



Framing and communicating climate change: The effects of distance and outcome frame manipulations

Alexa Spence^{*}, Nick Pidgeon

Understanding Risk Research Group, Cardiff University, Tower Building, Park Place, Cardiff CF10 3AT, United Kingdom

ARTICLE INFO

Article history:

Received 22 October 2009

Received in revised form 16 March 2010

Accepted 6 July 2010

Keywords:

Climate change
Gain–loss framing
Distance
Fear
Communications

ABSTRACT

Communications regarding climate change are increasingly being utilised in order to encourage sustainable behaviour and the way that these are framed can significantly alter the impact that they have on the recipient. This experimental study seeks to investigate how transferable existing research findings on framing from health and behavioural research are to the climate change case. The study ($N = 161$) examined how framing the same information about climate change in terms of gain or loss outcomes and in terms of local or distant impacts can affect perceptions. Text on potential climate change impacts was adapted from the 2007 Intergovernmental Panel on Climate Change report, alongside maps and images of potential flooding impacts. Participants then completed measures of various relevant socio-cognitive factors and questions assessing their responses to the information that they had received. Results indicated that, *ceteris paribus*, gain frames were superior to loss frames in increasing positive attitudes towards climate change mitigation, and also increased the perceived severity of climate change impacts. However, third variable analyses demonstrated that the superiority of the gain frame was partially suppressed by lower fear responses and poorer information recall within gain framed information. In addition, framing climate change impacts as distant (whilst keeping information presented the same) resulted in climate change impacts being perceived as more severe, whilst attitudes towards climate change mitigation were more positive when participants were asked to consider social rather than personal aspects of climate change. Implications for designing communications about climate change are outlined.

© 2010 Elsevier Ltd. All rights reserved.

1. Introduction

Climate change is a major public policy issue, with related impacts likely to be extensive and potentially devastating, supporting calls for urgent mitigation. Reflecting this, the British government has set ambitious carbon reduction targets, aiming to reduce emissions by 80% by 2050 as compared to 1990 levels (Committee on Climate Change, 2009). Elsewhere around the globe governments, businesses and communities are debating the appropriate responses to the emerging weight of scientific evidence. Whilst uncertainties will always exist with respect to climate modelling, and especially to projected impacts, the key policy debate is less about where we need to be in 40 years time, and more about the means for achieving what appear to be an increasingly ambitious set of aspirations. What is becoming clear is

that meeting the emission reduction targets needed to avoid dangerous levels of climate change will require major changes – technological, economic and behavioural – across all sectors of society (Committee on Climate Change, 2009; Office of Management and Budget, 2009).

Whilst much current policy debate focuses upon technological and economic instruments for reducing global emissions (IPCC, 2007; Stern, 2007), less attention has been given to changes to human behaviour. And yet this seems particularly important, not only because unsustainable behaviours represent a key cause of climate change, but because this presents the opportunity for a number of ‘quick wins’ in relation to reducing society-wide carbon emissions (see e.g. Gardner and Stern, 2008; Spence and Pidgeon, 2009). Recent modelling from the UK Energy Research Centre (2009), for example, indicates that in the UK lifestyle change could contribute a full 30% cut in greenhouse gas emissions against baseline, highlighting both the opportunities and challenges that behaviour change presents. Against such a background a key requirement will be to foster ongoing dialogue and communications between scientists, policymakers and the public regarding climate change risks and their implications (Lorenzoni et al., 2005).

^{*} Corresponding author at: School of Psychology, Cardiff University, Tower Building, Park Place, Cardiff CF10 3AT, United Kingdom. Tel.: +44 02920 876520; fax: +44 02920 874858.

E-mail address: SpenceA1@cardiff.ac.uk (A. Spence).

Risk and its communication is well-established in a number of academic and policy fields, and behavioural interventions and communications are commonly used in relation to personal health protection. However we currently have less empirical evidence about the most appropriate means for presenting and communicating climate change risks, and whether insights and theories developed in other risk domains are transferable to the climate case (Pelletier and Sharp, 2008), although some researchers are beginning to gather systematic evidence on this (see Hardisty and Weber, 2009). Exploring some of the factors which might prove significant for communicating climate risks is the main aim of the present study.

