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The role of attitude and attitude ambivalence in acceptance of the cancer risk associated with red meat

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Abstract

Many cancers are linked to varying degrees with common lifestyle factors such as smoking, drinking and diet, and are therefore partially preventable. Building on existing risk perception literature, this article uses the case of red meat consumption to examine the effect of people's attitudes and attitude ambivalence on health risk perceptions where there is some uncertainty about the risk. Data was obtained from an opportunity sample of community-dwelling adults ($n = 167$) using an online survey. The survey included information from a recent press release on the cancer risk associated with red meat consumption ('probably carcinogenic') as well as measures of attitude to red meat, attitude ambivalence, ambiguity aversion, information evaluation and acceptance of cancer risk. Participants who were more inclined to accept the risk of cancer linked to red meat tended to have a more negative attitude to red meat, higher attitude ambivalence, more favourable evaluation of the information provided, lower ambiguity aversion and lower red meat consumption; they also tended to be of older age. Attitude was a weaker predictor of risk perception among participants who were highly ambivalent. This, coupled with the finding that people with an ambivalent attitude to red meat evaluated the risk information more favourably and were more convinced that red meat can cause cancer, suggests that attitude ambivalence may play a more important role in risk perception than previously thought. These findings are discussed in the context of strategies for dealing with risk when drawing on rational and non-rational logics of handling evidence.

Introduction

This article uses the case of red meat to examine the role of attitude and attitude ambivalence in judging the level of risk attached to a particular health behaviour, and to consider the broader implications of this for our understanding of the way people process risk when there is uncertainty about the evidence for that risk. Prior research has established that people draw on multiple logics when assessing the risks they are faced with in the modern world – they are influenced by rational strategies such as scientific evidence and calculation, non-rational strategies such as belief and hope, and in-between strategies that rely on trust and intuition (Zinn, 2008). The new research presented here uses the case of red meat consumption, which experts say is ‘probably carcinogenic’ (International Agency for Research on Cancer (IARC), 2015), to explore how these logics are represented in a person’s attitude to red meat, and the ways in which they interact when people make a judgment about the cancer risk associated with eating red meat.

Cancer is one of the leading causes of mortality worldwide, with an estimated 8.2 million cancer-related deaths recorded in 2012 (Stewart & Wild, 2014), and the number of new cases of cancer expected to rise by approximately 70 per cent over the next 20 years (World Health Organization, 2015). In the United Kingdom alone, cancer diagnosis and treatment cost the National Health Service (NHS) £5 billion a year, and the cost to society at large (through decreased productivity, for example) is estimated to be around £18 billion (Department of Health, 2015). Many types of cancer are preventable – in the United Kingdom, it is thought that approximately 42 per cent of cancer cases each year are linked to lifestyle factors such as smoking, obesity and diet (Cancer Research UK, 2011). The possibility that such a large proportion of cases is preventable presents policy makers with an urgent challenge: how to modify people’s behaviour so as to reduce incidence of cancer. If people believe the risk associated with a given activity is low, there is little motivation for those who engage in that activity to modify their behaviour (Robb, Miles & Wardle, 2007), whereas increasing risk perception has been shown to lead to behaviour change (Sheeran, Harris & Epton, 2014). It is crucial therefore to gain a better understanding of how people perceive risk, in particular the relationships between the factors that predict risk perception.

Many people who engage in behaviours such as smoking and drinking that are linked with increased cancer risk accept the general fact that these behaviours can cause cancer, but are prone to optimistic bias when it comes to their own consumption (Weinstein, 1989; Raats & Sparks, 1995): Peretti-Watel et al. (2007) found that only 36 per cent of smokers thought they were at high risk of developing cancer because of their smoking; and Miles, Redeker and Pouli (2010) found that 94 per cent of participants in their study who were aware that alcohol is carcinogenic thought they did not drink enough themselves to increase their risk. People have a tendency to dismiss evidence that doesn't accord with their attitudes (Lord, Ross & Lepper, 1979), or at least to be more sceptical about such information (Ditto, Scepansky, Munro, Apanovitch & Lockhart, 1998) – for example, people regard their own underlying beliefs as more important in making health-related decisions than the content of information they receive (Farrell, Murphy & Schneider, 2002).

