Predicting behaviour towards genetically modified food using implicit and explicit attitudes

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Abstract

The predictive validity of implicit and explicit attitudes is a central question in social psychological research with important theoretical and empirical ramifications. Three main patterns of combining implicit and explicit attitudes to predict behaviour have been postulated. These are, double dissociation (in which implicit and explicit attitudes predict spontaneous and deliberate behaviour respectively), additive (in which implicit and explicit attitudes both predict variance in behaviour) and interactive (in which implicit and explicit attitudes combine to predict behaviour). These models were tested in this study using a structural equation modelling approach utilising three different measures of behaviour (of varying spontaneity) towards genetically modified (GM) food. The additive pattern, in which implicit attitudes and explicit attitudes both predict variance in behaviour, was found to best fit the data. In addition, all behaviour measures indicated that the majority of participants were willing to try GM food in some situations.

Introduction

The use of implicit attitude measures has increased greatly in recent years since the development of the Implicit Association Test (IAT: Greenwald, McGhee and Schwartz, 1998) and other measures of implicit attitude, e.g., the Extrinsic Affective Simon Task (De Houwer, 2003). One of the main issues that has emerged within the literature on implicit attitudes is their predictive validity. If implicit attitudes do not differ significantly from explicit attitudes, and if they do not provide additional information for predicting behaviour, then the usefulness of measuring implicit attitudes is limited.

There are several different ways in which implicit and explicit attitudes may combine, or dissociate, in order to predict behaviour. The majority of research has found a double dissociation pattern in which implicit attitudes are found to predict spontaneous behaviour and explicit attitudes predict deliberate behaviour, but not vice versa (Dovidio, Kawakami and Gaertner, 2002; Dovidio, Kawakami, Johnson, Johnson, and Howard, 1997; Fazio, Jackson, Dunton and Williams, 1995; Spalding and Hardin, 1999). However, there are several studies that have found a different pattern of results. These have indicated that either both implicit and explicit attitudes predict behaviour (Brunel, Collins, Greenwald and Tietje, 1999; Hugenberg, and Bodenhausen, 2003) or that implicit and explicit attitudes interact together in predicting behaviour (Jordan, Spencer, Zanna, Hoshino-Browne and Correll, 2003; McGregor and Marigold, 2003). Thus, the way in which implicit and explicit attitudes relate to behaviour is not clear cut.

Predicting behaviour

Explicit attitudes have been found to be a consistently good predictor of behaviour (Armitage and Conner, 2001). The predictive validity of implicit attitudes varies greatly between behaviours however. In some cases, studies have found that implicit attitudes were more highly predictive of behaviour than explicit attitude measures and in others implicit attitudes did not significantly predict behaviour at all (Fazio and Olson, 2003).

In general, research has found that explicit attitudes predict deliberate behaviour and implicit attitudes predict spontaneous behaviour (e.g., Dovidio et al., 1997; Dovidio et al., 2002; Fazio, et al., 1995; Spalding and Hardin, 1999). Fazio's (1990) MODE (Motivation and Opportunity as DEterminants of processing) model provided a framework to explain when behaviour would be spontaneous, and best predicted by implicit attitudes, and when behaviour would be deliberate, and best predicted by explicit attitudes. This model postulated that when an individual has the motivation and the opportunity to think carefully about a decision, behaviour will be driven by deliberate processes. On the other hand, if an individual does not have the time or cognitive resources to think about a decision behaviour will be driven by spontaneous processes.

Empirical data broadly supports the MODE model. A recent meta-analysis of the predictive validity of the IAT, and explicit attitude measures, found that explicit attitude measures were significantly better predictors of deliberate behaviour than spontaneous behaviour (Poehlman, Uhlmann, Greenwald and Banaji, 2005). Conversely, the IAT was found to be a good predictor of spontaneous behaviour. However, the IAT was also effective in predicting some behaviour that was controllable, such as brand related choices and voting behaviour. Other authors have

similarly stated that a double dissociation pattern, in which implicit and explicit attitudes predict spontaneous and deliberate behaviours respectively, may be overly simplistic (Rudman, 2004).

It should be acknowledged, however, that the available evidence does not necessarily contradict the double dissociation pattern of prediction. It is possible that the variance that has been accounted for in deliberate behaviour by implicit attitude measures, was shared with explicit attitude measures. Unfortunately, most studies that have examined the predictive validity of attitudes have not included both implicit and explicit measures of attitude together in the same analysis (and many of those that have also included additional variables) so it is not clear whether separate behavioural variance was predicted by the two attitude measures. Of those studies that have employed comprehensive analyses, several have found that implicit and explicit attitude measures do predict separate variance in behaviour, e.g., in the prediction of math SAT scores (Nosek, Banaji and Greenwald, 2002) and alcohol consumption (Wiers, Woerden, Smulders and de Jong, 2002).

Some research has suggested that implicit and explicit attitudes may interact together to explain additional variance in behaviour. A recent study found that individuals who had the combination of both high self-esteem on explicit attitude measures and low self-esteem on implicit attitude measures were relatively high in narcissism and defensiveness (Jordan, et al., 2003). So in this case, behaviour was found to be best predicted by combining implicit and explicit attitude measures in a multiplicative fashion (defensive behaviours including in-group bias and dissonance reduction were measured).

The predictive validity of implicit and explicit attitude measures seems to depend, in part, on the degree to which these measures correspond. When

correspondence between implicit and explicit attitude measures is low, both measures are associated with worse predictive validity than when correspondence is high (Poehlman et al., 2005). This finding is consistent with suggestions that individuals holding discrepant automatic and controlled evaluations may experience some internal conflict (Petty, Tormala, Brinol and Jarvis, in press). Explicit attitude measures may be less predictive of behaviour because these have to override an automatically evoked response and equally, implicit attitude measures may be less predictive of behaviour as these are pulling against opposing explicit attitudes. It was found that inconsistencies between implicit and explicit attitude measures had a significantly greater detrimental effect on the predictive validity of explicit attitude measures than implicit attitude measures. Poehlman et al., (2005) suggest that this is because people may be less aware of their automatic associations and, therefore, less able to override these

The relationship between explicit and implicit attitudes

The relationship between explicit and implicit attitudes is contentious. In many studies, particularly those investigating controversial research topics, e.g., stereotyping, implicit and explicit attitudes measures have not correlated with one another. However, in other areas, e.g., attitudes towards different product brands, significant correlations have been found (Hofmann, Gschwendner, Nosek and Schmitt, 2005; Nosek, 2005).

