions	Reliability (Cronbach's alpha)	Coding
Green consumption behaviours	Recycling of paper, etc. Purchase of environmentally friendly cleaning products Composting food scraps	0.26	Amount of recycling decreases as value increases
Willingness to pay premium	Prices received by farmers not high enough Fair to pay farmers more	0.54	Agreement decreases as value increases
Convenience	Can be bought in shops close to where you live Can be cooked very simply Is easily available in shops and supermarkets Is not messy to eat Is quick and easy to prepare	0.73	Importance increases as value increases
Sensory and emotional appeal	Looks nice Helps cope with stress Keeps you awake/alert Cheers you up Has a pleasant texture Helps relax Is adventurous and varied Is familiar Tastes good Is like the food eaten as a child Smells nice Makes you feel good Is what you usually eat	0.81	Importance increases as value increases
Natural foods	Contains natural ingredients Contains no additives Is as unprocessed as possible Certified free of chemical and hormone residues Is prepared in a way that preserves its natural goodness Contains no artificial ingredients	0.48	Importance increases as value increases

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Table 3 (continued)

Scale	Abbreviated questions	Reliability (Cronbach's alpha)	Coding
Political and ecological values	Risk from pesticides and other chemicals	0.90	Importance increases as value increases
	Risk from genetically modified organisms		
	Risk from food irradiation		
	Risk from preservatives and artificial colouring		
	Risk from hormones and antibiotics in meat		
	Is packaged in an environmentally friendly way		
	Comes from a country that you approve of		
	Comes from a country in which human rights not violated		
	Is grown and manufactured in Australia		
	Animals' rights have been respected		
Healthy Food Values	Prepared in an environmentally friendly way	0.85	Importance increases as value increases
	Is grown locally to reduce transportation		
	Animals have not experienced pain		
	Has the country of origin clearly marked		
	Has not shaken the balance of nature		
	Does not conflict with political values		
	Is nutritious		
	Is low in calories		
	Helps control weight		
	Is low in fat		
Acceptance of Biotechnology	Sporting and exercise goals	0.70	Agreement decreases as value increases
	Is high in protein		
	Keeps you healthy		
	Is high in fibre and roughage		
	Provides enough energy		
	Contains a lot of vitamins and minerals		
	Is good for skin, etc.		
	Foods containing GMOs should be labelled		
	Release GMOs too risky		
	Scientists going too far		
	Cloning etc against laws of nature

Fig. 1. Path model for increasingly positive disposition towards biotechnology.

Discussion

Of the eight variables significantly associated with consumers' acceptance of biotechnology, *natural foods* and *convenience* had by far the largest effects. These effects were, however, in opposite directions, with those consumers motivated to find foods they considered natural being least favourable towards biotechnology, and those consumers interested more in convenience being most favourable. Sex also contributed a moderate effect, with women less favourably disposed towards biotechnology than men.

The negative association between *natural foods* and *acceptance of biotechnology* is not surprising in light of several items included in the *natural foods* scale. The inclusion of items relating to the perceived riskiness of ingesting genetically modified foods and the benefits, in contrast, of organic foods, clearly establishes a logical inconsistency between concern for naturalness and support for biotechnology. However, in interpreting this seemingly inevitable result it is important to remember that the *natural foods* scale was a new variable based on factor analysis that revealed a high level of correlation between the general items on naturalness included in

Table 4
Path analysis – value of effects

Variable 1	Variable 2	Value of effect
Acceptance of biotechnology	Natural foods	–0.48
	Convenience	0.44
	Sex	–0.22
	Education	0.09
	Health	0.07
	Sensory and emotional appeal	0.06
	Political and ecological values	–0.04
	Income	0.01
Natural foods	Sex	0.45
	Responsibility for shopping	0.22
	Education	–0.05
	Age	0.02
Convenience	Responsibility for shopping	0.27
	Education	–0.12
	Sex	–0.09
	Income	–0.02
Responsibility for shopping	Sex	0.32
	Education	0.01
	Age	> 0.01
Sensory and emotional appeal	Sex	0.30
	Responsibility for shopping	0.22
	Education	–0.10
	Income	–0.02
	Age	0.01
Political and ecological values	Sex	0.44
	Education	–0.05
	Income	–0.02
	Age	0.01
Education	Sex	–0.29
	Age	–0.02
Health	Sex	0.49
	Education	–0.04
	Age	0.02
Income	Sex	–1.11
	Age	–0.05