The role of attitude in risk perception is an underexplored area of research, but it has been shown that a positive attitude to nuclear power is associated with a lower perception of the risks associated with it (Sjöberg, 2000; Eiser, Miles & Frewer, 2002), and that increasing people's perception of the risk attached to a given activity decreases their perception of the benefit of the activity (Finucane, Alhakami, Slovic & Johnson, 2000). However traditional unidimensional attitude measures fail to capture the fact that people can be ambivalent about an attitude object, in other words can hold positive and negative opinions about it at the same time (Jonas, Diehl & Brömer, 1997). The split-semantic differential technique (see Conner et al., 2002) measures people's positive feelings about an attitude object separately from their negative feelings, thereby providing an ambivalence measure that indicates whether an attitude is straightforwardly positive/negative or complicated by conflicting feelings. Studies examining health intentions and behaviours suggest that the relationship between attitude and intentions is attenuated by ambivalence (Sparks, Conner, James, Shepherd & Povey, 2001; Conner et al., 2002). There is also evidence that ambivalence leads to deeper, more systematic consideration of information related to the attitude object (Jonas et al., 1997; Maio, Greenland, Bernard & Esses, 2001; Hodson, Maio & Esses, 2001), and that the effectiveness of health messages

is partially determined by the ambivalence of the recipient (Hohman, Crano & Niedbala, 2016; Yan, 2015; Broemer, 2002).

Information plays an intrinsic role in attitude change (Anderson, 1971), and consideration must therefore be given to the quantity and quality of risk information to which the public is exposed. Much of the information on health risks comes to public consciousness via media coverage (Berry, 2007; Clarke & Everest, 2006). However it is argued that the volume of cancer risk information available can lead to cancer information overload rather than a better informed public (Kim, Lustria, Burke & Kwon, 2007): 72 per cent of a large, nationally representative, general population sample of adults in the United States thought there are so many different recommendations about preventing cancer that it's hard to know which ones to follow, and 63 per cent thought that it seems like everything causes cancer (National Cancer Institute, 2014). Such fatalism can lead people to adopt coping strategies that control their fear of cancer rather than the risky behaviour itself (Witte, 1994).

In terms of quality, the perceived tone, reliability and relevance of risk information are important in determining people's confidence in – and acceptance of – the central expression of risk. For example, studies have shown that the same health risk message is more effective when it is perceived as positive and motivating rather than negative and stigmatizing (Rothman, Salovey, Antone, Keough & Martin, 1993; Puhl, Peterson & Luedicke, 2013) although other factors have also been found to moderate this effect (Akl et al., 2011) – for example, factors such as personal relevance and source credibility play a key role in the elaboration likelihood model of persuasion (Petty & Cacioppo, 1986), which postulates that persuasion can occur either when people engage meaningfully with the arguments put forward in a communication *or* when they use peripheral cues such as perception of information quality and source expertise to make up their minds about its validity (Yi, Yoon, Davis & Lee, 2013). This model is supported by evidence pointing to the importance of people's trust in the authorities managing a given risk when their personal knowledge about the risk is lacking, but not when they are already fully informed (Siegrist & Cvetkovich, 2000).

‘Ambiguity’ is the term used to describe uncertainty about the reliability, credibility, or adequacy of risk-related information (Han, Reeve, Moser & Klein, 2009), created by conflicting information or by the absence of relevant information that could be known (Camerer & Weber, 1992). It is an important concept in cancer risk communication because there is an inverse association between perceptions of ambiguity in cancer prevention recommendations and the adoption of health-promoting behaviours (Han, Moser & Klein, 2007). Research suggests that lower levels of education, older age and non-white race are associated with higher perception of ambiguity (Han, Moser, et al., 2009). Crucially these factors are also associated with *aversion* to ambiguity (or lower tolerance for uncertainty), which in turn is linked to pessimistic risk judgments, lower perceptions of expert credibility and decreased trust in health-promoting interventions (Han, Reeve, et al., 2009; Longman, Turner, King & McCaffery, 2012). Given the potentially negative impact that perceptions of ambiguity can have, coupled with recent evidence that the alcohol industry is misrepresenting evidence of the risk of cancer from alcohol by denying or distorting the links between the two (Petticrew, Hessari, Knai & Weiderpass, 2017), there is an imperative to examine how people respond to uncertainty in risk communications.

Red meat presents an interesting case, because while the health risks associated with behaviours like smoking and drinking are relatively certain (see IARC, 2017), the health risks associated with red meat consumption are genuinely ambiguous – a recent report published by the World Health Organization (WHO) evaluating the carcinogenicity of red meat consumption (Bouvard et al., 2015) made the following points: red meat contains important proteins and nutrients; there is limited evidence in human beings that eating red meat causes cancer (since chance, bias and confounds could not be ruled out of some studies), although one meta-analysis of colorectal cancer reported a 17 per cent increased risk per 100g of red meat eaten daily (Chan et al., 2011); and there is good mechanistic evidence supporting a link between red meat consumption and colorectal cancer. The IARC concluded on the basis of this report that the consumption of red meat is ‘probably carcinogenic to humans’ (IARC, 2015). The findings were widely reported around the world, with major publications

in the UK (for example Boseley, 2015; Borland, 2015), the US (for example O'Connor, 2015) and India (for example Sinha, 2015) reproducing the ambiguous phrase 'probably carcinogenic'.