Two main theoretical stances have been adopted in explaining the relationship between explicit and implicit attitudes. The dual attitude model (Wilson, Lindsay, and Schooler 2000) postulated that an individual may hold two or more attitudes towards the same attitude object. Therefore, differences between implicit and explicit

attitudes would be explained by suggesting that these are entirely separate constructs which are developed in different ways.

The dominant view, however, is the single attitude approach which suggests that there is one attitude construct and implicit and explicit attitudes are actually just different ways of measuring the same thing. For this reason, it was suggested that implicit and explicit attitudes should actually be referred to as different implicit and explicit measures of attitudes (Fazio and Olson, 2003). The single attitude approach was the stance taken by dual process theorists, e.g., within the MODE model (Fazio, 1990) and the heuristic-systematic model (Bohner, Moskowitz and Chaiken, 1995). This group of theories generally agrees that attitudes are produced jointly as a function of deliberate and spontaneous processing. Explicit attitudes are thought to measure deliberate processing and implicit attitudes are thought to measure spontaneous processing. Differences between implicit and explicit attitudes are explained as being a result of a variety of influences that impact upon deliberate processes but not spontaneous processes. These influences include self-presentation effects and demand characteristics.

A more general theoretical approach has recently been provided in Strack and Deutsch's (2004) 'Reflective-Impulsive' model. This model built on dual process theories by relating postulated processes to motivations and behaviour. It was suggested that reflective and impulsive processes (corresponding to deliberate and spontaneous processes) operate in parallel, but interact at various stages of processing. Information is thought to always be processed in the impulsive system and will also be processed by the reflective system depending on its intensity and the attention it receives. Processing within the reflective system is thought to be applied to representations that are retrieved from the impulsive system and in turn, reflective

processing may lead to the formation of new associations within the impulsive system (see Gregg, Seibt and Banaji, 2006)

Impulsive and reflective processes combine in a final common pathway to stimulate behaviour; this is thought to consist of behavioural schemata (e.g., Norman and Shallice, 1986) of varying levels of abstractness. Behavioural schemata are described as being part of the impulsive system but as also being linked to the reflective system through the process of intending (e.g., Gollwitzer, 1999). Behaviour is produced when schemata are activated above a certain critical threshold. A motivational dimension (e.g., Cacioppo, Priester and Berntson, 1993) was also included in the model in that it was proposed that the valence of processing within the impulsive system will ready behaviour for either approach or avoidance. Thus, the Reflective-Impulsive model quite neatly integrated elements from existing theories in order to explain attitudinal and behavioural processes.

Testing Predictive Models

Different theoretical stances regarding the relationship between implicit and explicit attitudes correspond loosely to different postulated patterns of combining implicit and explicit attitudes to predict behaviour (Perugini, 2005). Altogether, three main predictive models of combining implicit and explicit attitudes to predict behaviour have been suggested: an additive model, a double dissociation model and an interactive model. Traditional dual process theories (e.g., Fazio, 1990; Bohner, et al., 1995) imply an additive pattern indicating that implicit and explicit attitudes predict separate variance in behaviour and that both will predict all behaviours, to a greater or lesser extent. The dual attitude model (Wilson, Lindsay and Schooler, 2000) implies a double dissociation pattern, which predicts that implicit attitudes will

predict spontaneous behaviour and explicit attitudes will predict deliberate behaviour. (The extent to which implicit attitudes may predict deliberate behaviour or explicit attitudes may predict spontaneous behaviour is explained as shared variance between the two attitude measures.) The integrative approach of the reflective-impulsive model (Strack and Deutsch, 2004) implies an interactive combination pattern in which implicit and explicit attitudes combine to predict behaviour in a synergistic fashion. It is emphasised, however, that the confirmation of one particular pattern does not confirm or deny the validity of the associated theoretical approach as each theoretical approach could in fact explain each of the predictive patterns.

Asendorpf, Banse and Mücke (2002) tested two potential predictive models (the additive model and the double dissociation model) within the domain of shyness. Their results showed that even though implicit self-concepts and explicit self-concepts correlated with both spontaneous and deliberate measures of shy behaviour, the double dissociation model was found to fit the data better than the additive model. A further examination of predictive models was carried out by Perugini (2005) who examined two different behaviours, smoking and eating snacks versus fruits. In the study of smoking behaviour an interactive, rather than an additive model was supported (it was not possible to examine the double dissociation model because only one behaviour was examined). Within the study of eating snacks versus fruits, two behaviours were examined. The deliberate behaviour was a self-report of the frequency of which the individual eats snacks versus fruits, and the spontaneous behaviour was the choice made by the participant when offered the choice of either fruit, or a snack, at the end of the experiment. All three of the predictive models were examined and of these, it was found that the double dissociation model was supported.

The conclusion was that different patterns of combining implicit and explicit attitudes may account for different behaviours across domains.

Attitudes and Behaviour towards GM food

Within the domain of GM food, predicting behavioural responses is extremely important not only for producers but also for policy makers, consumer organisations, and food retail outlets, amongst others. Whilst there have obviously been protestations about the introduction of GM food by particular environmental and consumer pressure groups (Grant et al., 2003), it is less clear how widespread this negative feeling is and how this will translate into actual consumer behaviour. Overall the British population seem to be ambivalent in their explicit attitudes towards GM food (Gaskell, Allum and Stares, 2003), however, implicit attitudes towards GM food in Britain were found to be positive (Spence and Townsend, 2006). The question of how these different attitude measures will translate into behaviour is as yet unanswered. Research examining actual behaviour towards GM food is sparse, partly due to practical reasons in that GM food is still not widely available in Britain. Available research on behaviour towards GM food has been varied, with self-report data and real choice experiments generally indicating that people would try GM food (Sparks, Shepherd and Frewer, 1995; Spence and Townsend, 2006; Townsend and Campbell, 2004) and data from studies using contingent valuation techniques indicating that a majority of individuals in the UK would not accept GM food even if it was cheaper than alternatives (Moon and Balasubramanian, 2003). Differences in results are likely to be due to methodological and contextual differences as well as differences in the amount of deliberation the methods elicit from the individual.