Communicating about climate change risks raises a number of complex issues. As Lorenzoni et al. (2005) point out, what we individually consider to be 'dangerous' climate change involves at minimum judgements about uncertain and complex science, potential impacts far into the future, as well as the perceptions and values we use to establish whether a particular outcome is acceptable or not (see also Dessai et al., 2004). As a result, it is impossible to present information about climate change in a neutral manner without some kind of context (Hulme, 2009; Thaler and Sunstein, 2008), and therefore the way in which such information is 'framed' is paramount. Framing theory and research seeks to understand the ways in which related sets of ideas in the public sphere are organised, presented and debated, and is increasingly being used to understand a range of environmental problems and issues (Miller, 2000). A frame allows complex issues to be pared down and for some aspects of that issue to be given greater emphasis than others in order that particular audiences can rapidly identify why an issue may be relevant to them (Nisbet and Mooney, 2007). Frames can also serve ideological and governance purposes, and as a consequence different social actors within the climate change policy domain (as within other fields) constantly compete in order to present and legitimise their own interpretations of the salient issues (Carvalho and Burgess, 2005; Nisbet, 2009).

A variety of different types of frames are discussed in the theoretical literature on the topic (for a review see Levin et al., 1998). In the present study we focus on attribute frames and outcome frames. *Attribute framing* is the process of highlighting some particular aspect, or attribute, of the target object or issue. This is a commonly used technique within policy or political debate, often with the intention to influence evaluations: for example, in the USA Republican supporters often emphasise the uncertainties involved with climate science (Nisbet and Mooney, 2007). In the present study we are interested in using the attribute of distance as a means of increasing the personal relevance of climate change to people. This is achieved through framing climate change in terms of consequences which are either local or distant to the study participants. *Outcome framing* by contrast refers to presenting a particular behaviour or issue in terms of gains or losses, an approach sometimes used (for example in health promotion campaigns) to persuade an individual to undertake a particular lifestyle or behaviour. Hence we also explore the attitudinal impacts of presenting climate change in terms of the gains involved with mitigating climate change or the losses involved with not mitigating climate change.

1.1. Personal relevance and distance

Whilst climate change is perceived as an important and concerning issue both in the UK and across Europe (Eurobarometer, 2007), many people still do not behave in a sustainable fashion (Energy Saving Trust, 2007). One potential reason for this inaction is the suggestion that climate change is a psychologically distant issue, in that people generally perceive it is most likely to

impact geographically and temporally distant people and places (Leiserowitz, 2005; Rathzel and Uzzell, 2009). A frequently voiced hypothesis arising from this is that situating climate change in terms of an individual's present locality will render the issue more salient (Lorenzoni and Pidgeon, 2006) and more likely to promote emotional and cognitive engagement with the issue (Lorenzoni et al., 2007). Other recent research suggests that the use of iconography and imagery may also help to give greater personal meaning to what is otherwise a diffuse global problem (O'Neill and Nicholson-Cole, 2009; O'Neill and Hulme, 2009), whilst strong imagery is often a central component of the communications from environmental campaign groups such as Greenpeace which espouse the philosophy of 'bearing witness to environmental damage' (Hulme, 2009, p. 238). Rayner and Malone (1997) further suggest that by highlighting local impacts of climate change, the benefits of acting to mitigate climate change will be made tangible and people will be more likely to act sustainably. This line of argument is congruent with Construal Level Theory (Trope and Liberman, 2003) which suggests that we are better at predicting and making decisions about events that are psychologically closer to ourselves compared to those that are more psychologically distant. In addition, there are suggestions that action on a local level may set a precedent in behaviour change and inspire change in underlying social norms and value systems which may then initiate a broader range of environmentally beneficial activities (Hassol and Udall, 2003).

It is important to acknowledge however that the distant impacts of climate change tend to be viewed as more serious than local impacts. Survey evidence from Britain suggests that people perceive the risks of climate change to outweigh the benefits (OST/MORI, 2004; Poortinga et al., 2006) but that it is not viewed as a personally threatening issue (Kirby, 2004; also for USA see Bord et al., 1998). Furthermore, Palutikof et al. (2004) report that some people actually see potential personal benefits arising from climate change, e.g. better weather, whilst the perception is that the negative effects of climate change are most likely to be experienced by more vulnerable groups and societies. People can also distinguish between personal and societal impacts of climate change, with studies suggesting that personal risks are judged to be lower than societal risks (Leiserowitz, 2005; Lorenzoni, 2003; Zwick and Renn, 2002). Similarly, local environmental problems tend to be viewed as less serious than global environmental problems (Uzzell, 2000). Paradoxically, then, framing climate change in more local, personal terms might merely result in individuals focusing on what they believe are *less* significant aspects of the issue, with the potential to *reduce* the overall perceived severity of the problem as a whole.