In line with previous research, it was hypothesized that higher levels of acceptance that red meat can cause cancer would be associated with negative attitudes towards red meat, lower personal consumption of red meat, greater aversion to ambiguity, and a more positive evaluation of information about the cancer risk associated with red meat. In addition to a direct relationship between attitude to red meat and cancer risk acceptance, it was also hypothesized that there would be an indirect relationship from attitude to cancer risk via information evaluation. Finally it was hypothesized that attitude ambivalence would attenuate the relationship between attitude and cancer risk acceptance, such that the relationship would be weaker among participants with more ambivalent attitudes – see Figure 1.

[Figure 1 near here]

Method

Participants

An opportunity sample of 167 community-dwelling adult participants (including but not restricted to students) took part in the study which was conducted via online questionnaire, yielding cross-sectional data appropriate to an exploratory study of this kind. Participation was voluntary; participants were not paid. Their consent was obtained electronically and they were informed of their right to withdraw. The study was approved by the ethics committee of the Department of Psychological Sciences at Birkbeck, University of London, and carried out by CD in 2016.

Cancer risk information

Participants were asked to read an extract from a recent WHO press release describing the decision of an international group of experts to classify 'the consumption of red meat as probably carcinogenic to humans (Group 2A), based on limited evidence that the consumption of red meat causes cancer in

humans and strong mechanistic evidence supporting a carcinogenic effect' (IARC, 2015) – see Appendix A.

Outcome variable

Participants were asked to indicate on a 6-point scale (1 = 'strongly disagree', 2 = 'moderately disagree', 3 = 'slightly disagree', 4 = 'slightly agree', 5 = 'moderately agree', 6 = 'strongly agree') the extent to which they agreed with the statement 'eating red meat can cause cancer'.

Predictor variables

Attitude to red meat

Participants were asked to indicate on a 5-point scale ('strongly disagree', 'disagree', 'don't know', 'agree', 'strongly agree') the extent to which they agreed with 17 different statements related to red meat, devised specifically for this study but informed by prior research on trends in red meat consumption (for instance Richardson, Shepherd & Elliman, 1993). The items encompassed the cognitive and affective aspects of people's relationship with red meat (Cronbach's $\alpha = .90$), for example 'red meat contains important nutrients that cannot be found elsewhere', 'it makes me sad to think that animals are killed so that humans can eat red meat'. Statements expressing a negative view of red meat were reverse-scored so that a higher attitude score reflected a more positive attitude to red meat. Appendix B contains a full list of all items of which the predictor variables were comprised.

Attitude ambivalence

Replicating Conner et al. (2002), the split-semantic differential technique was used to calculate a measure of attitude ambivalence by recording participants' positive and negative judgments of red meat separately. Participants were asked: 'considering only the positive aspects of red meat and ignoring the negative aspects, how positive is your evaluation of red meat?' They responded on a 4-point scale from 'not at all positive' to 'extremely positive'. This was repeated for 'negative aspects', followed by the 'beneficial'/'harmful' dyad. An ambivalence score for each dyad was calculated

using the formula: $(P + N)/2 - |P - N|$, where P is 'positivity/benefit score' and N is 'negativity/harm score'. An overall ambivalence score was calculated across both dyads.

Evaluation of information

A measure of participants' subjective evaluation of the extract was obtained across 7 items (Cronbach's $\alpha = .74$) devised specifically for this study but based on previous studies concerned with quality of health information (such as Yi et al., 2013; Puhl et al., 2013; Han, Reeve, et al., 2009). They were asked to indicate on a 5-point scale (from 'strongly disagree' to 'strongly agree') how they felt about the information, for instance 'I think the information in this extract is reliable', 'I think the information in this extract is relevant to me'. They were also asked how positive, interesting, engaging and informative they found the extract ('not at all', 'somewhat', 'moderately', 'very', 'extremely').

Aversion to ambiguity

Participants were asked to indicate on a 5-point scale (from 'strongly disagree' to 'strongly agree') to what extent they agreed with 6 statements adapted from Han, Reeve, et al. (2009) to measure 'aversion to ambiguity' (Cronbach's $\alpha = .72$), for example 'conflicting expert opinions about a preventive healthcare recommendation would lower my trust in the experts', 'I would not have confidence in a preventive healthcare recommendation if experts had conflicting opinions about it'.

Background variables

Behaviour and demographic variables were included to ensure the patterns predicted by the model were indeed being driven by the predictor variables. Participants were asked how many portions of red meat they eat in a typical week. Participants were also asked their age, their gender, the highest level of educational qualification achieved so far, and their ethnicity.