Measuring spontaneous behaviour

Behaviour can be thought of as deliberate or as spontaneous and, in fact, different types of behaviour may fall along a continuum between being completely deliberate and being completely spontaneous (Beach and Mitchell, 1978; Fazio, 1990; Møller, 2003; Schneider and Shriffrin, 1977). It was theorised that deliberate behaviour is distinguished from spontaneous behaviour with respect to the amount of cognitive effort used in making the decision to carry out the particular behaviour. Fazio's (1990) MODE model suggested that behaviour will be deliberate when the individual has the motivation and the opportunity to carry out the behaviour. Motivation is thought to increase with involvement as well as with the perceived risk connected with the decision and with the costs involved with making the wrong decision. Opportunity is decreased by time pressure and with ability, which can be affected by cognitive capacity available with which to make the behavioural decision. Following this reasoning, behaviour can be forced to become more spontaneous by decreasing motivation, by increasing time pressure or by decreasing the individual's cognitive capacity available (Beach and Mitchell, 1978).

Overview of aims

The aim of the present study is to examine the three main predictive models of implicit and explicit attitudes within the domain of behaviour towards GM food. This is the first study to examine the predictive validity of implicit attitudes towards GM food. In addition, this is the first study to utilise a structural equation modelling approach in testing all three predictive models concurrently. In doing this, this study uses three different behaviour measures and these are aimed to represent ecologically valid types of behaviour of varying levels of spontaneity. For this reason, one

behavioural measure is designed to measure very deliberate behaviour, one behavioural measure is designed in order to measure behaviour that was partly spontaneous and partly deliberate (henceforth referred to as combined behaviour) and one behavioural measure is designed in order to measure combined behaviour with increased spontaneity which was imposed by introducing a time limit for the task (henceforth referred to as spontaneous behaviour).

Design

This experiment had a repeated measures design in which all participants completed five tasks. These were a Go No-Go Association Task (GNAT; Nosek and Banaji, 2001) which examined implicit attitudes towards GM food, direct questions which examined explicit attitudes towards GM food, a vignette task which examined deliberate behaviour towards GM food, a real choice task which examined combined behaviour towards GM food and an equivalent gain lottery task which examined spontaneous behaviour towards GM food.

Participants

Two hundred participants were recruited for this study. Recruitment was carried out in a topic blind fashion, to avoid self-selection on the basis of an interest in biotechnology (Campbell and Townsend, 2003), through posters advertising the study around the University campus as well as e-mail advertising to undergraduate university students.

Materials

GNAT (Implicit attitudes)

A GNAT was used to examine implicit attitudes towards GM food. The GNAT (Nosek and Banaji, 2001) was developed from the Implicit Association Test (Greenwald, McGhee, and Schwartz, 1998) and is based on the same logic as the IAT and other response competition tasks. It is assumed that performance within the task will be superior when responses are made to a pair of items that are strongly associated than to a pair of items that are weakly associated. The GNAT differs from the IAT in that participants respond to just one key target category rather than two, as is required within the IAT, and therefore the GNAT is amenable to examining implicit attitudes in a context free manner.

The procedure of the GNAT was identical to that used by Nosek and Banaji (2001) except 20 practice trials and 80 critical trials (in two blocks of 40) were used, in comparison to 16 and 40 respectively used in Nosek and Banaji (2001). As reaction times were to be used for analysis[1], a response deadline of 1000ms was used for target words and a response deadline of 500ms was used for distracter items; a shorter time is recommended for distracter items in order to maintain the speed of responses. The procedure was slightly modified in order to reduce extrapersonal associations in a similar way to the IAT (Olson and Fazio, 2004). This involved changing attribute titles from 'Pleasant' to 'I like' and 'Unpleasant' to 'I dislike' although exemplars were kept the same.

The actual procedure of the GNAT requires participants to respond to certain categories (Go) and not to other categories (No-Go). In one section of the task, participants must respond to exemplar words belonging to the categories 'GM food' (e.g., engineered salmon' and 'modified tomatoes') and 'I like' (e.g., 'happy' and

'pleasant') and in a second section of the task, participants must respond to exemplar words belonging to the categories 'GM food' and 'I don't like' (e.g., 'bad' and 'nasty'). Performance in the GNAT is analysed either by comparing the amount of errors made in each condition or by comparing reaction times in each condition. In the context free version of the task, as was used here, the background to the target items (GM food) used was composed of attributes only. In one condition participants were therefore required to respond to exemplars of the 'GM food' category and one set of attribute category words, e.g., 'I like', and to ignore exemplars of the opposing attribute category, i.e., 'I don't like'. In the second condition participants responded to the 'GM food' category and the other attribute category, e.g., 'I don't like', and ignored the originally paired attribute category, i.e., 'I like'.

The stimuli presented were exemplars of each category (i.e., 'GM food', 'I like' and 'I dislike') and five exemplar stimuli were used in each category, see Appendix. These were chosen as being highly related to the category labels.

Explicit attitude questions

Questions assessing explicit attitudes towards GM food were measured using eleven semantic differential seven-point scales ranging from minus three to plus three. Adjectives used were bipolar pairs, e.g., bad - good, and were the same as those used by Swanson, Rudman, and Greenwald (2001) and Perugini (2005).

Vignettes (Deliberate behaviour)

In total nine vignettes were constructed. These were developed by determining possible real scenarios in which participants might encounter GM food and have to decide whether to try it or not. For example:

'You attend a restaurant with friends for dinner and notice that at the bottom of the menu there is a notice stating that some of the food served may contain GM ingredients. What do you do?'

To aid decision making, multiple choice options for potential behaviour were provided and the same three options were used for each vignette. These options were, (a) Eat the GM food, (b) Do not eat the GM food, or (c) Don't know. Each question also included space for participants to write further comments if they desired. A pre-test, involving 13 participants, was used in order to evaluate the consistency of the questions used; this was high with Cronbach's alpha of 0.84. It is noted that vignettes measure intentions to perform behaviour, rather than actual behaviour itself, but these will be used as a measure of potential deliberate behaviour.

Real choice task (Combined behaviour)

The real choice task utilised (purportedly) GM chocolate chip cookies that were individually wrapped and presented on a serving plate. The ingredients labels of each cookie was removed so as to disguise the fact that ingredients were not GM which left each cookie in a sealed, transparent, plastic wrapper. This task also made use of a voice recorder that was hidden from view within an open drawer in order to record the time taken to make the decision about whether to accept the cookie or not.

Equivalent gain lottery task (Spontaneous behaviour)

The equivalent gain task is a type of contingent valuation task (see Venkatachalam, 2004, for a review), often used within the economics literature (Bateman, Munro, Rhodes, Starmer and Sugden, 1997). Participants are asked to choose among a series of options, here consisting of a monetary amount and a box of

eight chocolates, e.g., 'We give you £0.60 or a box of eight chocolates'. Two pages of 20 options were used here that increased in monetary amount offered from zero to £5.70 (increasing in increments of £0.30). One page offered a box of eight GM chocolates as an alternative to the monetary options and one page offered a box of eight non-GM chocolates as an alternative; which version was presented first was counterbalanced between participants. As an incentive to be truthful in the choices that they made, it was emphasised to participants that they would receive one of these options drawn from one of the lotteries. A stopwatch was also used for this task in order to measure one minute which was the time limit allowed for the participants to complete the task. As noted earlier, the use of time pressure is established as a standard method of encouraging spontaneous behaviour (Beach and Mitchell, 1978).