1.2. Outcome framing as gain versus loss

It is possible to discuss climate change mitigation in terms of the positive consequences of undertaking mitigation actions or in terms of the negative consequences of not mitigating. In fact we would suggest that much contemporary literature focuses on the dangerous consequences of climate change which might follow if we do not act to mitigate (discussed in Hulme, 2008). However, a focus upon loss is not always the most effective communication approach. In the present study we are interested in comparing the relative impact of loss and gain frames on attitudes towards mitigation. There is a large amount of framing literature (particularly well developed within health psychology) which focuses on comparing the relative effectiveness of information frames which focus either on the positive consequences of undertaking a particular behaviour (gain frame) or on the negative consequences of not undertaking a particular behaviour (loss frame). For example, sunscreen use may be presented in terms of

the benefits of applying sunscreen (gain frame) or in terms of the risks of not applying sunscreen (loss frame). Both frames should increase the likelihood of the behaviour in question but of interest is which information frame is more effective.

Of particular relevance to framing outcomes in terms of gains and losses is the idea of loss aversion, which is the idea that individuals tend to dislike losses more than equivalent gains (Kahneman and Tversky, 1979). Loss aversion is consistent with the well documented finding of a negativity bias in our attention (Meyerowitz and Chaiken, 1987). Evidence suggests that negative information in general has a stronger impact on decision making than equivalent positive information. Empirical evidence supporting the stronger influence of loss frames is inconsistent, however, and it appears that the relative effectiveness of gain and loss frames may depend on other factors, including the particular behaviour in question as well as the relationship between the individual and that behaviour (Maheswaran and Meyers-Levy, 1990; Rothman et al., 1993). In particular it has been found that loss frames are more effective in changing behaviours considered risky whilst gain frames are more effective within behaviours considered safe (Banks et al., 1995; Edwards et al., 2001). These ideas are based on prospect theory (Tversky and Kahneman, 1981) which relates message framing and risk taking.

Prospect theory proposes that people are less inclined to take risks when considering gains because the perceived subjective value of gains is fairly low whilst people will take risks to avoid losses because the subjective value of losses are relatively high. In applying prospect theory, the individual's perspective of what is risky and safe must also be taken into account when analysing the effectiveness of different frames. Within health psychology, a distinction is made between prevention behaviours which are perceived as low in risk (e.g. sunscreen use) and detection behaviours (e.g. testing for HIV) which are perceived as having a high short term risk (Banks et al., 1995). Detecting a health problem is considered as high in short term risk, to the extent that an individual may anticipate receiving negative and disturbing information. This conceptualisation of risk is different from the objective probability of a given outcome but rather focuses on the subjective meaning assigned to the potential outcome. Here, the evidence indicates that loss frames are found to be more effective for encouraging detection behaviour and gain frames for encouraging prevention behaviour (Rothman et al., 2006).

We would suggest that when conceptualising risk behaviour in this way, climate change mitigation actions are most similar to prevention behaviour in that mitigation behaviour is undertaken in order to prevent potential future negative impacts of climate change. The hypothesis which follows from this is that climate change mitigation may be most effectively promoted within gain frames, i.e. by focusing on the benefits of undertaking mitigation behaviour.

