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The effects of label design characteristics on perceptions of genetically modified food

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Objective. To explore the effects on perceptions of labelling food for genetically modified content. Background: there is increasing public pressure for the compulsory labelling of genetically modified food content on all food products, and yet little is known about how the design and content of such food labels will influence product perceptions. The current research draws upon warning label research – a field in which the effect of label design manipulations on perceptions of, and responses to, potential or perceived risks is well documented. *Method*. Two experiments are reported that investigate how label design features influence the perception of genetically modified foods. The effects of label colour (red, blue and green), wording style (definitive vs. probabilistic and explicit vs. non-explicit) and information source (government agency, consumer group and manufacturer) on hazard perceptions and purchase intentions were measured. *Results*. Hazard perceptions and purchase intentions were both influenced by label design characteristics in predictable ways. Any reference to genetic modification, even if the label is stating that the product is free of genetically modified ingredients, increased hazard perception, and decreased purchase intentions, relative to a no-label condition. *Conclusion*. Label design effects generalise from warning label research to influence the perception of genetically modified foods in predictable ways. *Application*. The design of genetically modified food labels.

Keywords: food labelling; genetically modified food; hazard perception; purchase intention

Introduction

The genetic modification (GM) of food is a hotly contentious issue that attracts much media coverage and research indicates that many consumers, particularly in Europe, have negative attitudes to GM foods (e.g. Batrinou, Spiliotis, and Satellaris 2008; Costa-Font, Gil, and Traill 2008; Frewer 1999; Gaskell 2006; Grove-White et al. 1997; Oguz 2009). Central to the debate surrounding the acceptability of GM foods has been the adequacy of the labels that indicate GM content, and hence the extent to which consumers are able to choose whether or not to buy these foods. Consumers believe GM products should be labelled and want labelling (Cope et al. 2010; Food Standards Agency 2003; Hallman 2000; Hallman et al. 2002), labelling

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is the only means of determining whether or not a product contains GM ingredients. Some researchers have even suggested that tolerance for GM foods would be increased with labelling, as it would allow consumers control over the perceived risks associated with GM products (Hunt and Frewer 2001a). In the UK, it is not currently mandatory to label GM foods as such, but even in the USA and the rest of the European Union where labelling for GM foods is mandated, there is concern that the labels used may not be informative and that the effects of these labels on consumer perceptions are unknown (Gruere, Carter, and Farzin 2008; Select Committee on the European Communities Report 1998).

In contrast to consumer demand for the labelling of GM foods, food producers lobby to resist the mandatory labelling of GM foodstuffs for fear that it will negatively impact on trade (Newspeg 1998). Clearly then, governments are under pressure to both promote the sale of authorised GM foods for economic reasons, whilst also satisfying the demand for consumer choice through labelling. Little published research is available on the nature of consumers' reactions to labels indicating GM content, and so research is needed to investigate consumer reactions not just to GM foods themselves but also to existing and potential GM food labels. The research presented here tackles the latter issue.

Previous research that has been done specifically on GM food labelling has looked at the effects of the information source and the wording of the label. The work of Frewer, Howard, and Shepherd (1996) and Sparks, Shepherd, and Frewer (1994) suggests that trust in the attributed information source for a label determines the believability of the information provided. The finding that information provided by consumer associations is more trusted than that provided by the Department of Health is typical, although how perceptions of trust that the information is accurate translate into purchase intentions or other subjective responses is not known. It has also been suggested that the wording of GM food labels could affect the acceptability of the product. Runge and Jackson (2000) claimed that negative labelling (e.g. this product contains no genetically modified ingredients) was the most appropriate way to inform the public about GM content. These were compared to positive labels (e.g. this product may contain GM ingredients) which, they argued, gave little information to the consumer. However, the difference between these two statements is not just positive and negative. The statement 'this product *may* contain GM ingredients' is probabilistic, whereas 'this product *contains no* GM ingredients' is definite, so the positive and negative label content is confounded with the use of definitive or probabilistic wording. Research in the area of warning labelling has shown that definitive wording on warning labels is associated with increased hazard perception and behavioural compliance when compared to probabilistic wording. For example, Heaps and Henley (1999) compared probabilistic statements with definitive statements and showed that definitive expressions scored significantly higher on believability. Edworthy et al. (2004) also found that definitive statements of risk were preferred to probabilistic ones. The effect of probabilistic vs. definitive wording on GM food labels, and how it might interact with positive or negative label content, is not known.