Procedure

Participants were firstly provided with an information sheet and a consent form which explained that they could withdraw from the study at any time without having to give a reason, and that their data could be withdrawn from analysis on request. The procedure of the study was then described. Participants completed four tasks within the study with full knowledge of participation and completed a final fifth section that was purportedly not part of the experiment. The four tasks that participants completed with knowledge of participation were a GNAT examining implicit attitudes towards GM food, direct questions examining attitudes towards GM food, a series of vignette questions examining deliberate behaviour and an equivalent gain lottery task examining spontaneous behaviour towards GM food. Participants were given no time restrictions on tasks apart from the GNAT which utilised a response window inherent to the task design and the equivalent gain task in which

participants were given one minute to complete the task in order to increase spontaneity of responses. All participants completed the equivalent gain task within the time limit set. Presentation order was counterbalanced, although, it was ensured that attitude tasks were presented first and behavioural tasks second. In other words, whether participants completed the GNAT or the direct attitude questions first was counterbalanced and whether participants completed vignettes or the lottery task first was counterbalanced but the attitude questions always preceded the vignettes and the lottery task. In addition, the different versions of the GNAT and the lottery task were counterbalanced between participants.

The participants were then told that the study was over and they were provided with their prize from the lottery task. This was chosen by the participants themselves by drawing a number (from a selection of 1 – 20) from a bag without being able to see the numbers. The corresponding prize option was then consulted and the participants were provided with whatever they chose for that option. For example, if a participant drew number nine, option nine was consulted and if they had chosen the monetary amount within this option, they were provided with this amount of money, if they had chosen chocolates, they were provided with the chocolates. All participants were allocated to the group that received the prize from the page that listed choices between money and non-GM chocolate. This was done for practical reasons as it was not feasible to obtain GM food samples for use in the study.

The final fifth section involved offering participants a chocolate chip cookie that was purportedly made using GM ingredients and provided as a sample from a biotechnology company. Again, for practical reasons, the cookie used was not actually GM. In addition, participants were led to believe that this was not part of the experiment as previously they had been told that the experiment was over.

Participants had the choice of whether to accept the cookie or not. In addition, the amount of time that participants took to make the choice of whether to accept the cookie or not was recorded. To ensure that this was standardised across participants, the time taken was recorded discretely using a voice recorder. The recorder was started as soon as the experimenter had finished explaining that participants were allowed to take a cookie and stopped as soon as participants indicated that either they would or would not like to have the cookie. The participant's choice was measured as either when they actually picked up a cookie or as when they verbally accepted or rejected the cookie.

Finally, the purpose of the experiment was revealed to participants. The deceptions involved in the experiment were explained, both in terms of what these were, and in terms of why they were used. Several follow up questions were also asked of participants. These were (a) whether they realised that the offer of a chocolate chip cookie, at the end of the experiment, was part of the actual study and (b) if they believed that the chocolates, and the chocolate chip cookie, that they had been offered contained genetically modified ingredients. In addition, if participants had refused the cookie, they were asked to give a reason for refusing the cookie. If they had accepted the cookie, they were asked if they had accepted the cookie for themselves, and whether they had intended to eat the cookie.

Results

Explicit attitudes

The measurement of explicit attitudes displayed good consistency as measured by Cronbach's alpha (0.80). The data for the explicit attitudes for two participants were lost, leaving the data from 198 participants for analysis. Across participants,

explicit attitudes towards GM food had a mean of -0.12 (SD = 0.73) which was found to be significantly negative by a one sample t-test ($t(197) = -2.329$, $p < 0.05$) with a small effect size (Cohen's d = -0.23).

Implicit attitudes

GNATs were evaluated using reaction time data. Internal consistencies were examined using split-half reliabilities and these were found to be acceptable with a value of 0.67 (after adjustment using the Spearman – Brown correction; Nunnally, 1978). Overall, the mean percentage of errors made by participants was 5.30%.

Across participants, it was found that when responding to 'GM food' words, mean reaction time was 495.24ms (SD = 44.44ms) when paired with 'I like' words and was 501.25ms (SD = 44.98ms) when paired with 'I don't like' words. Reactions to the pairing of 'GM food' and 'I like' were significantly faster than to the pairing of 'GM food' and 'I don't like' ($t(199) = -2.329$, $p < 0.05$). This difference had a small effect size (Cohen's d = -0.13).

Vignettes (Deliberate behaviour)

Behaviour, as measured by the vignette questions, was coded as plus one if the participant indicated that they would eat GM food, zero if the participant was not sure, and minus one if the participant would not eat GM food. Scores were added for all the vignettes to provide a total deliberate behaviour score for each individual, therefore, a higher score indicates that a participant is more likely to eat GM food. Consistencies across questions were found to be good, with Cronbach's alpha amounting to 0.77. The overall mean behavioural score was 3.01 (SD = 4.11) indicating that the majority of people would eat GM food in most of the situations

provided. A one sample t-test indicated that this was significantly positive ($t(196) = 10.256$, $p < 0.001$; Cohen's d = 1.04).

Real Choice (Combined behaviour)

Altogether, 84% (168/200) of our sample accepted the (purportedly GM) chocolate chip cookie. However, it was also noted that five people who did not take the cookie said that they would have accepted an alternative GM product. In addition, five people who did take the cookie said that they would not have tried the cookie but accepted it in order to give it to a friend. A further two people who did take the cookie were not sure whether they would actually eat it or not.

The time taken for participants to make the choice whether to accept the (purportedly GM) cookie or not was also measured. This was used in conjunction with the participant's decision of whether or not to accept the cookie so as to order participants' preferences for the cookie. Thus, the length of time participants took to make their decision was taken as a measure of the certainty of their choice and this was supported by qualitative responses. Those that took longer to decide, whether they wanted to take the (purportedly GM) cookie, generally filled the decision time with questions regarding the safety of GM food, e.g., 'Does it have any side effects?', questions regarding the ingredients in the cookie, e.g., 'What's GM about it?', or regarding the taste, e.g., 'What do they taste like?'. Others simply paused for a length of time before making their decision or expressed uncertainty over their decision, e.g., 'I'm not sure whether to try it or not'.