1.3. Fear

The emotive quality of the message is also likely to impact how participants respond to a communication. There is a growing literature on the impacts of *fear framing*: in effect a more extreme version of a negatively focused loss frame. Such framing emphasises the threat content of a message (e.g. the size and consequences of the potential loss) in order to provoke a more extreme emotional response (Wilson et al., 1988). For example gain and loss outcomes could be referred to in terms of whether people will live or whether people will not live respectively, or in terms of the type and number of deaths. The latter language used is more emotive, and could therefore be referred to as 'fear framing'. Hulme (2008) has argued that the contemporary discourse of fear evident in some climate change communications, with a linguistic

repertoire of words such as 'catastrophe', 'terror', and 'danger' routinely used, is unhelpful for engaging ordinary people, and has frequently been labelled alarmism (Ereaut and Segnit, 2006). Indeed, a recent UK government 'Bedtime Story' advertising campaign in the UK, which featured a father telling his daughter a scary bedtime story about climate change, has received heavy criticism for being inappropriate and upsetting for children (Sweeney, 2009). However Risbey (2008) makes an interesting distinction between alarmist discourses, i.e. sensationalist, rhetorical and inconsistent with the science, and those which are alarming, i.e. emergent from scientific understanding and intended to inform the public. Risbey argues that those who fail to adopt alarming language where necessary may be failing in their civic duty to inform the public of important findings.

Interestingly, experimental evidence from psychology suggests that fear framing is indeed effective in motivating behaviour change across various different behaviours. In general, the greater the level of fear produced by a communication, the greater the level of attitude change found (assuming perceptions of control over the situation and behaviour are held constant: Witte and Allen, 2000). Various applied studies of fear framing within relevant domains (including environmental risks and energy consumption) also find fear appeals to be an effective way of impacting attitudes (Mejinders et al., 2001a,b), intentions (Hass et al., 1975) and behaviour (Hine and Gifford, 1991). However, Moser (2007) rightly cautions that fear framing cannot be used indiscriminately, and that a number of preconditions also need to be in place (a sense of personal vulnerability, self efficacy, low response costs, and wider social support; see e.g. Milne et al., 2000) which then make appeals to emotion and fear particularly effective in changing attitudes and behaviour. Whilst fear framing is not the central concern of the current study, fear responses do appear to be a key aspect of message impacts and should therefore be examined alongside direct framing effects, so as to clarify the causes and reasons for impacts noted (Levin et al., 1998).

1.4. Information processing

The extent to which individuals process communications that they receive is an additional important factor which can also impact framing effects; if people do not attend to communications, they are unlikely to be affected by them. In fact, the majority of research within the literature on information processing indicates that negatively focused information (including both loss frames and fear appeals) generally promotes more careful, systematic processing of information than positively focused information (Liberman and Chaiken, 1992; Baron et al., 1994) and that systematic information processing generally facilitates persuasion (Chaiken and Eagly, 1976; Chaiken, 1980). For example, Mejinders et al. (2001a) examine communications about CO₂ risks and find that high levels of fear led to systematic processing of information about energy conservation and consequently more positive attitudes towards energy conservation. In reality, the situation is likely to be more complex; it is possible that differently framed appeals may result in biases in information processing (De Hoog et al., 2005), and for some people, high levels of fear may actually result in the complete avoidance of related situations and information (Janis, 1967; Leventhal, 1970; Witte, 1992). However, in general it appears that loss frames are most likely to provoke systematic processing of information.

Personal relevance is also known to impact the way in which information is processed. A highly personally relevant message might be expected to provoke a more considered, systematic processing of that message and indeed empirical evidence confirms this (Kiesler et al., 1969; Petty and Cacioppo, 1979). Further to this, the literature on persuasion indicates that personal

relevance has a moderating effect on framing in that framing effects tend to be stronger when personal relevance is high, because messages and frames are more carefully attended to when personal relevance is high (Eagly and Chaiken, 1993; Petty and Wegener, 1999). Accordingly, in the present study we also examine, as a potential moderating variable, the extent to which participants have processed the information that they receive.

1.5. Aims and hypotheses

As discussed above some research does exist which demonstrates the significance of the frame in which climate change is presented and, as reviewed, there is some systematic evidence demonstrating the effects that specific types of frames can have on individuals' responses. However, a further much larger body of evidence on framing effects can be drawn upon from the more general academic literature (primarily situated in decision research, behavioural economics and health promotion). The current study aims to explore the transferability of insights from these combined literatures to the study of climate change communication. We examine the impacts of manipulating climate change information in terms of distance (local versus distant), and in terms of outcome frames (gains versus losses), on individuals' attitudes and perceptions. We additionally utilise a repeated measures manipulation to examine how evaluations of climate change mitigation alter when participants are focused either on personal or social impacts.