Steptoe et al.'s (1995) *natural content* scale and additional items developed to assess more specifically the perceived riskiness of industrialised foods, and so on. While the survey, in other words, made no presuppositions about the naturalness or otherwise of food biotechnologies, respondents very clearly signalled their belief that food biotechnologies were not natural. The arguments of biotechnology proponents that new technologies such as genetic engineering are natural extensions of age-old selective breeding practices – and the resultant products functionally equivalent to conventional

foods – had not convinced the majority of food consumers. As a consequence, those consumers who were more supportive of biotechnology tended to be those who were less motivated to avoid foods that were processed or contained artificial additives, less likely to believe that industrial food technologies such as agri-chemicals and food irradiation posed significant threats, and less likely to believe that organic foods offered consumers greater safety, quality or nutrition. As Tables 1 and 2 show, such consumers were comparatively few in number.

Those consumers who were more positively disposed towards biotechnology were also considerably more motivated to base their food choices on *convenience*; that is, on foods that are quick and easy both to purchase and to prepare. This result is consistent with outcomes of the consumer focus groups, which found a perceived lack of convenience to be a major barrier to increased consumption of certified organic foods even among those who considered the ‘naturalness’ of organic foods a distinct advantage (see Lyons et al., 2001; Lockie et al., 2002).

While high levels of motivation towards *natural foods* and *convenience* produced contradictory effects on disposition towards biotechnology, both were influenced in turn to an equally strong positive degree by whether or not consumers undertook household shopping on a regular basis. Taking responsibility for household food provisioning may be seen logically to influence levels of motivation towards both *natural foods* and *convenience* on the basis that those taking such responsibility are confronted with the additional responsibility of ensuring household members are provided with foods that are safe and nutritious, and with the burden on their time and energy that comes with such responsibility. Forced into confronting the implications of their choices for themselves and others, those who take responsibility for food provisioning express stronger views on the importance of both naturalness and convenience than do those who are fed by others. The question that remains is how taking responsibility for shopping can lead, it seems, to both positive and negative effects on consumers’ dispositions towards biotechnology through the intervening variables *natural foods* and *convenience*. The critical point here is that while responsibility for shopping had a strong effect on both *natural foods* and *convenience* it was not the only variable exerting an influence and did not itself have a significant direct relationship on *acceptance of biotechnology*.

The largest effect on motivation towards *natural foods* came not from responsibility for shopping but from sex, with women considerably more likely to be motivated towards *natural foods* than were men. Consistent with this result, women were slightly less likely than men to be motivated by *convenience* despite being considerably more likely to take responsibility for household shopping on a regular basis. Further, women had lower levels of education than men with education, in turn, having a moderate negative effect on motivation towards *convenience*. Taking all this into account, the effect of sex on *acceptance of biotechnology* both directly and through the intervening variables *natural foods* and *convenience* best accounts for the seemingly contradictory impact of responsibility for shopping.

It is worth noting that sex had a major effect on all variables except for age, with women showing consistently less positive attitudes towards biotechnologies and

other industrialised food production and processing technologies conceived as unnatural and risky. Women also were considerably more motivated than men to consume foods they regarded as consistent with their *political and ecological values* and foods that offered *sensory and emotional appeal*. In fact, the only food-related value towards which women were less motivated than men was *convenience*. These gender differences were explained by several focus group participants as the outcome of women's traditionally care-oriented roles within the household, an explanation echoed in a range of other studies (see [Cunningham, 2001](#)). The results here, however, do not support this explanation. The effect of responsibility for shopping on *acceptance of biotechnology* was no greater in magnitude than a range of other variables, indirect and, most importantly, contradictory. In fact, taking responsibility for shopping was just as likely to lead to an *acceptance of biotechnology* (through the intervening variable of *convenience*) as it was to its rejection (through the intervening variable of *natural foods*). As the path diagram shows, women both were more likely than men to be directly motivated to consume foods they considered natural and to reject biotechnology outright.