Procedure

Participants completed the questionnaire online at a time and location of their choosing. The questionnaire was presented in the following *fixed* order across all participants (with items within each of the measures randomised): red meat consumption, attitude to red meat, attitude ambivalence, press release extract, acceptance of cancer risk, evaluation of the extract, aversion to ambiguity, and finally demographic information. The order of measures was not randomised as it was important to ensure participants' responses to questions about eating habits and attitude to red meat were not influenced by the risk information.

Design

As the aim of the study was to identify the most important predictors of cancer risk acceptance (outcome variable), a regression model was created using the following predictor variables: attitude to red meat, attitude ambivalence, evaluation of information and aversion to ambiguity, as well as level of red meat consumption, age, gender, level of education and ethnicity. Simultaneous multiple regression was used to test the extent to which attitude, attitude ambivalence, evaluation of information and aversion to ambiguity explained the variance in cancer risk acceptance once behaviour (red meat consumption) and demographic variables (age, gender, education and ethnicity) had been accounted for. Analysis was performed using SPSS version 22, including the PROCESS plug-in for moderation/mediation analyses. Statistical significance was assigned at the 5 per cent level, two-tailed.

The variables used to construct the regression model were derived from Likert scales (with the exception of red meat consumption), most commonly a 5-point scale where the options were 'strongly disagree', 'disagree', 'not sure', 'agree', and 'strongly agree', coded as integers between 1 and 5.

There has been much debate over the legitimacy of adopting a parametric approach to the analysis of ordinal data (essentially treating the data as interval) – some see it as an inexcusable violation of the rules of statistical analysis (Kuzon, Urbanchek & McCabe, 1996), while others argue that parametric tests stand up robustly to violations of the assumptions associated with their use and can be used widely without impinging on the integrity of the results (Norman, 2010). A detailed discussion of the

arguments put forward on either side is outside the scope of this article, but we are inclined towards a flexible approach that lies in between these positions, whereby distribution and sample size are considered alongside data level when determining the best statistical design (Knapp, 1990), and account is taken of potentially problematic characteristics within the data, such as non-normal distribution, skewness and kurtosis. Data characteristics are described in the Results section.

Although the issues associated with non-probability sampling are well rehearsed (Couper, 2000; Schreuder, Gregoire & Weyer, 2001), the use of an opportunity sample in this study is justifiable on the basis that it is exploratory in nature and should therefore be seen as generating a hypothesis rather than testing a hypothesis. It is also concerned with a psychological process (assessment of risk) rather than the prediction of a specific outcome, and it is plausible to suggest that while outcomes may vary greatly across different sections of the population, the psychological process underlying those outcomes is to a great extent the same. Insights gleaned from non-probability samples should rightly be seen as a first step, but are useful for guiding future research that might refine the hypothesis using representative sampling methods.

Nevertheless self-selection bias is still a concern, particularly given the fact that there are demographic differences in online health-seeking behaviours, with internet use associated with individuals who are younger, more educated and better off financially (Koch-Weser, Bradshaw, Gualtieri & Gallagher, 2010). This design was chosen in spite of these issues because of the growing importance of the internet in health-seeking behaviours: the majority of internet users report searching for health information online (Atkinson, Saperstein & Pleis, 2009; Pew Research Center, 2013), and the demographic differences that exist in health-related internet use are narrowing as internet access continues to proliferate (Hong & Cho, 2017). It is therefore vital that we gain a better understanding of how people interpret the information they are presented with online, while acknowledging that there are still sections of the population that are less likely to access this information.

Finally, although a cross-sectional design limits the ability to infer causality, the aim of this study was to identify the important relationships between factors in acceptance of cancer risk rather than to test the causal mechanisms underlying those relationships. The approach used in this study also has countervailing strengths: it provides grounds for a better theoretical understanding of how people in general respond to cancer risk information using a real-world example rather than a narrower focus on how a particular group responds to targeted information. There are many studies already published that explore students' responses to specially constructed vignettes (such as Siegrist & Cvetkovich, 2001), so it was felt that a broader, real-world approach using part of a press release could offer a different, potentially valuable contribution to the literature. Design issues are further considered in the Discussion.

Results

Of the 167 participants who took part in the study, 61 were male, 103 were female and 3 did not disclose their gender. Participants ranged in age from 17 to 74 ($M = 43$, $SD = 15$). 134 participants were educated to degree level or above; 151 were of white ethnicity. The mean score for agreement that red meat consumption can cause cancer was 4.22 ($SD = 1.17$), where 4 = 'slightly agree' that red meat can cause cancer and 5 = 'moderately agree'. Scores were roughly normally distributed, with no serious issues of skewness or kurtosis. 137 participants agreed to some extent that red meat can cause cancer.