1.5.1. Distance (Attribute) framing

As discussed above previous authors have argued that highlighting personally relevant local impacts of climate change will help to promote action (e.g. Rayner and Malone, 1997). However some empirical evidence also indicates that local impacts of climate change tend to be viewed as less serious than distant impacts (e.g. Leiserowitz, 2005). We therefore hypothesise that experimental manipulation of the perceived distance of climate change impacts (specifically local versus distant in space), will result in local impacts being viewed as less severe. Along similar lines, given previous data indicating that the social risks of climate change are perceived to be higher than personal risks (Zwick and Renn, 2002; Leiserowitz, 2005), we suggest that when focused on social impacts of climate change people will be more positive towards mitigation than when focused on personal impacts of climate change.

1.5.2. Outcome framing

The second principal hypothesis concerns the effect of framing climate outcomes in terms of losses or gains. Although there is a general tendency noted in the literature for loss frames to be more effective in changing attitudes and promoting new behaviours, we suggest here that climate change mitigation can be conceptualised as a prevention behaviour, as described within the literature on health psychology (e.g. Banks et al., 1995). Here research shows attitudes will be more effectively promoted using gain frames as compared to loss frames.

We also expect some interaction between our framing manipulations and levels of fear provoked, and the extent to which information frames are processed by participants. Loss frames may provoke a greater level of fear, something previously linked with *greater* levels of attitude change (Witte and Allen, 2000). Similarly, both loss frames and personally relevant frames have been linked with a greater depth of information processing (e.g. Liberman and Chaiken, 1992; Kiesler et al., 1969) and consequently greater levels of attitude change (e.g. Chaiken and Eagly, 1976). Exploring any possible interactions is an important secondary aim of this study.

2. Material and methods

2.1. Participants

A total of 161 psychology students (22 men and 139 women) were recruited, in a topic blind manner, to take part in this study in exchange for partial course credit. The study was conducted online using Bristol Online Survey software. Participants were randomly allocated to framing conditions in a 2×2 design where participants either received a gain frame or a loss frame ($N = 81$ and 80 respectively) and a local or a distant frame ($N = 80$ and 81 respectively).

2.2. Procedure

Participants were emailed a web link to the study which they completed in their own time. On entering the website, participants were provided with outline information about the study and information about the procedure. Participants were told that they would be asked to complete a series of questions about climate change and that the study would take approximately 30 min. They were also told that because most people are relatively uninformed about climate change, they would first be provided with some information taken from the latest (fourth) Intergovernmental Panel on Climate Change (IPCC, 2007) report on potential impacts of climate change.

Participants were asked to provide their participant identification number and gender information. Next, they were provided with information regarding the impacts of climate change presented both in terms of gains or losses, and in terms of local impacts or distant impacts. Instructions emphasised that participants should take the time to read the information carefully as they would be asked questions about the information at a later point in the study. On the following page, participants were presented with a map, shaded to indicate potential flooding from sea level rises of 5 and 10 m respectively. Subsequently three urban landscape photographs of flooding were provided to participants on a separate page. Further web pages asked participants to complete a number of questions assessing socio-cognitive factors relating to climate change. These were followed by a thought listing task and questions examining fear responses in relation to the information previously presented. Finally, participants completed several manipulation checks. Note that once participants had proceeded through the web pages they could not return to previous pages.

2.3. Materials

Information provided to participants was obtained and adapted from the IPCC (2007) fourth assessment report. Text was condensed to focus on main impacts of climate change and adjusted to either describe the losses that will occur from climate change or the gains that will occur from climate change mitigation. In addition, text was modified to refer to local geographical areas, i.e. the UK and South Wales specifically, or to refer to distant geographical areas, i.e. continental Europe, and other specific European countries, see Appendix A for example extracts. Texts were developed and adapted by one researcher before another researcher reviewed these for clarity, coherence and consistency; these were then piloted on a small convenience sample of colleagues ($n = 4$). In total, the length of information presented was approximately 900 words; this was presented on one web page and was broken up into coherent sections to enhance readability.