A further question remains regarding why the remaining variables had little, if any, effect on dispositions towards biotechnology. Of most interest in this regard are those variables related to values since there is no a priori reason to suspect that the remaining demographic variables would have substantial effects. Given the importance of *natural foods*, in particular, it would be reasonable to speculate that other health and environmental values would also have major effects. The most convincing explanation, we believe, for why they did not lies in the confusion and ambivalence many consumers express towards the environmental and health attributes of biotechnology (see [Lockie et al., 2002](#)). Focus group participants were aware, for example, of claims by biotechnology proponents that technologies such as genetic engineering offered opportunities to improve the environmental sustainability of food production while developing foods that were more nutritious, tasted better and/or contained medicinal compounds. They were also aware of the criticisms made by biotechnology proponents of alternative production systems such as organic agriculture, which they charged with depleting soil reserves and lowering food production in an era of rapid population growth. Despite the scepticism of many focus group participants regarding these claims, consumers were clearly faced with an environment in which competing knowledge claims regarding biotechnology may reasonably have led them to a range of conclusions regarding its advantages and disadvantages.

Implications for food governance

State regulation of the new biotechnologies predominantly has been based on scientifically defined notions of 'risk management' and 'substantial equivalence'. Criticisms of this regime have focussed on what is perceived as an undemocratic bias towards narrow sectoral interests; a myopia towards indeterminable ecological and health risks; and a failure to learn the lessons of earlier food scares and the

erosion of trust in regulatory and scientific institutions to which they have contributed (Schweiger, 2001; Tokar, 2001). Underlying this, according to Barling et al. (2002); Lang et al. (2001) and Murcott (1999), has been a dominance of productivity concerns within food policy more generally and an ensuing lack of institutional and legislative integration between the goals of food production, public health and natural resource management. Within this context, calls to establish public debate and participation in decision-making as the touchstone of new policy about food regulation and safety make considerable sense (see Murcott, 1999). They are consistent also with the finding here that despite the many millions of dollars spent by industry and governments on public relations campaigns designed to promote the merits of the new biotechnologies (Hindmarsh and Lawrence, 2001), food consumers remain, on the whole, sceptical. However, it is important to note that state-based legislative processes are not the only arenas through which biotechnologies are governed.

New regulatory regimes are emerging due, in large part, to the increasingly influential role of large retailers in the food industry (Marsden et al., 2000). A clear pattern has become evident in Australia, the UK and elsewhere, of pre-emptive moves on the part of large supermarket chains to impose quality assurance schemes that exceed legislative requirements for labelling, food safety and so on (Lockie and Salem, 2005; Pearce and Hansson, 2000). These may be seen as part of a broader strategy to foster consumer trust, reduce exposure to food-borne risks and minimise liability (Pearce and Hansson, 2000) that potentially stands supermarkets in stark contrast with the pro-biotech orientation of the food production and processing industries (Goodman and Redclift, 1991; Weeks, 1999). Indeed, some of the world's largest retailing chains have taken steps to eliminate genetically modified foods from their own-brand products and to make organic and other certified GE-free foods more widely available (Burch et al., 2001; Tokar, 2001). It would be naïve to suggest that these steps have been simply out of response to consumer 'demands'. It would be equally naïve to suggest that reluctance to stock GE products either is universal across the retailing sector (see Schweiger, 2001) or that it is not likely to be challenged. Nevertheless, in a legislative environment in which the public is accorded little role beyond the choices they may make as consumers (see above), the opportunities opened up for the expression of consumer and social movement agency by retailer-led regulatory regimes are interesting and important.