There is a substantial body of research documenting the effects of other warning label design features on responses to labels, which might inform the design of labels for GM foods, as well as providing a methodological paradigm for assessing the impact of different GM food labels. For example, studies have shown that the colour of a warning label is an important determinant of perceptions of, and responses to, it. In general, this research has been consistent in revealing that in western culture, the colour red is perceived as implying a high level of hazard, followed by colours such as orange and yellow, then blue and green, with white implying the least hazard (e.g. Adams and Edworthy 1995; Braun and Silver 1995; Chapanais 1994; Dunlap, Granda, and Kustas 1986). Besides indicating the level of hazard implied by a label, the use of colour (as opposed to monochrome) has also been associated with increasing the noticeability of a label (e.g. Young 1991); with increases in label identification speed and accuracy (e.g. Ellis, Dewar, and Milloy 1980; Young 1991) and with increases in perceived readability (Kline et al. 1993). Some authors (e.g. Braun and Silver 1995) have also demonstrated that label colour influences compliance levels – they found higher levels of compliance to red labels than to either black or green ones.

More specific work on the linguistic expressions used in label wording has shown that linguistic factors can influence perceived risks and hazards, product perceptions and purchase intentions. For example, Laughery et al. (1993) looked at the relationship between the explicitness and severity of information on warning labels. They found that expressing a hazard explicitly (e.g. if you drink while you are pregnant, your child may be born with Foetal Alcohol Syndrome and need institutionalisation) rather than non-explicitly (e.g. mixing alcohol and medicine can be life-threatening) led to higher ratings of the seriousness of the risk and lower ratings for purchase intention. Heaps and Henley (1999) tested explicitness vs. implicitness, and found that explicitness improved a label's believability and increased perceived product dangerousness. Edworthy et al. (2004) explored responses to pesticide labels and also found that explicit (rather than non-explicit) risk statements were preferred.

In the studies presented here, we will explore the effects of key warning design variables on perceptions of GM food labels. The selected variables, colour, definitiveness and explicitness of wording are chosen on the basis that they have been shown to have consistent effects on warning perception and also because they are variables that it is practical to manipulate in the design of food labels (unlike something like size of font which is limited at the small extreme by considerations of readability and at the large extreme by the constraints of label size). In addition, the present studies will also investigate variations in the attributed source of the label information. Trust is known to be an important determinant of responses to information about food-related risks and GM (e.g. Frewer and Miles 2003; Grove-White et al. 1997; Hossain and Onyango 2004) and the extent to which an attributed source of label information is trusted may well mediate the effects of label design manipulations. The effects of label variations on different types of food product (natural and synthetic) are also explored as responses to GM have been shown to depend in part on the context in which the technology is applied (e.g. Bredahl 1999; Grove-White et al. 1997; Hoban and Kendall 1992) and so it is possible that the effects of label variations may be mediated by product type.

General method

We systematically varied label colour, explicitness of wording, how definitive the wording is, attributed source of information and product type in two experiments. We factorially combined these variables to create a wide range of possible GM food labels which were scanned onto photographs of food products. We took measures of perceived hazard and purchase intention. The use of subjective measures allowed us to analyse a large number of label variations without the need to deceive participants into the belief that they were at risk. The subjective approach to measuring responses to labels is commonly used in warnings research as a precursor to objectively measuring behaviour, and subjective measures have been found to be good predictors of actual behaviour (Hellier and Edworthy 2002). Perceived hazard was measured to facilitate comparison with the warning label research and also because perceived risk is known to be an important determinant of food choice generally (Knox 2000), and of GM food choice in particular (e.g. Cooke, Kerr, and Moore 2002; Miles and Frewer 2001; Miles, Ueland, and Frewer 2005). Purchase intention is obviously an important measure in the context of food labelling and it is vital to delineate the effects of label design manipulations on purchase intention. Although purchase intention is rarely measured in warnings research (as so it is difficult to predict from the hazard measures taken what the effect on purchase intention might be), some authors suggest that an inverse relationship between hazard perception and purchase intention exists (e.g. Hyde and Hellier 1997; Onyargo 2004; Yeung and Morris 2001).

The pictures of the food product plus label were presented to participants in one of four different random orders. When viewing the pictures, participants were asked to assume that each product was of the same price and quality and that they would, in principle, buy the product. Participants were asked ‘How much hazard is indicated by the label?’ and indicated their response on an 8-point Likert-type scale answer, where 0 represented ‘No Hazard’ and 8 represented ‘Extreme Hazard’. Participants were also asked ‘How likely would you be to buy this product?’ and indicated their response on an 8-point Likert-type scale that ran from 0 to 8, where 0 represented ‘Not at all Likely’ and 8 represented ‘Extremely Likely’. The order in which the purchase intention and hazard questions were asked was counterbalanced between participants.