A regression analysis was performed where the outcome variable was participants' acceptance that red meat can cause cancer. In univariate terms, participants' attitude to red meat significantly predicted their acceptance of the risk ($\beta = -.40$, $p < .001$) such that the more favourable their attitude to red meat, the less they agreed that it can cause cancer. The following variables were also significant predictors of acceptance of the risk: attitude ambivalence ($\beta = .26$, $p = .001$); the interaction between attitude and ambivalence ($\beta = -.39$, $p < .001$); aversion to ambiguity ($\beta = -.24$, $p = .002$); evaluation of

risk information ($\beta = .38, p < .001$); red meat consumption ($\beta = -.22, p = .004$); and age ($\beta = .22, p = .004$).

No two variables were correlated beyond .64; the highest variance inflation factor was 2.31 for attitude, corresponding to a tolerance score of .43. These values suggest that multicollinearity was not a concern within the given dataset, meaning that the coefficient estimates associated with these variables should be reliable in a multivariate model.

The adjusted associations between cancer risk acceptance and the predictor variables in the multivariate model were as follows: attitude to red meat ($\beta = -.23, p = .019$); attitude ambivalence ($\beta = .22, p = .001$); the interaction between attitude and ambivalence ($\beta = -.21, p = .009$); aversion to ambiguity ($\beta = -.13, p = .053, n.s.$); evaluation of risk information ($\beta = .26, p < .001$); red meat consumption ($\beta = .07, p = .426, n.s.$); and age ($\beta = .14, p = .040$).

The factors included in the model were found to explain 39 per cent of the variance in the extent to which participants agreed that red meat can cause cancer ($R^2 = .39$). The model was highly significant, $F(10,156) = 9.77, p < .001$. In the final model, attitude, ambivalence, the interaction between the two, participants' evaluation of the information and age were significant at the .05 level. The two predictor variables that turned out to be non-significant in the multivariate model were both significantly correlated with attitude: aversion to ambiguity ($r = .27, p < .001$); and red meat consumption ($r = .64, p < .001$).

The PROCESS macro for SPSS was used to examine more closely the moderating role of ambivalence on the relationship between attitude and risk acceptance. The analysis revealed that attitude was a significant predictor of risk at the mean value of ambivalence and one standard deviation below the mean ($ps < .005$), thus when ambivalence was low, but not at one standard deviation above the mean ($p = .528$), thus when ambivalence was high. Information evaluation and aversion to ambiguity were included as covariates in the model.

Although the correlation between ambivalence and information evaluation was fairly weak ($r = .17$), it was nevertheless found to be significant ($p = .031$). A post-hoc analysis using PROCESS investigated whether information evaluation mediated the relationship between ambivalence and acceptance of the risk. This mediation analysis revealed that the total effect of ambivalence on risk acceptance was significant (unstandardised $\beta = .37$, $p < .001$), split between a direct effect (unstandardised $\beta = .30$, LLCI = .132, ULCI = .477) and a smaller indirect effect (unstandardised $\beta = .07$, LLCI = .001, ULCI = .170). Aversion to ambiguity and attitude were included as covariates in the model.

Attitude was not found to be a significant univariate predictor of information evaluation ($\beta = -.12$, $p = .129$). Therefore information evaluation could not mediate the relationship between attitude and risk acceptance.

Figure 2 updates the proposed model on the basis of these results.

[Figure 2 near here]

Discussion

General support was found for the model: participants' attitude to red meat was found to predict their acceptance of the risk associated with its consumption, and this relationship was attenuated by ambivalence. Participants' evaluation of the cancer risk information provided in the press release extract was also a strong predictor of their acceptance of the cancer risk message.

However the unexpected finding that attitude did not predict participants' evaluation of the risk information meant that information evaluation could not mediate the relationship between attitude and risk acceptance. Instead it was found that information evaluation partially mediates the relationship between ambivalence and risk acceptance. Aversion to ambiguity was not found to be a significant

predictor of cancer risk acceptance in the model. Of the background variables, only age was a significant predictor in the final model, but it was not highly significant and the regression coefficient was relatively small, so it is likely that the psychological predictors accounted for the model's predictive power.

These findings suggest that the attenuating effect of ambivalence on the attitude-intention relationship (Sparks et al., 2001; Conner et al., 2002) also prevails in the attitude-risk acceptance relationship. However participants' evaluation of the information contained in the press release in terms of tone, reliability, relevance and persuasiveness was a stronger predictor of their acceptance of the cancer risk message than their attitude: the more favourable their judgment of the quality of the information, the more convinced they were that red meat consumption can cause cancer. The reliability component of the evaluation measure supports the existing literature on the role of social trust in risk perception (Siegrist & Cvetkovich, 2000) – the fact that the information provided to participants came from a highly respected source (the WHO) is likely to have added to its persuasive power. Although the cross-sectional nature of the data examined for this article means it is not possible to draw conclusions about the direction of causality, the results indicate that there is a strong relationship between people's evaluation of the quality of health risk information and their acceptance of the core message being communicated.