Participants' preferences were measured on a scale which had six discrete points, with three points representing the decision to accept the cookie at varying lengths of time and three points representing the decision to refuse the cookie at

varying time lengths. The scale ran from one to six in which one represented a certain refusal and six represented a certain acceptance, see Figure 1. Scores on this scale were used as an indication of the participant's decision in further analyses.

Insert Figure 1 about here

The majority of participants made the choice whether to accept the cookie or not quite quickly (under five seconds). Much less people took between five and 15s to make the decision and only a few people took over 15s to make the decision, see Table 1.

Insert Table 1 about here

Equivalent gain lottery task (Spontaneous behaviour)

Overall, the amounts of money that participants were willing to accept in preference of a box of GM chocolates were positively skewed, with a median of £1.20 and a full range of £5.70. The amounts of money participants were willing to accept in preference of a box of non-GM chocolates were also positively skewed and had a median of £2.10, and a full range of £5.70. A Wilcoxon signed ranks test showed that amounts of money accepted in preference of a box of GM chocolates were significantly lower than those accepted in preference of a box of non-GM chocolates ($z = -6.041$, $p < 0.001$).

In order to control for individual preferences for chocolates, behaviour towards GM food was calculated as the difference between the monetary amount the participant was willing to accept in preference for GM chocolate and the monetary

amount the participant was willing to accept in preference for non-GM chocolate. Again this measure was very positively skewed, and extremely kurtotic, with an almost unimodal distribution at zero.

Correlations

Pearson's product moment correlations were carried out between all variables apart from between real choice task data and other variables for which polyserial correlations were used because this variable has an ordinal level metric, see Table 2. Correlations between factors measured indicated that explicit attitudes were not significantly correlated with implicit attitudes. Explicit attitudes were significantly correlated with all three behavioural measures of the vignettes, the lottery task, and the final real choice decision. Implicit attitudes were found to correlate with just one behavioural measure which was the lottery task (spontaneous behaviour). The vignette behaviour measure demonstrated significant correlations with the real choice task and the equivalent gain lottery task.

Insert Table 2 about here

Structural Equation Modelling (SEM)

A SEM was used to rigorously test the relationships between attitudes and behaviour and to evaluate the three different theoretical models discussed earlier. All three models (additive, double dissociation and interactive) were tested using structural equation modelling with LISREL software.

All data was measured on interval or ratio scales apart from data from the real choice task which was measured on an ordinal scale. Additionally, data from the real

choice task and from the equivalent gain lottery task was severely negatively skewed and was therefore transformed by reflecting and inversing scores in order to obtain more normally distributed samples (Tabachnik and Fidell, 1996). The explicit attitude latent factor was loaded by two halves of the semantic differential scales utilised (because there were an odd number of semantic differentials used, the first six were used as one indicator and the second five were used as a second indicator). The implicit attitude latent factor was loaded by two GNAT scores which were calculated as the difference between the first and third critical trial blocks of the task and the difference between the second and fourth critical trial blocks of the task; the critical trial blocks compared were those that paired the target attribute of GM foods with opposing attributes. Behavioural measures were all used as direct indicators of their latent counterparts. The correlation matrix displayed in Table 3 was used as the input matrix for LISREL, again this contains Pearson's product moment correlations and polyserial correlations as appropriate.

The fit of the additive model was good ($\chi^2 = 5.30$, $p = 0.81$), see Table 4 for a comparison of model fit indices. Implicit attitudes did not significantly predict deliberate behaviour or combination behaviour but did significantly predict spontaneous behaviour. Explicit attitudes, on the other hand, significantly predicted deliberate behaviour, combination behaviour and spontaneous behaviour, see Figure 2.

Insert Table 4 about here

Insert Figure 2 about here

To test the double dissociation pattern, a modified nested model without the additive crossed paths was run, see Figure 3. This model was restricted so that implicit attitudes only predicted spontaneous behaviour and explicit attitudes only predicted deliberate behaviour. In addition, for the double dissociation model, only one attitude measurement could be allowed to predict combination behaviour and as gamma (γ) values were higher for the path from explicit attitudes to combination behaviour within the additive model, this path was kept free and the path from implicit attitudes to combination behaviour was restricted[2]. The fit was again very good ($\chi^2 = 13.76$, $p = 0.32$). As the double dissociation model was nested within the additive model, a formal test of the need for the additive paths was possible. In fact, the difference between model chi-squares was significant ($\chi^2_{d(2)} = 8.46$, $p < 0.05$) indicating that the fit of the model was significantly improved by the additional paths included within the additive model.

Insert Figure 3 about here

The interactive pattern was tested according to the approach suggested by Ping (1995), see Figure 4. Ping (1995) recommends using the product of the sums of the indicators of the component variables as the sole indicator of the latent product. In other words, the recommendation is to sum the indicators of the latent variable, implicit attitude, and to sum the indicators of the latent variable, explicit attitude, and multiply these summed totals together to obtain the indicator for the latent product variable. It is then suggested that the additive model is established first and the

relevant values from this analysis be used in order to fix the paths associated with the latent product in the interactive model.

Insert Figure 4 about here

The fit of the interactive model was good ($\chi^2 = 5.30$, $p = 0.81$). This model was very similar to the additive model indicating that the extra product variable included did not significantly improve the fit of the model. Comparing the model AIC (Akaikes information criterion) and NNFI (non-normed fit index) for these models (both criteria which penalise for model complexity) demonstrates that the additive model is the model of best fit, see Table 4. It was therefore concluded that the additive model was supported; the double dissociation model and the interactive models did fit the data well but the additive model fitted the data better than the double dissociation model and was more parsimonious than the interactive model.

Discussion

The results of the structural equation modelling analysis indicated that the additive pattern of predicting behaviour from implicit and explicit attitudes was supported here. Furthermore, this was demonstrated using a structural equation modelling approach and with the use of three different measures of behaviour, which emphasises the reliability and validity of findings. Of additional interest was the finding that implicit attitudes towards GM food were predictively valid and that all three behavioural measures demonstrated that the majority of participants would try GM food.

Predicting behaviour

This study found that the additive model, in which explicit attitudes and implicit attitudes both predicted separate variance in behaviour, provided the best and most parsimonious fit to the data. This finding is consistent with several previous studies (Brunel, Collins, Greenwald and Tietje, 1999; Hugenberg, and Bodenhausen, 2003) and is in line with the recent meta-analysis conducted by Poehlman et al. (2005) that assessed the predictive validity of the IAT and found that implicit attitudes (as measured by the IAT) predicted significant independent variance, over and above explicit attitudes, in some behaviour measures.