Experiment 1: the effects of label colour, wording, content and attributed information source

In this study, the effects of label colour, wording, content and attributed information source on hazard perception and purchase intention for GM foods were explored. The colours red, blue, green and white were selected, on the basis of previous research (e.g. Adams and Edworthy 1995), to represent a range of hazard association values from high (red) to low (white) that are approximately equally spaced. The wording manipulation varied the extent to which the wording was definitive vs. probabilistic, with the expectation that this manipulation would interact with the label content (GM or non-GM), so that definitive wording was expected to result in negative perceptions when the GM content was positive (contains GM), but definitive wording was expected to result in positive perceptions when GM content was negative (no GM). In warnings research, definitive wording is usually associated with increases in hazard perception and compliance (e.g. Heaps and Henley 1999), and some research on GM food labelling has also found that probabilistic wording is not favoured. For example, a Canadian focus group study examined reactions to the use of the words ‘May Contain’ and found that the words conveyed the image of a producer who did not know enough about the product he or she was selling to say whether it was GM or not (National Institute of Nutrition 1998). Similarly, US focus group members also disliked the words ‘may contain’ (Teisl et al. 2002).

Various attributed sources of the label information were also examined (a consumer association, the Department of Health, the manufacturer and no attributed source). These sources were selected, on the basis of previous research, to represent a range of trust (and a control). For example, Frewer et al. (1995), as well as Frewer et al. (1999) found that consumer associations were among the most trusted sources of information and government departments the least. Hunt and Frewer (2001b) also found the same relative levels of trust, with the addition that food manufacturers were included as less trusted sources of information. Food manufacturers are included here, as currently in the UK, it is food manufacturers who are responsible for the GM labelling of their products.

Method

Design

The design was a 4 (colour: red, green, blue and white) × 4 (source: no source, consumer association, and Department of Health and manufacturer) × 2 (wording: probabilistic vs. definitive) × 2 (content: GM vs. no GM) within participant design.

Participants

Forty two native English-speaking participants (29 females and 13 males) aged 18–40 years took part in the experiment. They were recruited through posters displayed at the University of Plymouth and were paid £3.50.

Stimuli and materials

Factorial combination of all levels of colour, warning source, content and wording resulted in 64 different labels. The labels were scanned onto identical pictures of a food product (a foil-wrapped packet of cheese biscuits). A picture of the food product with no label was also included as a comparison.

The labels were all identical in size, had the signal word 'Notice' as a header and were printed in Times New Roman font size 12. The labels were coloured red, green, blue and white as appropriate. The information source was indicated by the heading 'Consumer Association Notice', 'Department of Health Notice', 'Manufacturers Notice' or 'Notice' as appropriate. The wording of the labels was either definitive ('Contains'/'Contains no') or probabilistic ('May contain'/'Unlikely to contain'). Definitive vs. probabilistic wording was combined with information content (whether the label indicated the presence or absence of GM ingredients) to produce four label variations, 'Contains Genetically Modified ingredients'; 'May contain Genetically Modified ingredients', 'Contains no Genetically Modified ingredients' or 'Unlikely to contain Genetically Modified ingredients'. (Thus there were two definitive labels and two probabilistic labels in each case, one indicated the presence and one the absence of GM ingredients.)

Procedure

Participants were presented with booklets containing 65 photographs of the food product, each with a different label. They rated perceived hazard and purchase intention in relation to each photograph. The study took no longer than 30 min.

Results and discussion

The mean ratings for hazard perception and purchase intention as a function of label design features are shown in Table 1. Overall, as the mean scores for hazard perception increased, the scores for purchase intention decreased ($r = -0.97$, $p > 0.01$).

No label condition

The no label condition resulted in the lowest perceptions of hazard ($M = 1.2$) and the highest purchase intentions ($M = 5.3$) of all the conditions. Thus having no label at all resulted in lower perceptions of hazard and higher levels of purchase intention than labels stating that there were 'no GM' ingredients in the product.

Hazard perception

The data were analysed in a 4 (colour) × 4 (source) × 2 (content) × 2 (wording) repeated measures analysis of variance. The Univariate F tests are reported with Greenhouse-Geisser adjustments to the degrees of freedom, indicated by superscript 'g', where violations of sphericity occurred.