Maps presented to participants were either of Cardiff (local) or of Rome (distant) and were developed using Google maps (2008) in conjunction with a sea level rise maplet (Kosowsky, 2008) which illustrated potential flooding through shading with a 5 and also a

10 m rise in sea level. Sea level rises of a similar magnitude were discussed in the text provided in relation to potential collapses of ice sheets.¹ Cardiff was chosen as the location for the local frame as all participants lived in, or close to the city of Cardiff. Rome was chosen as the location for the distant frame because it was a city that participants were likely to know in Europe, that formed an image similar to the map of Cardiff used, i.e. had similar coastal morphology and a similar amount of sea, land, and projected flooding, see [Appendix B](#). Photographs of flooding were obtained from online sources and whilst locations were not specified, these were chosen to be representative of a UK scene or of a continental scene, see [Appendix C](#).

A wide range of socio-cognitive factors were examined here encompassing attitudes towards climate change and climate change mitigation, perceived attitudes of others, perceptions of severity, control, concerns, benefits, trust, and uncertainties in relation to climate change and fear control responses; several of these were used in order to pilot questions for a subsequent study. Here, we focus on perceived severity of climate change impacts and attitudes towards climate change mitigation, which are the factors that correspond most highly to the information within the framing manipulations presented. Attitude towards climate change mitigation was measured using a general question asking participants how they felt about climate change mitigation. Two further questions examined evaluations of climate change mitigation within a personal focus where participants were asked to consider climate change mitigation 'in terms of personal considerations only' or within a social focus where participants were asked to think about climate change mitigation 'in social terms, i.e. with regard to being a member of society'. A further three questions asked respondents about how severe they perceived the impacts from climate change to be, which formed a reliable scale ($\alpha = 0.75$). All questions were responded to on five-point Likert scales marked from 'Very negative' to 'Very positive' or from 'Strongly agree' to 'Strongly disagree' as appropriate, coded so that higher values indicated positivity or agreement, see [Appendix D](#) for question wording.

Participants were also asked to complete a thought listing task (Cacioppo and Petty, 1981; cf. Meyers-Levy and Maheswaran, 2004) in order to measure the degree to which the presented information about climate change had been attended to and processed. Participants were first asked to free recall as many significant points as they could remember from the information that was presented to them. They were then asked to list all thoughts that had occurred to them when examining that information (they were not able to look back at this information). Blank spaces were provided for text responses to these questions. Participants were also asked to rate the extent to which they experienced a range of fear related emotions (fearful, tense, nervous, anxious, reassured, relaxed, comforted) in response to the information that they viewed. These were rated on a five point scale marked from, 'Not at all' to 'Very much' and formed a reliable scale ($\alpha = 0.77$).

Manipulation checks administered asked participants to consider how personally relevant that they felt the information was and how positive or negative they perceived it to be. Personal relevance was evaluated with a scale of four questions which asked participants how interesting, involving, personally relevant and pertinent information presented was ($\alpha = 0.81$). Perceptions of how positive or negative information was were measured by a scale formed by four questions asking participants the extent to

which information stressed positive implications, negative implications, gains, and losses associated with mitigating climate change ($\alpha = 0.83$). Questions examining the manipulated information were all responded to on five-point Likert scales marked from 'Strongly agree' to 'Strongly disagree'; combined scales were then developed so that higher values reflected greater personal relevance or more positive implications.

3. Results

3.1. Mean attitudes and perceptions across participants

Overall, participants expressed positive feelings about climate change mitigation, with a mean attitude rating of 3.69 ($SD = 0.92$). When participants were asked to consider solely social aspects of climate change mitigation they were more positive than when participants were asked to consider solely personal aspects of mitigation, $M_s = 3.87$ ($SD = 0.94$) versus 3.56 ($SD = 0.88$), $t(158) = -5.10$, $p < 0.001$). In addition, perceptions of the severity of climate change impacts were high, $M = 3.93$ ($SD = 0.67$) and fear responses produced by the information presented were high $M = 3.28$ ($SD = 0.65$).

3.2. Information processing measures

To explore the extent to which information processing occurred, participants' free recalled and thought listing responses were examined. Two independent judges coded and counted the number of statements free recalled and the number of thoughts produced condition blind (so that the coder did not know which frame the respondent had received). Interjudge agreement was 85.3% for free recalled statements and 89.7% for thoughts listed and coding discrepancies were resolved through discussion. Free recalled information was positively skewed with a median amount of statements recalled of 6 and a range from 0 to 22 statements; data was transformed by square rooting all values for subsequent analyses and subsequently approximated a normal distribution. Number of thoughts listed was very positive skewed with a median amount of thoughts listed of 3 and a range from 0 to 29; data was therefore log transformed so as to approximate a normal distribution for further analyses. It is clear that there was a great deal of variability in the extent to which participants paid attention to the information presented, however, we suggest that this reflects real life variability in the extent to which the public engage with information received.