These results differ from many previous studies though that have supported a double dissociation pattern in which implicit attitudes predict spontaneous behaviour and explicit attitudes predict deliberate behaviour (Spalding and Hardin, 1999; Fazio, et al., 1995; Dovidio, et al., 1997; Dovidio, Kawakami and Gaertner, 2002). Findings also differ from previous comparisons of predictive models which have supported the double dissociation model (Asendorpf et al., 2002; Perugini, 2005) and the interactive model (Perugini, 2005). It is noted that the current study examined a wide range of behaviours that were specifically designed to vary with regards to their level of spontaneity and this may be the cause of differences noted. It is possible that had the real choice task not been included in this study, the additive model may not have been the best fitting model because this was the only behaviour measure to be significantly predicted by both explicit and implicit attitudes. As Perugini (2005) suggests, it is likely that different behaviours may be better predicted by different patterns of combining implicit and explicit attitude measures. However, our study does indicate that a double dissociation pattern alone is not always sufficient to account for behaviour. Therefore, when predicting behaviour, it is insufficient to consider just

one attitude measure; it is important to consider both explicit and implicit attitudes as each may predict separate variance.

It would also be advisable to consider the possibility that implicit and explicit measures may interact to explain further variance in behaviour. The interactive model of predicting behaviour was not found to be optimal for this research and receives only limited support in the literature (Poehlman et al., 2005). This indicates that only in certain specific circumstances will behaviour best be predicted by an interaction between implicit and explicit attitudes[3]. Further research is required across a variety of different domains in order to delineate specific cases, and possibly types of cases, in which behaviour is best predicted by additive or interactive patterns of combining implicit and explicit attitudes.

It is noted that results from this study, although loosely associated with traditional dual process theories (e.g., Bohner, et al., 1995; Fazio, 1990) should not be taken as support for this theory. It is feasible that either the model of dual attitudes (Wilson, Lindsay, and Schooler 2000) or the Reflective-Impulsive model (Strack and Deutsch, 2004) could also account for results found here.

Explicit attitudes were found to significantly predict all three behaviours measured, spontaneous behaviour (as measured by the equivalent gain lottery task), deliberate behaviour (as measured by vignettes) and combination behaviour (as measured by the real choice task). Implicit attitudes, on the other hand, were found only to predict spontaneous behaviour. Results are, therefore, mostly in line with previous research and Fazio's MODE model which suggests that implicit attitudes are better predictors of spontaneous behaviour and that explicit attitudes are better predictors of deliberate behaviour. However, it is unclear why implicit attitudes did not predict combination behaviour. Combination behaviour was measured using a

real choice task and was an ecologically valid behaviour that was intended to be of intermediate spontaneity, being partly spontaneous and partly deliberate. The most likely explanation is that the behaviour was not as spontaneous as predicted. The real choice behaviour was obtained at the end of the experiment after participants had been questioned thoroughly about their views on GM food and after completing two other tasks questioning them on their behaviour regarding GM food which is likely to have reduced the spontaneity of decisions made. This possibility is supported by comments made by participants during debriefing. Comments made suggested that the real choice was similar to decisions made during the vignette task. The real choice behaviour was measured at the end of the experiment in order to validate the deception that this was not part of the actual experiment and so as to decrease any associated demand characteristics, however, it would be useful in future similar research to include this type of measure at the beginning of an experiment or on a separate occasion.

Attitudes and Behaviour towards GM food

Regarding empirical data, it is of interest that explicit attitudes towards GM food were found to be negative. This finding contrasts with previous research that indicated that people in Britain were generally ambivalent towards GM food (Gaskell et al., 2003). The population sample within this study were not representative of the British public, however, and results are likely to be characteristic of the population examined, which was a young, student population. Interestingly, implicit attitudes within this study were found to be positive which supports previous research that found implicit attitudes towards GM food to be positive (Spence and Townsend, 2006).

It is also of note that all three behavioural measures were positive towards GM food (the lottery task indicated that GM food would be accepted over some amount of money). This indicated that the majority of the population sample examined here would try GM food, even though this sample demonstrated more negative explicit attitudes towards GM food than is generally observed within the British population. This adds to previously sparse data regarding behaviour towards GM food and supports previous evidence obtained from self-report data and real choice experiments (Sparks et al., 1995; Spence and Townsend, 2006; Townsend and Campbell, 2004). Results obtained here were rather more positive than previous data obtained from contingent valuation tasks (Moon and Balasubramanian, 2003) and this disparity is likely to be due to methodological differences. The contingent valuation task utilised here was an equivalent gain task which minimised any potential loss aversion biases and also provided real consequences for participants' decisions rather than hypothetical choices as used within previous studies. These results have important implications for the possible future of GM food in Britain. Individuals may be more likely to accept, and purchase, GM food than has been indicated by some previous research.

Limitations and Directions for Future Research

This study utilised a context free GNAT in order to measure implicit attitudes towards GM food. Although this task has been found to be valid and reliable (Nosek and Banaji, 2001; Sedikides, 2005) it remains a fairly new task. It may, therefore, have been more pragmatic to have used the IAT within this study. This would have meant that implicit attitudes towards GM food would have had to be measured with a context category. However, it might be argued that it would have been more

ecologically valid to have measured attitudes towards GM food in the context of attitudes towards non-GM food. Another alternative in future research is to use an IAT that has been modified in order to examine single categories, e.g., the single target implicit association task (ST-IAT; Karpinski and Steinman, in press) or the simple association task (SAT; Blanton, Jaccard, Gonzales and Christie, 2006).

It is also acknowledged that the use of only one implicit task here limits the latent variable modelling of the implicit attitude. The well documented low convergent validity of implicit tasks indicates that it is possible that results might vary if different implicit attitude measures are used. Further research should utilise several different implicit attitude measures, in the same way as was done here, in order to examine this point.

Future research within this field should attempt to delineate conditions in which the different patterns of combining implicit and explicit attitude measures may apply. In particular it seems that the particular circumstances under which additive and interactive predictive patterns of combining attitudes in order to predict behaviour should be examined, as these patterns seem to be more unusual. This can be done by examining implicit attitudes, explicit attitudes and behaviour within a variety of domains and under a variety of conditions.

In relation to this, it would be useful to further examine the predictive value of attitudes for behaviours of varying spontaneity. It is recommended that behaviour is methodically varied with regards to the spontaneity with which it is performed, either by gradually increasing time pressure or by increasing cognitive load during performance, or both. It would also be useful to find some external means of validating behaviour in terms of its level of spontaneity.