There were main effects of colour, source and content. The hazard ratings for colour, $F(1.5, 60.5)^g = 7.4$, $p = 0.003$, showed that red labels produced higher perceptions of hazard than the other three colours, which differed only marginally. Hazard ratings for information source indicated that Department of Health and Notice gave rise to higher perceptions of hazard than the manufacturer and consumer association, $F(2.5, 101.9)^g = 3.5$, $p = 0.025$. In line with the opposite pattern in the purchase intentions, labels with GM content were reliably perceived as more hazardous ($M = 3.84$) than those without ($M = 1.73$), $F(1, 41) = 95.2$, $p < 0.001$.

Colour interacted with all other factors. With source, $F(6.6, 269.8)^g = 2.1$, $p = 0.047$, the largest contribution to the interaction was a relatively low hazard rating for green consumer association labels. With GM content, $F(3, 123) = 7.1$, $p < 0.001$, red and white labels showed a relatively high perceived hazard for GM over non-GM content compared to green and blue ones. The interaction with word-

Table 1. The mean ratings for hazard perception and purchase intention as a function of label design features (Experiment 1).

	Hazard		Purchase	
	Mean	SE	Mean	SE
Red	3.14	0.20	3.50	0.21
Blue	2.69	0.17	3.66	0.22
Green	2.63	0.17	3.76	0.21
White	2.67	0.18	3.65	0.22
Manufacturer	2.75	0.17	3.61	0.22
Consumer's	2.68	0.16	3.72	0.21
Department of Health	2.85	0.16	3.63	0.21
Notice	2.85	0.17	3.62	0.22
GM	3.84	0.24	2.77	0.24
Non-GM	1.72	0.15	4.52	0.23
Probabilistic	2.73	0.17	3.92	0.19
Definitive	2.84	0.18	3.36	0.25

ing, $F(2.3, 95.1)^{g} = 3.8$, $p = 0.021$, arose from a greater perceived hazard for definite over probabilistic wording for red and green labels whereas no difference was observed between the two wording types for white and blue labels.

GM content also interacted with wording, $F(1, 41) = 109.7$, $p < 0.001$. For probabilistic wording, the difference in perceived hazard between GM and no GM content was small ($M = 3.2$ vs. 2.5), whereas when the wording was definite this difference was much larger ($M = 4.46$ vs. 1.0). Finally there was a three-way interaction between colour, content and wording, $F(3, 123) = 3.5$, $p = 0.018$.

Purchase intention

The same ANOVA on purchase intentions showed main effects of colour, content and wording. For colour, the pattern was essentially the reverse of the hazard perception data with green labels producing the highest purchase intentions ($M = 3.76$) and red the lowest ($M = 3.50$) with white and blue labels showing similar levels ($M = 3.66$, 3.65), $F(2.5, 103)^{g}$, $p = 0.018$. In line with the opposite pattern in the perception of hazard, labels referring to GM content produced lower mean purchase intentions ($M = 2.77$) than those without GM content ($M = 4.52$), $F(1, 41) = 65.9$, $p < 0.001$. Probabilistic wording resulted in higher purchase intentions ($M = 3.92$) than definite ($M = 3.37$), $F(1, 41) = 15.5$, $p < 0.001$.

The interpretation of all main effects needs to be modified by a number of higher order interactions. Colour interacted with source, $F(9, 369) = 3.89$, $p < 0.001$. This complex interaction is probably best understood as a deviation from the main colour effect for 'Notice' which showed the highest purchase intentions for white labels followed by red, green and blue. Source interacted with content, $F(3, 123) = 7.26$, $p < 0.001$, primarily as a result of a greater difference between GM and non-GM for Department of Health labels. A colour by wording interaction, $F(3, 123) = 3.24$, $p = 0.025$, indicated a greater advantage in purchase intentions for blue labels and probabilistic wording. Wording also interacted with content, $F(1, 41) = 69.6$, $p < 0.001$. This interaction was similar but in reverse to that found for perceived hazard. The overall higher purchase intentions for non-GM products were largely the result of a strong preference for non-GM products ($M = 5.4$) over GM products ($M = 2.5$), when the labels contained definitive wording compared to only a minor difference when the wording was probabilistic ($M = 3.7$ vs. 3.1). There were also two 3-way interactions between colour, source and content $F(5.7, 232)^{g}$ and colour, content and wording $F(2.3, 93.6)^{g}$ which we do not attempt to interpret.