3.3. Impact of framing manipulation

Manipulation checks were utilised in order to assess whether there were overall differences in how the differently framed information was perceived. Participants who had been presented with a gain frame rated the information as being significantly more positive with a mean of 3.91 (0.64), than those who had been presented with a loss frame,² who had a mean of 3.33 (0.91), $F(2, 156) = 11.67$, $p < 0.001$. Individuals who had been presented with information relating to their local area rated the information as being more personally relevant with a mean rating of 3.13 (0.80) than those presented with information relating to a distant area who had an overall mean rating of 2.75 (0.74), $F(2, 156) = 4.94$,

¹ We acknowledge that projections of a sea level rise of this magnitude may be considered extreme in relation to the time frame discussed (25–50 years). These levels were chosen in order to enhance the salience of climate change impacts. Importantly, potential impacts illustrated were consistent across conditions.

² Note that evaluations of how positive or negative the information presented was perceived as was positively skewed and was therefore transformed using a log transformation before analysis. This substantially reduced skew; however Levene's test for the MANOVA subsequently conducted remained significant indicating that the assumption of homogeneity of variance was not met and results should be treated with some caution. However, follow up t-tests in which equality of variances were not assumed provided similar results.

$p < 0.01$. Manipulation checks therefore indicated that the intended factors were manipulated successfully.

3.4. Fear related emotions between differently framed conditions

Reported fear related emotions were significantly higher within loss framed conditions ($M = 3.45$, $SD = 0.63$) than within gain framed conditions ($M = 3.10$, $SD = 0.61$), $F(1, 157) = 12.60$, $p < 0.01$. No significant differences were found in levels of fear between locally framed and distant framed conditions, $M_s = 3.37$ ($SD = 0.68$) versus 3.19 ($SD = 0.60$), $F(1, 157) = 2.99$, $p = ns$.

3.5. Levels of information processing between differently framed conditions

Number of statements free recalled were significantly higher within loss frames compared with gain frames, $M_s = 6.93^3$ ($SD = 4.38$) versus $M_s = 4.96$ ($SD = 2.89$), $F(1, 153) = 8.81$, $p < 0.01$. However, the number of thoughts listed did not differ between loss or gain frames, $M_s = 4.29$ ($SD = 3.84$) versus $M_s = 3.78$ ($SD = 3.05$), $F(1, 153) = 0.93$, $p = ns$. Neither number of statements free recalled, nor number of thoughts listed differed between local and distant frames, $F(1, 153) = 1.39$, $p = ns$ and $F(1, 153) = 0.67$, $p = ns$ respectively ($M_s = 5.58$, $SD = 3.26$ versus $M_s = 6.30$, $SD = 4.30$ for free recalled statements and $M_s = 4.06$, $SD = 4.13$ versus $M_s = 4.00$, $SD = 2.67$ for number of thoughts listed).

3.6. Impact of framing manipulation on perceived severity of climate change and attitudes towards climate change mitigation

The impact of framing manipulations on attitudes were examined using a MANCOVA with perceived severity of impacts of climate change⁴ and attitudes towards climate change mitigation as dependent variables, outcome (gain/loss) and distance (local/distant) frames as fixed factors, and fear responses and statements free recalled as covariates. Both the outcome frame and the distance frame were found to have a significant impact on the dependent variables, $F(2, 154) = 6.49$, $p < 0.01$ and $F(2, 154) = 6.01$, $p < 0.01$ respectively. No interaction was noted between outcome and distance frames, $F(2, 154) = 0.43$, $p = ns$.