The unexpected finding that participants' attitude to red meat did not predict their evaluation of the risk information seems on the face of it to challenge the idea of biased assimilation (Lord et al., 1979) or sceptical assimilation (Ditto et al., 1998), but this presupposes assimilation took place in all cases. The post-hoc finding that information evaluation mediates the relationship between attitude *ambivalence* and risk acceptance rather than the relationship between *attitude* and risk acceptance points to the interesting possibility that people with a strong, unambivalent attitude to red meat used that attitude as a shortcut to decide on the risk posed by red meat (similar to the affect heuristic; Slovic, Finucane, Peters & MacGregor, 2007) and did not assimilate the information in any meaningful way; and conversely that people with an ambivalent attitude to red meat could not use that

attitude as a reliable shortcut for judging the risk and therefore sought further information as a more solid basis on which to estimate the risk. In other words, the internal conflict that characterises ambivalence may cause ambivalent people not to trust their attitude alone to judge risk, prompting them to seek information from other sources to compensate for their internal lack of certainty.

The idea that there are two different ways in which people can judge risk, determined by their level of ambivalence, is consistent with the finding that ambivalent individuals engage in higher levels of cognitive elaboration than univalent individuals (Yan, 2015). It is interesting to consider this finding in the context of the elaboration likelihood model of persuasion (Petty & Cacioppo, 1986): the results of the study cited above suggest that in cases where ambivalence is low, people may neither engage meaningfully with the information nor use cues such as source expertise and perceptions of information quality to decide whether a given behaviour is risky, relying instead on their existing attitude.

One caveat concerning the mediating role of information evaluation is that this indirect pathway was small relative to the direct pathway between ambivalence and risk acceptance. Previous research has focused on the moderating role of ambivalence on other relationships rather than the direct effect of ambivalence on an outcome variable (for example Sparks et al., 2001; Broemer, 2002; Conner et al., 2013), but the data analysed for this article suggest that ambivalence itself may be associated with risk perception much as aversion to ambiguity has been found in other studies to be directly associated with pessimistic risk judgments (Longman et al., 2012; Han, Klein et al., 2009). One possibility is that the physiological arousal caused by ambivalence (Maio et al., 2001) – that uncomfortable feeling of having to balance two conflicting beliefs simultaneously – is responsible for the increased perception of risk. This would need to be verified experimentally by isolating ambivalence as a physiological phenomenon, perhaps by inducing a feeling of ambivalence in a group of participants before asking them to make a risk judgment on an issue unrelated to the object of their ambivalence and comparing their responses with a control group. In any case, the possibility that attitude ambivalence makes people more receptive to risk information could have important implications for health risk

communicators, particularly in the information age when messages can be tailored and targeted to greater effect (Ems & Gonzales, 2016).

In the final analysis, aversion to ambiguity was not found to be a significant predictor of risk acceptance (although it approached the threshold for significance). However aversion to ambiguity is associated with lower levels of education (Han, Reeve, et al., 2009), and 80 per cent of participants who took part in the study were educated to degree level or above. It is possible that aversion to ambiguity would play a more important role among people who are not so highly educated, and could conceivably find it harder to deal with a mix of positivity, negativity and uncertainty in risk information.

This research has two main limitations: (i) 80 per cent of participants who took part in the study were university graduates, and given there is an established association between education level and diet (Irala-Estévez et al., 2000; Darmon & Drewnowski, 2008), this sample is unlikely to be representative of the population as a whole, which reduces the generalizability of the findings; and (ii) the design of the study was observational rather than experimental – all participants were exposed to the same real-world information. This design was chosen in order to maximise ecological validity, and to identify the important predictors of risk acceptance rather than the mechanisms underlying *changes* in risk acceptance, but it means that inferences about causality cannot be drawn with confidence.

Nevertheless it is interesting to consider the analysis presented in this article in the context of wider themes in the risk and uncertainty literature: Zinn (2008) argues for the existence of rational strategies for dealing with risk (thought, calculation), non-rational strategies (belief, hope and faith), and *in-between* strategies that rely on trust, intuition and emotion. He argues that the complexity of the modern world requires lay people to make risk judgments in instances where they do not have access to the full range of knowledge that exists, leading them to decide based partly on their trust in experts who do possess the relevant knowledge, but also on feelings and hunches that have their origins in pre-conscious awareness. The research presented here explores what in-between strategies look like in

practice. Red meat consumption is particularly appropriate because the best that scientific experts can say about red meat is that eating it ‘probably’ causes cancer, so in trying to decide how much of a risk to health red meat really is, trust in scientific expertise is not enough and people must turn to other sources. Attitude to red meat is an operationalisation of an in-between strategy because it encompasses a cognitive component and an affective component (Breckler, 1984), as well as a moral component (Vauclair & Fischer, 2011). In other words, people might compensate for the uncertainty in the epidemiological evidence by drawing on existing knowledge about the nutritional value of red meat, the way they feel about the taste of red meat, and their beliefs about animal rights or environmental issues.