Experiment 2: the effects of product type and warning explicitness

In this study, the effect of explicit vs. non-explicit label wording on perceptions of two different types of food product was explored. While explicit wording has been associated with increases in hazard perception in warnings research (e.g. Laughery et al. 1993), the effects for explicit vs. non-explicit wording have also been shown to vary as a function of different types of product. Explicit warnings have been shown to be perceived more favourably on products that are perceived as hazardous (and do not negatively impact on product perceptions), whereas for products that are not perceived as being hazardous, explicit warnings do negatively impact on product perceptions (Hyde and Hellier 1997; Laughery et al. 1993). This study will investigate whether there is a parallel effect for food warnings, whether there is an effect of explicit product wording and whether this effect is dependent on the type of food products being rated. There is some evidence from existing research into genetically modified foods that perceptions vary as a function of the type of food product being considered (e.g. Bredahl 1999).

The food products used in this study were categorised as either ‘natural’ or ‘synthetic’, ‘naturalness’ is an everyday dimension on which food products vary, and may also be a food-related corollary of the hazardous and non-hazardous products used in warning label research. Fifteen participants rated a pool of 30 food products on a scale from ‘totally natural’ to ‘totally synthetic’, and the six most natural and the six most synthetic products were used as the experimental stimuli. On the basis of previous research, an interaction is predicted so that explicit label wording on natural products negatively influences product perceptions (but explicit wording on synthetic products does not negatively influence product perceptions). In addition, we employed two different label contexts, one indicating the presence of GM ingredients, the other indicating the presence of preservatives. Categorising our stimuli as either ‘synthetic’ or ‘natural’, and using either ‘GM’ or ‘preservative’ as the label context, will enable us to gauge the extent to which the effects of label wording on perceptions of GM foods are mediated by product type.

Method

Design

The design was a 2 (product type: natural vs. synthetic) $\times$ 2 (explicitness of wording: explicit vs. non-explicit) $\times$ 2 (context: GM vs. preservative) mixed design. Product type and explicitness were within participant variables and context was between participant variables.

Participants

Forty native English-speaking participants (24 females and 16 males) aged 19–46 years took part in the experiment.

Stimuli and materials

There were six different food products in the ‘natural’ condition (plaice, carrots, bran flakes, pork chops, milk and rice) and six in the synthetic condition (chewing gum, instant noodles, pop tarts, crispy pancakes and cola). Photographs were taken of these 12 products in their packaging, with all manufacturers’ identification removed, and labels were scanned onto the photographs, as appropriate. In the GM condition, each product appeared three times, once with a non-explicit label reading ‘Contains GM ingredients’, once with an explicit label reading ‘Contains GM ingredients – This product has been genetically modified to improve shelf life’ and once with no label. In the preservative condition, the non-explicit label read ‘Contains Preservatives’, the explicit label read ‘Contains Preservatives – Preservatives have been added to this product to improve shelf life’ and again, the products were also presented with no labels. Each participant was thus presented with 36 photographs of food products. The labels were all identical in size, had the signal word ‘Notice’ as a header and were printed in Times New Roman font size 12.

Procedure

Twenty participants completed the preservatives condition and 20 completed the GM condition. In each between subjects condition, participants were presented with booklets containing 36 photographs of the food products. In addition to rating perceived hazard and purchase intention, participants were also asked to indicate their attitude to genetically modified foods on a five-point scale running from 'strongly agree' to 'strongly disagree'. The item used was 'I am in favour of Genetically Modified Foods'. The study took no longer than 30 min.

Results and discussion

The mean ratings for hazard perception and purchase intention as a function of label design features are shown in Table 2. An overall comparison of mean hazard ratings and mean purchase intention ratings showed that they were negatively correlated, as expected, $r = -0.297$, $n = 40$, $p = 0.063$. For the purpose of the main analysis, only the explicit and non-explicit label conditions were analysed, as the 'no-label' condition was not directly comparable and could not be considered a level of explicitness.

No-label condition

The data for the no-label condition were analysed with a two-factor mixed analysis of variance with the repeated measures factor of product type (natural and synthetic) and the between subjects factor of context (GM, preservative). There was a marginally significant effect of product type on the hazard ratings such that natural products ($M = 0.55$) were rated as less hazardous than synthetic ($M = 0.84$), $F(1, 38) = 3.65$, $p = 0.064$. This effect was much stronger in the purchase intention data with natural products ($M = 4.4$) having higher ratings than the synthetic ones ($M = 3.2$), $F(1, 38) = 28.5$, $p < 0.001$. In addition, there was a significant interaction between the preservative or GM group and product type for the purchase intention data. For both groups, natural products were perceived as more likely to be purchased but this difference was stronger for the GM group (4.8 vs. 3.1) than for the preservative group (3.9 vs. 3.3), $F(1, 38) = 5.14$, $p = 0.029$.