As this study shows, few Australian consumers consider foods produced using biotechnologies such as genetic engineering to be natural and many reject them on that basis. While taking responsibility for household food provisioning itself produces contradictory effects, it is telling that women, who are overwhelmingly responsible for shopping and food preparation, are also overwhelmingly convinced that biotech foods are not natural. For retailers – the primary point of contact between food consumers and the food industry – there seem to be three broad ways in which they may respond to these concerns. The first, echoing the approach promoted by the biotech sector, is to continue to promote 'risk management' and 'substantial equivalence'; that is, to cooperate with existing legislative requirements that effectively hide the GE status of foods through minimal, if any, labelling. The second, is to seek to eliminate all

GE foods by stocking only those that can be certified GE-free using reliable audit procedures. The third, and perhaps most likely, is a compromise whereby genetically engineered and other biotech foods sit alongside organic (or other 'natural') foods on supermarket shelves. Whichever of these options individual retailers pursue, it can be taken more-or-less as given that their own regulatory activities – including the use of third party certified quality assurance systems – will continue to expand. The challenge for retailers will lie in aligning these essentially bureaucratic procedures with notions of food 'quality', such as 'naturalness', that are not easily defined. While the items comprising the *natural foods* scale used in this research provide a negative definition (i.e. natural foods are those that are not processed, irradiated and so on), it is rather more difficult for the majority of consumers to say what natural foods actually are. The same is true of foods construed to be of higher quality due to attributes of locality, tradition and so on. The one thing that is certain here is that, in the minds of consumers, quality embodies more than the measurable physical and chemical properties of food. While this is most obvious in rapidly rising consumption of certified organic foods (a system that successfully combines auditable production standards with the signification of less tangible characteristics such as naturalness), and the emergence of social movements around fair trade and slow foods, its implications for the mainstream food sector cannot be ignored.

With worldwide resistance to GM described as one of the fastest growing social movements in a generation' (Tokar, 2001, p. 315), it seems unlikely that the invisible penetration of unlabelled biotech products into the food marketplace will be tolerated. The results presented here suggest that some of the key determinants of long-term acceptance or rejection of biotech foods will be the extent to which the food industry is able to ensure that regulatory regimes (public and private) allow biotechnologies to be considered 'normal' and their ability to counter, in the minds of consumers, the arguments of social movement organisations that such foods are 'unnatural'. While confusion among consumers regarding the risks and benefits of biotechnology may be seen by some to justify the allocation of regulatory power to expert scientific institutions, such moves, in the past, have contributed to a crisis of trust in many such institutions and are inconsistent with the mission of retailers to use private regulatory regimes to build trust. Given that the key determinant of *acceptance of biotechnology* is concern for *convenience* in the procurement and preparation of foods, opportunities to increase the market penetration of biotech foods may coalesce around the development of genuine convenience benefits over their competitors. But this presents another area in which biotech foods potentially are vulnerable, as the opportunity to enhance convenience is just as open to the proponents of organic and other 'natural' foods as it is to the biotech industry.

Conclusion

In keeping with previous studies of consumer attitudes to biotechnology, this Australian study showed consumers to have mixed, but on average, less positive attitudes toward biotechnologies. It also showed, however, that the interactions between

a small number of motivational and demographic variables can be used to explain much of the variability that is evident in the strength and direction of consumer dispositions towards biotechnology. The extent to which consumers were motivated to eat foods they considered natural had a very strong direct negative effect on their dispositions towards biotechnology, while the extent to which they were motivated to find foods that were convenient to purchase and prepare had a similarly strong, but positive, effect. Both these variables were influenced, in turn, by whether or not consumers took responsibility themselves for shopping for food for their households on a regular basis. Although this finding may appear contradictory, it is important to keep in mind the major effect of sex on almost all other variables including responsibility for shopping, natural foods and, to a lesser extent, acceptance of biotechnology directly. Finally, in a policy context, the results of the study support the cautionary approach being taken by most of the large supermarket chains: that is, providing consumers with what are construed to be 'natural' products, despite the 'convenience' that GE products might afford.

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