The gathering of evidence from various sources, including pre-rational knowledge derived from past experience and standards of moral acceptability, constitutes a form of scientific investigation (Horlick-Jones, Walls & Kitzinger, 2007). The idea that people use such “bricolage-like processes” (p.83) to manage risk in the real world is important for understanding why people behave the way they do, but our research suggests that, as well as identifying the sources people draw on, it is important to consider how they interact. For example, Gjernes (2008) refers to the creative use of health information in the search for a ‘healthy balance’ when there is a discrepancy between expert advice and personal or cultural circumstances – in other words, people may look for ways to legitimise behaviours that are unhealthy according to a medical discourse by citing countervailing health benefits according to a cultural discourse. The attempt to accommodate conflicting perspectives is at the heart of what lay people do every day as they try to negotiate the risks associated with modern life, and the interaction between sources is likely to play a particularly important role in situations where there is a great discrepancy between those sources. This discrepancy will usually be internalised as ambivalence, and the evidence cited in this article that people who are ambivalent in their attitude may assess risk in a different way from those whose attitude is more consistently positive or negative points to a potentially promising direction for future research.

Risk is not normally assessed in isolation (Douglas, 1994), and if researchers are to gain a better understanding of risk perceptions, they must examine the ways in which risk is situated within the complexity of a person's life, where balance is sought among factors that may be pulling against each other. On a practical level, Ropeik (2012) is rightly critical of the approach to public health that involves "simply telling people only what the experts think they need to know, to try and make them think and do what the communicators have decided people ought to think and do" (p.1224). Such an approach ignores the multiplicity of logics involved in risk perception and opens up the danger that people will disregard expert advice (Zinn, 2008), thereby weakening their armoury of decision-making aids.

Conclusion

Although the volume of cancer risk information available can lead to cancer information overload rather than a better informed public (Kim et al., 2007), this article provides some reassuring news for cancer risk communicators: on the whole, participants did not reject the idea that red meat can cause cancer, regardless of their attitude to red meat. Although participants with a positive attitude towards red meat were less convinced than the others that it is carcinogenic, 82 per cent of participants overall still agreed that red meat can cause cancer. Furthermore the best predictor of participants' acceptance of the cancer risk message was their evaluation of the risk information, so in spite of the perception that there is an overwhelming amount of cancer research out there (National Cancer Institute, 2014), it should still be possible with high quality risk information to help people make well informed and appropriate judgments about the risks attached to lifestyle factors like red meat consumption.

Nevertheless, in a world where health systems are under increasing strain and where vested interests may try to undermine the credibility of robust evidence of risk, it is crucial that we understand more about how people make risk judgments under conditions of uncertainty. This article has identified attitude ambivalence as a potentially important factor per se in risk perception, above and beyond its moderating influence on other factors. Further research should help to illuminate exactly how it asserts itself in the processes underlying risk perception.

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Appendix A: Cancer risk information provided to participants

The following extract from a recent World Health Organization (WHO) press release summarises the main findings from a review of research into the relationship between red meat and cancer. Please read it carefully and continue the questionnaire below.

Notes on terms:

1. carcinogenic = causes cancer
2. colorectal cancer = bowel cancer
3. IARC = International Agency for Research on Cancer (part of the World Health Organization)

After thoroughly reviewing the accumulated scientific literature, a Working Group of 22 experts from 10 countries convened by the IARC Monographs Programme classified the consumption of red meat as probably carcinogenic to humans (Group 2A), based on limited evidence that the consumption of red meat causes cancer in humans and strong mechanistic evidence supporting a carcinogenic effect.

This association was observed mainly for colorectal cancer, but associations were also seen for pancreatic cancer and prostate cancer.

“These findings further support current public health recommendations to limit intake of meat,” says Dr Christopher Wild, Director of IARC. “At the same time, red meat has nutritional value. Therefore, these results are important in enabling governments and international regulatory

agencies to conduct risk assessments, in order to balance the risks and benefits of eating red meat and to provide the best possible dietary recommendations.”

A summary of the final evaluations is available online in [The Lancet Oncology](#).

The International Agency for Research on Cancer (IARC) is part of the World Health Organization. Its mission is to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control.