Table 2. The mean ratings for hazard perception and purchase intention as a function of label design features (Experiment 2).

	Hazard		Purchase	
	Mean	SE	Mean	SE
Preservative	2.64	0.36	3.08	0.27
GM	3.65	0.36	1.67	0.27
Non-explicit	2.83	0.25	2.52	0.19
Explicit	3.46	0.28	2.24	0.21
Synthetic	3.21	0.26	2.30	0.20
Natural	3.08	0.25	2.46	0.23
No label				
Preservative	0.84	0.20	3.17	0.21
GM	0.55	0.14	4.35	0.22
Synthetic	0.86	0.22	3.59	0.26
Natural	0.53	0.22	3.93	0.26

Hazard perception

A 2 (wording) × 2 (product type) × 2 (context) analysis of variance revealed a single significant effect of the wording manipulation. Non-explicit labels resulted in a lower perceived hazard ($M = 2.8$) than explicit labels ($M = 3.5$), $F(1, 38) = 16.8$, $p < 0.001$. In addition, there was a marginally significant difference between contexts with the preservative group producing lower ($M = 2.6$) hazard ratings than the GM group ($M = 3.6$), $F(1, 38) = 3.9$, $p = 0.054$.

Purchase intention

The same analysis on the purchase ratings showed only significant effects of wording and context. The effect of labelling was similar in size and opposite in direction to the hazard ratings. Non-explicit labels produced higher purchase intentions ($M = 2.5$) than explicit labels ($M = 2.2$), $F(1, 38) = 10.1$, $p = 0.003$. The difference between contexts was slightly more marked than with the hazard ratings; the preservative group produced higher purchase intentions ($M = 3.1$) than the GM group ($M = 1.7$), $F(1, 38) = 13.2$, $p = 0.001$.

General discussion

The studies described above have tried to show how to elucidate the effects of label design parameters on perceptions of GM foods, and suggest the extent to which these effects might be specific to particular food types. In general, many of the variables known to affect the perceived hazard of warning labels have been shown to generalise their effects to food labels, and perceptions of hazard have been shown to be inversely related to purchase intentions. That is not to say that the effects of design manipulations on perceived hazard and purchase intention mirror each other perfectly, however, for example, the attributed source of the label information was shown in Experiment 1 to influence hazard perception but not purchase intentions. This finding for the effect of attributed information source develops earlier work, such as that of Sparks, Shepherd, and Frewer (1994), who showed that information source affects the believability of information in the same way that it affects perceived hazard here, with consumer associations perceived positively and the Department of Health, more negatively.

One important finding to emerge from these studies is that a food product with no label resulted in lower hazard ratings and higher purchase intention ratings than any other label variation – even when compared with labels indicating the absence of GM ingredients. So including any label at all, even one stating the absence of the risk, appears to increase perceptions of hazard and reduce purchase intention. This is a surprising finding which suggests that rather than processing the semantic meaning of the label 'contains *no* GM ingredients', participants are responding to it more holistically with 'GM' perhaps triggering some sort of negative mental model or schema for risk or outrage (Sandman 1987), which results in more negative product perceptions. This finding obviously has important implications for food labelling and the extent of the effect, whether for example, it generalises to 'low fat' foods and beyond, is worthy of continued exploration. The effect of explicit vs. non-explicit label wording, whereby more explicit wording further increases perceived hazard and reduces purchase intention, speaks to the same effect. Rather than offering additional reassurance and explanation, explicit wording appears to reinforce negative mental models and strengthen negative product perceptions.

The effect of label content (whether it is positive, indicating the presence of GM ingredients, or negative, indicating their absence) has been clarified here. Previously, Runge and Jackson (2000) suggested that negative label content might be more informative for consumers, however, the examples they used confounded positive and negative label content with definitive and probabilistic wording. When these factors were controlled in Experiment 1, we found that when the label content was positive (indicating the presence of GM) then definitive wording resulted in increases in perceived hazard and decreases in purchase intention. However, when the label content was negative, indicating the absence of GM, then definitive wording reduced perceived hazard and increased purchase intention. It would appear then that the effect of a positive label can be further increased by use of definitive wording, and that the effect of a more negative label can be minimised by the use of probabilistic wording.

With regard to the effect of explicit vs. non-explicit wording on hazard perception and purchase intention, this did not vary as a function of product type or context as was predicted. Instead, explicit label wording increased hazard perception and reduced purchase intention for both natural and synthetic products and for both the GM and preservative contexts. This may suggest that the effect of explicitness generalises across food types or may alternatively indicate that our product categorisations were not sufficiently distinct. There were no effects of product type on hazard perception or purchase intention scores in Experiment 2, but those presented in the GM (rather than preservative) context attracted lower hazard ratings and higher purchase intentions. The issue of how label effects generalise across products and product types has only been touched upon here and would benefit from continued exploration.