Conclusions

Overall, this study has useful implications both theoretically and empirically. We have demonstrated that the additive pattern of combining attitudes in order to predict behaviour was superior to both the double dissociation model and the interactive model within the domain of GM food behaviour. The study also showed that implicit attitudes towards GM food were useful in predicting spontaneous behaviour towards GM food and that behaviour towards GM food may be more positive than previously indicated.

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Footnotes

[1]Reaction times were used for analysis in preference to error rates as it is likely that the internal consistency of the task will be higher with an analysis of reaction times rather than of errors (Nosek and Banaji, 2001)

[2] The alternative double dissociation model, in which the path from implicit attitudes to spontaneous behaviour is restricted and the path from explicit attitudes to combination behaviour was freed, was also tested. This model did not fit the data as well as the original double dissociation model tested and again the additive model proved to fit the data better than this alternative double dissociation model.

[3] Of course this study only examined multiplicative ways in which implicit and explicit attitude measures may interact, it is feasible that these may combine in other ways.

Figure 1 – Ordinal scale used in which to classify preferences within the real choice task

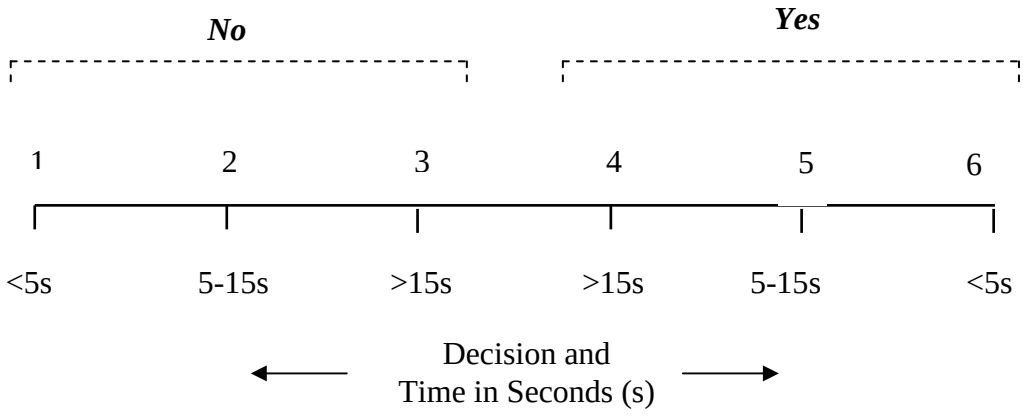
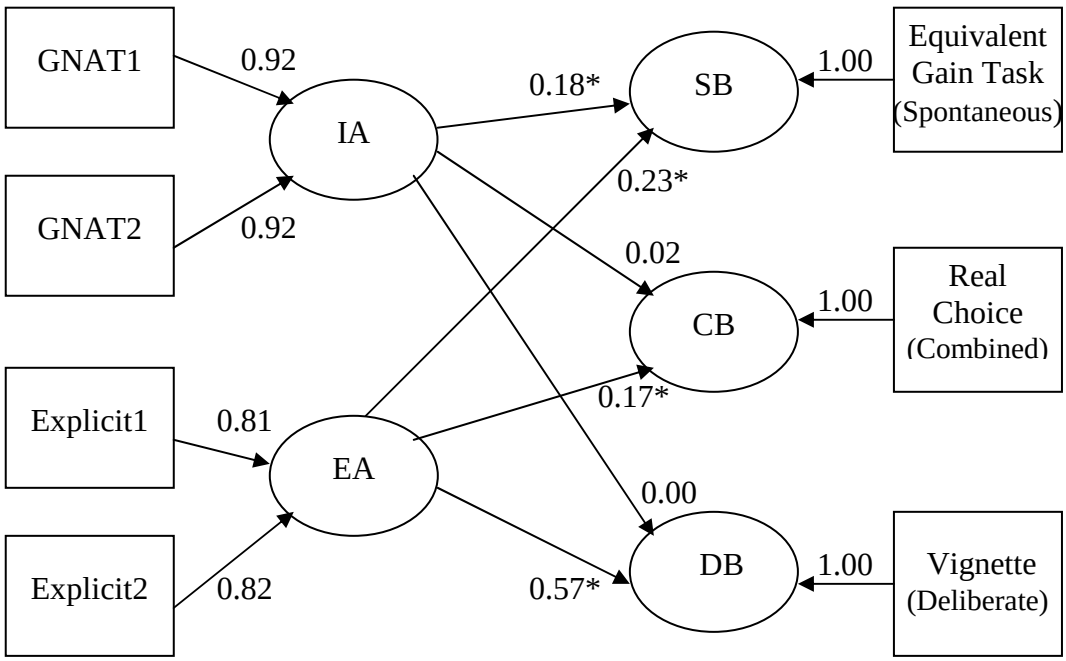
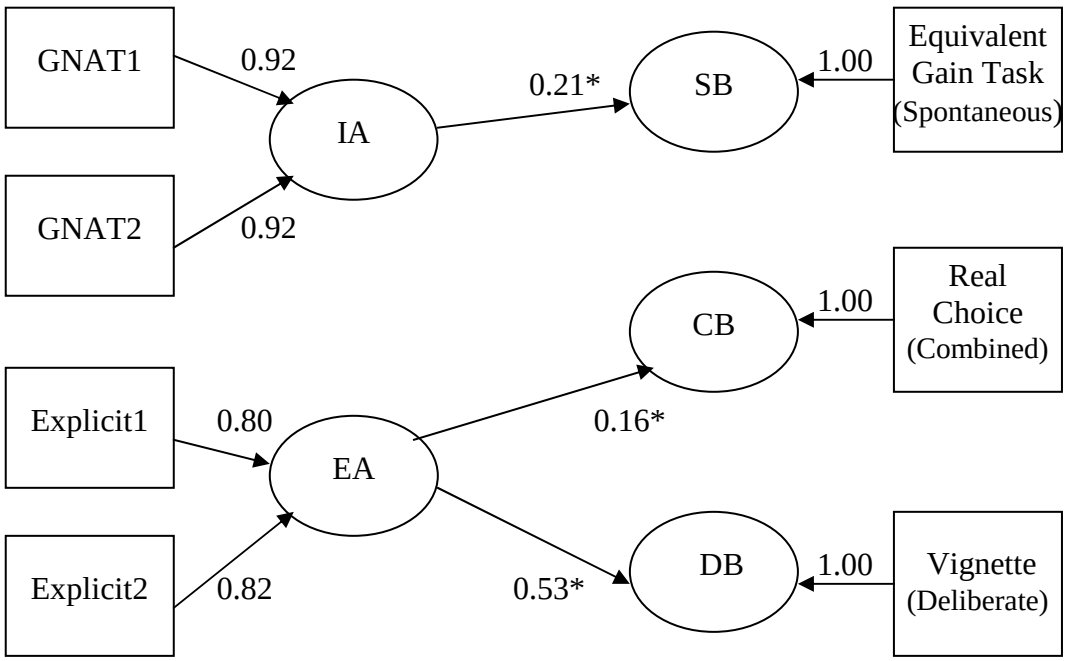