Appendix B: Questionnaire items comprising predictor variables

Attitude to red meat

Red meat contains important nutrients that cannot be found elsewhere.

A vegetarian diet alone can provide all the nutrients necessary for good health.

It is not possible to know what growth hormones are contained in the red meat we eat.

Eating red meat benefits the economy.

It is possible to save money by switching to a vegetarian diet.

We should not eat red meat as it is damaging to the environment.

It is natural for humans to eat red meat.

Eating red meat is morally wrong because of animal rights issues.

Eating red meat is unhealthy.

I worry about the impact that red meat production has on the environment.

The idea of humans eating animal meat disgusts me.

I would be upset if I was told I could never eat red meat in the future.

It makes me sad to think that animals are killed so that humans can eat red meat.

I like the taste of red meat.

Sometimes my mouth waters when I think of red meat.

Eating red meat is enjoyable.

A meal containing red meat feels more satisfying than one without red meat.

Attitude ambivalence

Considering only the positive aspects of red meat and ignoring the negative aspects, how positive is your evaluation of red meat?

Considering only the negative aspects of red meat and ignoring the positive aspects, how negative is your evaluation of red meat?

Considering only the harmful aspects of red meat and ignoring the beneficial aspects, how harmful is your evaluation of red meat?

Considering only the beneficial aspects of red meat and ignoring the harmful aspects, how beneficial is your evaluation of red meat?

Evaluation of information

I think the information in this extract is reliable.

I think the information in this extract is relevant to me.

The information in this extract makes me think differently about red meat.

How positive did you find the tone of the extract?

How interesting did you find the extract?

How engaging did you find the extract?

How informative did you find the extract?

Aversion to ambiguity

Conflicting expert opinions about a preventive healthcare recommendation would lower my trust in the experts.

I would not have confidence in a preventive healthcare recommendation if experts had conflicting opinions about it.

Conflicting expert opinions about a preventive healthcare recommendation would make me upset.

I would not be afraid of trying a preventive healthcare recommendation even if experts had conflicting opinions about it.

If experts had conflicting opinions about a preventive healthcare recommendation, I would still be willing to try it.

I would avoid making a decision about a preventive healthcare recommendation if experts had conflicting opinions about it.

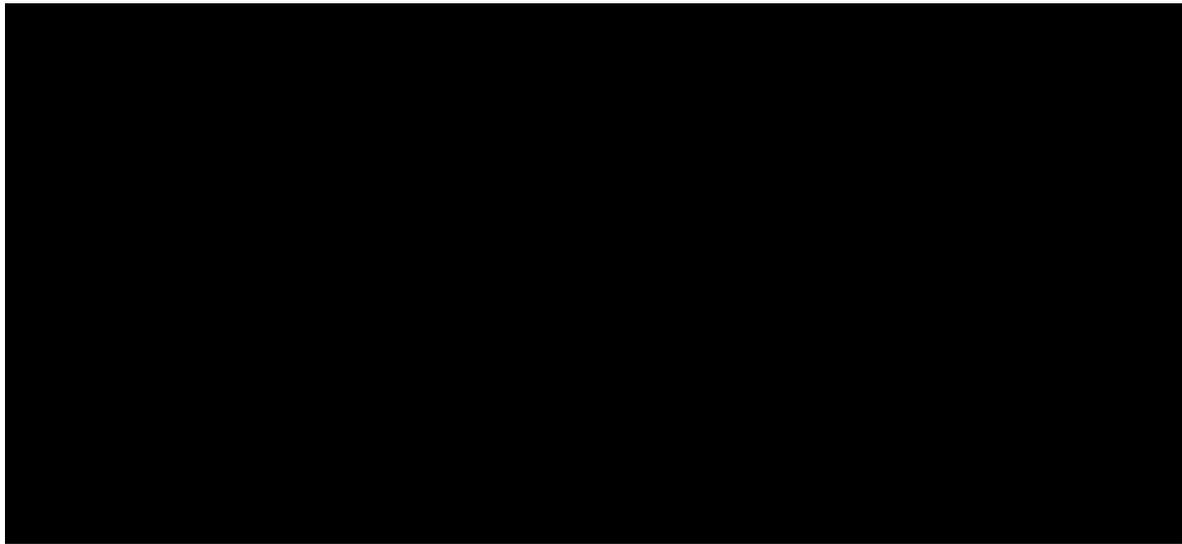


Figure 1: a proposed model for predicting people's acceptance of the cancer risk associated with red meat consumption based on their attitude to red meat, the ambivalence of their attitude, their evaluation of the risk information available and their aversion to ambiguity.



Figure 2: a revised model (with beta coefficients) for predicting people's acceptance of the cancer risk associated with red meat consumption. Parentheses indicate a non-significant effect.