In summary, these data indicate that products labelled as containing GM ingredients result in increased hazard perception and decreased purchase intention, relative to those that are labelled as GM free. Furthermore, any mention of GM ingredients, even if the label declares the product to be GM free, appears to increase hazard perception and decrease purchase intention relative to no label at all. It has been demonstrated that label design characteristics such as wording, colour and attributed information source can clearly modify reactions to food labels in predictable ways. The decision whether or not to label GM products is an important one, and one that may have consequences for consumer perceptions and consequently the sale of GM and non-GM food products. Here it is suggested that the design and wording of such labelling will affect how well genetically modified foods are received.

References

Adams, A.S., and J. Edworthy. 1995. Quantifying the effects of basic text display variables on the perceived urgency of warning labels: Trade-offs involving font size, border weight and colour. *Ergonomics* 38, no. 11: 2221–37.

Batrinou, A., V. Spiliotis, and G. Satellaris. 2008. Acceptability of genetically modified maize by young people. *British Journal of Food* 110, no. 2–3: 250–9.

Braun, C.C., and N.C. Silver. 1995. Interaction of signal word and colour on warning labels: Differences in perceived hazard and behavioural compliance. *Ergonomics* 38, no. 11: 2207–20.

Bredahl, L. 1999. Consumers cognitions with regard to genetically modified foods. Results of a qualitative study in 4 countries. *Appetite* 33, no. 3: 343–60.

Chapanais, A. 1994. Hazards associated with three signal words and four colors on warning signs. *Ergonomics* 37: 265–76.
Cooke, A.J., G.N. Kerr, and K. Moore. 2002. Attitudes and intentions towards purchasing GM food. *Journal of Economic Psychology* 23: 557–72.
Cope, S., L. Frewer, J. Houghton, G. Rowe, A. Fischer, and J. de Jonge. 2010. Consumer perceptions of best practice in food risk communication and management: Implications for risk analysis policy. *Food Policy* 35, no. 4: 349–57.
Costa-Font, M., J. Gil, and B. Traill. 2008. Consumer acceptance, valuation of and attitudes towards genetically modified food: Review and implications for food policy. *Food Policy* 2: 99–111.
Dunlap, G., R. Granda, and M. Kustas. 1986. *Observer perceptions of implied hazard: Safety signal words and color words. Technical Report, TR 00.3428*. Poughkeepsie, NY: IBM.
Edworthy, J., E.J. Hellier, N. Morley, C. Grey, and A. Lee. 2004. Linguistic and location effects in compliance with pesticide warning labels for amateur and professional users. *Human Factors* 46, no. 1: 11–31.
Ellis, J., R. Dewar, and D. Milloy. 1980. An evaluation of six configurations of the railway crossbuck sign. *Ergonomics* 23: 359–67.
Food Standards Agency. 2003. *Consumer views of GM food*. London: Food Standards Agency.
Frewer, L.J. 1999. Public perceptions of genetically modified foods in Europe. *Journal of Commercial Biotechnology* 6, no. 2: 108–15.
Frewer, L.J., C. Howard, D. Hedderley, and R. Shepherd. 1995. What determines trust in information about food related risk? Underlying psychological constructs. *Risk Analysis* 16, no. 4: 473–86.
Frewer, L.J., C. Howard, D. Hedderley, and R. Shepherd. 1999. Reactions to information about genetic engineering: Impact of source characteristics, perceived personal relevance and persuasiveness. *Public Understanding of Science* 8: 35–50.
Frewer, L.J., C. Howard, and R. Shepherd. 1996. The influence of realistic product exposure on attitudes towards genetic engineering in food production. *Food Quality and Preference* 7, no. 1: 61–7.
Frewer, L.J., and S. Miles. 2003. Temporal stability of the psychological determinants of trust: Implications for communication about food risks. *Health Risk and Society* 5, no. 3: 259–71.
Gaskell, G. 2006. Centre for the study of Bioscience BBaSB., 2006. Europeans and Biotechnology in 2005: Patterns and Trends. Eurobarometer 64.3.
Grove-White, R., P. MacNaughton, S. Mayer, and B. Wynne. 1997. *Uncertain world-genetically modified organisms, food and public attitudes in Britain*. A report for the 'Centre for Environmental Change'. Lancaster: Lancaster University.
Gruere, G., C. Carter, and Y. Farzin. 2008. What labelling policy for consumer choice? The case of genetically modified food in Canada and Europe. *Canadian Journal of Economics* 41, no. 4: 1472–97.
Hallman, W. 2000. *Consumer concerns about biotechnology.* New Brunswick, NJ: Food Policy Institute, Rutgers.
Hallman, W., A.O. Adelaja, B.J. Scilling, and J.T. Lang. 2002. *Public perceptions of genetically modified foods – Americans know not what they eat*. New Brunswick, NJ: Food Policy Institute, Rutgers.
Heaps, C.M., and T.B. Henley. 1999. Language matters: Wording considerations in hazard perception and warning comprehension. *Journal of Psychology* 133: 341–51.
Hellier, E., and J. Edworthy. 2002. Subjective rating scales: Scientific measurement of perceived urgency? *Ergonomics* 45, no. 14: 1011–4.
Hoban, T.J., and P.A. Kendall. 1992. *Consumer attitudes about the use of biotechnology in agriculture and food production*. Raleigh, NC: North Carolina State University.
Hossain, F., and B. Onyango. 2004. Product attributes and consumer acceptance of nutritionally enhanced GM foods. *International Journal of Consumer Studies* 28, no. 3: 255–67.
Hunt, S., and L.J. Frewer. 2001a. Impact of BSE on attitudes to GM foods. *Risk, Decision and Policy* 6: 91–103.
Hunt, S., and L.J. Frewer. 2001b. Trust in sources of information about genetically modified food risks in the UK. *British Journal of Food* 103, no. 1: 46–62.