Figure 2 – Additive model



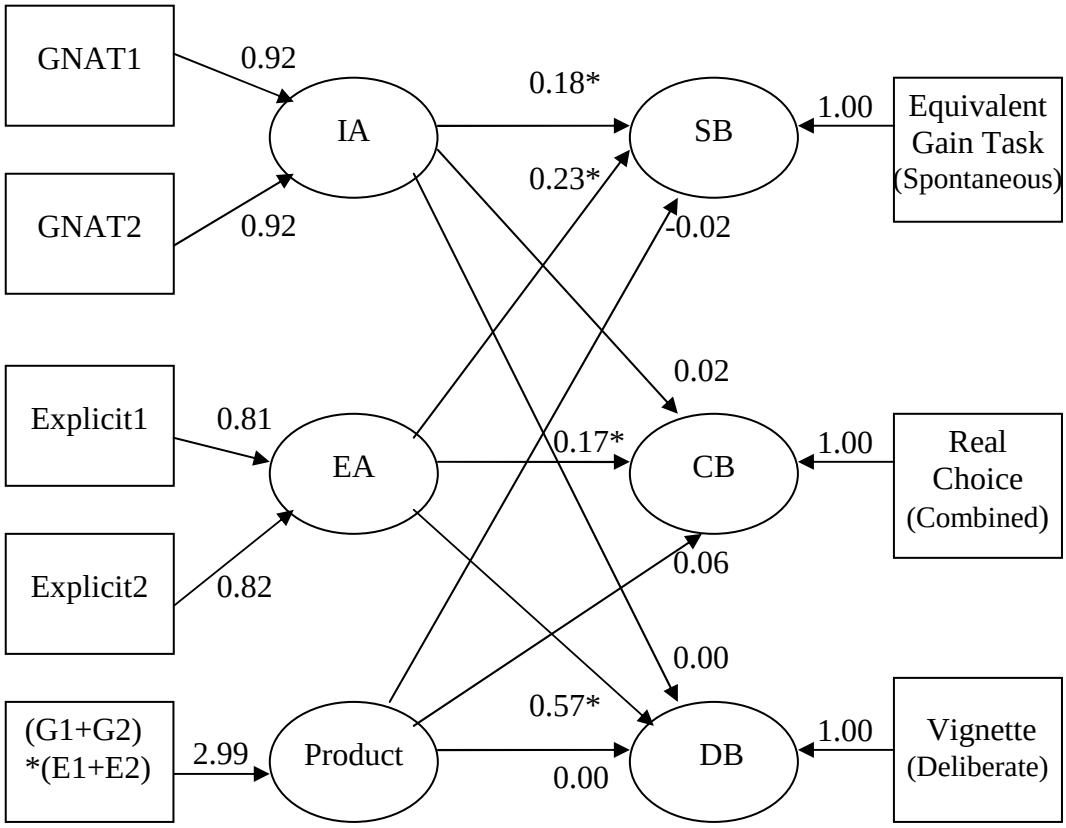
KEY: IA = Implicit Attitude; EA = Explicit Attitudes; SB = Spontaneous Behaviour; DB = Deliberate Behaviour; CB = Combination Behaviour; (G1+G2)*(E1+E2) = multiplication of the sum of implicit attitude indicators (GNAT1 and GNAT2) and of explicit attitude indicators (Explicit1 and Explicit2)

Figure 3 – Double Dissociation Model



KEY: As Figure 2.

Figure 4 – Interactive Model



KEY: As Figure 2.

Table 1 – Time taken (in seconds) to make spontaneous choice

Decision and Time taken	**Frequency**	**Percent**
No – less than 5s	21	10.5
No – between 5 and 15s	10	5
No – over 15s	1	0.5
Yes – over 15s	3	1.5
Yes – between 5 and 15s	21	10.5
Yes – less than 5s	144	72

Table 2 – Correlations between factors measured (Pearson's product moment and Polyserial correlations)

	Vignettes (Deliberate)	Equivalent Gain Task (Spontaneous)	Real Choice (Combined)	Implicit Attitude	Explicit Attitude
Vignettes (Deliberate)	-				
Equivalent Gain Task (Spontaneous)	0.306***	-			
Real Choice (Combined)	0.311***	0.112	-		
Implicit Attitude	0.077	0.242***	0.034	-	
Explicit Attitude	0.507***	0.205**	0.154*	0.135	-

*Note: *p<0.05, **p<0.01, ***p<0.001.*

Table 3 – Correlation matrix entered into LISREL (Pearson's product moment and polyserial correlations)

	Vignettes	Equivalent Gain Task	Real Choice	GNAT1	GNAT2	Explicit1	Explicit2	Product
Vignettes	1.000							
Equivalent Gain Task	0.289	1.000						
Real Choice	0.310	0.112	1.000					
GNAT1	0.050	0.174	0.071	1.000				
GNAT2	0.096	0.213	0.011	0.500	1.000			
Explicit1	0.459	0.246	0.158	0.069	0.136	1.000		
Explicit2	0.471	0.165	0.129	0.081	0.138	0.674	1.000	
Product	-0.003	-0.006	-0.051	-0.144	-0.132	-0.007	0.049	1.000

Table 4 - Comparison of model fit indices

	Chi - square	**df**	**Model AIC**	**CFI**	**NNFI**
Additive model	5.30	9	43.30	1.00	1.03
Double dissociation model	13.76	12	45.76	0.99	0.99
Interactive model	5.30	9	59.30	1.00	1.04

Appendix: Stimuli used within the GNAT

Target Categories	GM foods	I Like	I Don't Like
Exemplars	Transgenic crops	Good	Bad
	GE[†] livestock	Excellent	Horrible
	GM[††] plants	Happy	Nasty
	Modified tomatoes	Pleasant	Unpleasant
	GM Maize	Wonderful	Terrible

[†]GE = genetically engineered (definitions were made clear to participants within instructions)

[††]GM = genetically modified