Hyde, C., and E.J. Hellier. 1997. How do warning labels and product familiarity influence hazard perceptions. In *Contemporary ergonomics*, ed. S. Robertson, 79–84. London: Taylor and Francis.
Kline, P., C. Braun, N. Peterson, and C. Silver. 1993. The impact of color on warnings research. Proceedings of 37th Meeting of the Human Factors and Ergonomics Society (Santa Monica, CA: Human Factors and Ergonomics Association) 940–944.
Knox, B. 2000. Consumer perception and understanding of risk from food. *British Medical Bulletin* 56, no. 1: 97–109.
Laughery, K.R., K.P. Vaubel, S.L. Young, J.W. Brelsford, and A.L. Rowe. 1993. Explicitness of consequence information in warnings. *Safety Science* 16: 597–613.
Miles, S., and L.J. Frewer. 2001. Investigating specific concerns about different food hazards. *Food Quality and Preference* 12: 47–61.
Miles, S., O. Ueland, and L.J. Frewer. 2005. Public attitudes towards genetically modified food. *British Food Journal* 107, no. 4: 246–62.
National Institute of Nutrition. 1998. *Nutritional labelling in Canada*. Ottawa: National Institute of Nutrition.
Newspeg. 1998. Greed or need? Genetically modified crops. *Review of African Political Economy* 25, no. 78: 651–3.
Oguz, O. 2009. Attitude of consumers around the effects of genetically modified organisms (GMOs): The example of Turkey. *Journal of Food, Agriculture & Environment* 7, no. 3–4: 159–65.
Onyargo, B. 2004. Consumer acceptance of genetically modified foods: The role of product benefits and perceived risks. *Journal of Food Distribution Research* 35, no. 1: 154–61.
Runge, C.F., and L.A. Jackson. 2000. Labelling, trade and genetically modified organisms: A proposed solution. *Journal of World Trade* 34, no. 1: 111–222.
Sandman, P.M. 1987. Risk communication: Facing public outrage. *Environmental Protection Agency Journal* 13, no. 9: 21–2.
Select Committee on the European Communities report to the House of Lords, Session. 1998–1999. *EC Regulations of Genetic Modification in Agriculture*. 2nd Report. London: The Stationary Office.
Sparks, P., R. Shepherd, and L.J. Frewer. 1994. Gene technology, food production, and public opinion: A UK study. *Agriculture and Human Values* 11, no. 1: 19–28.
Teisl, M.F., L. Halverson, K. O'Brien, B. Roe, N. Ross, and M. Vayda. 2002. Focus group reactions to genetically modified food labels. *AgBioForum* 5, no. 1: 6–9.
Yeung, R.M.W., and J. Morris. 2001. Food safety risk: Consumer perception and purchase behaviour. *British Food Journal* 103, no. 3: 170–86.
Young, S.L. 1991. Increasing the noticeability of warnings, effects of pictorial, colour, signal icon and border. Paper presented at the Human Factors Society, in Santa Monica, CA.