With regards to the outcome frame, gain frames were found to produce judgements of climate impacts that were significantly more severe than those produced by loss frames, $M_s = 3.95$ (0.70) versus 3.90 , (0.63), $F(1, 155) = 5.60$, $p < 0.05$, and attitudes towards climate change mitigation that were significantly more positive than those produced by loss frames, $M_s = 3.84$, (0.83) versus 3.54 , (0.99), $F(1, 155) = 9.45$, $p < 0.01$ (see Fig. 1). The distance frame also impacted responses in that distant frames were found to produce significantly higher judgements of severity of climate change in comparison to local frames, $M_s = 4.04$ (0.62), versus 3.81 (0.69), $F(1, 155) = 9.37$, $p < 0.01$ (see Fig. 2). No significant differences were found between distant and local frames for attitudes towards climate change mitigation however, $M_s = 3.60$ (0.94) versus 3.78 (0.90), $F(1, 155) = 1.30$, $p = ns$.

Both fear responses and amount of free recalled information were significant covariates within the analysis, $F(2, 154) = 16.87$, $p < 0.001$ and $F(2, 154) = 6.90$, $p < 0.001$ respectively. Notably, fear responses significantly covaried with the perceived severity of climate change impacts, $F(1, 155) = 33.53$, $p < 0.001$, but not with attitudes towards climate change mitigation, $F(1, 155) = 2.07$,

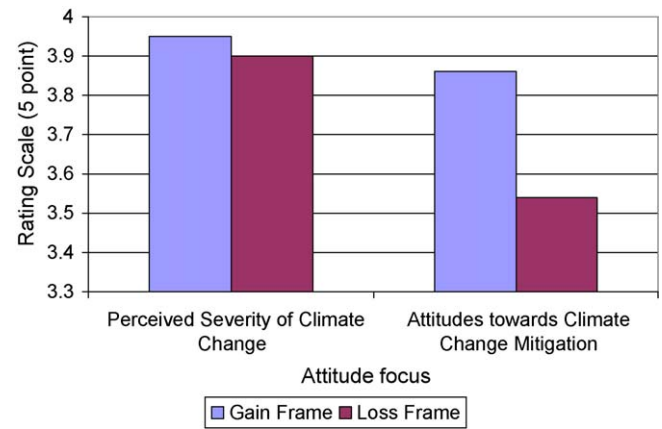


Fig. 1. Impact of outcome framing on perceived severity of impacts of climate change and on attitudes towards climate change mitigation.

$p = ns$, and amount of free recalled information significantly covaried with attitudes towards climate change mitigation, $F(1, 155) = 13.13$, $p < 0.001$, but not with perceived severity of climate change impacts, $F(1, 155) = 2.50$, $p = ns$.

3.7. Fear responses as a mediator for the impact of frames and information recall on attitudes

Mediation analyses were conducted in order to further explore the way in which fear responses and free recalled information interacted with framing effects on attitude measures. Mediation effects can be said to occur if (a) there is a significant relationship between the frame and the mediator (fear responses or free recalled information) and (b) if the mediator significantly predicts the dependent variable (perceived severity of climate change impacts or attitude towards climate change mitigation) in an equation including both the frame and the mediator (MacKinnon et al., 2000).

To reiterate, the direct impact of the outcome experimental manipulation was that the gain frame produced somewhat higher perceptions of climate change impact severity, as compared to those obtained with the loss frame (significant at $p < 0.05$), and despite similar impacts being described. However, a series of regression analyses demonstrated that the loss frame produced significantly greater levels of fear responses and that, in turn, fear responses increased the perceived severity of climate change impacts. Accordingly the mediation analysis tests the true extent of loss–gain framing impacts on judgements of climate change

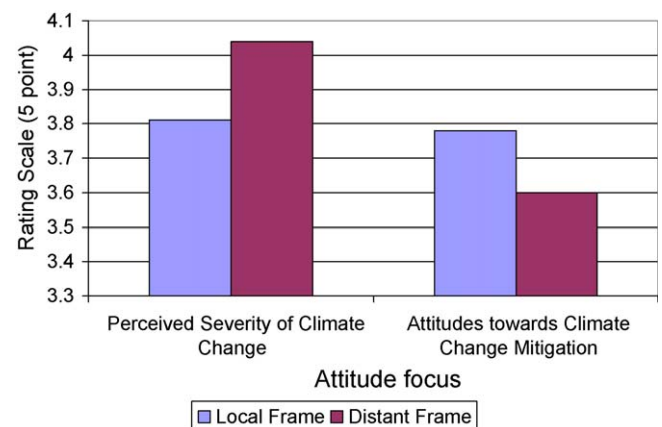
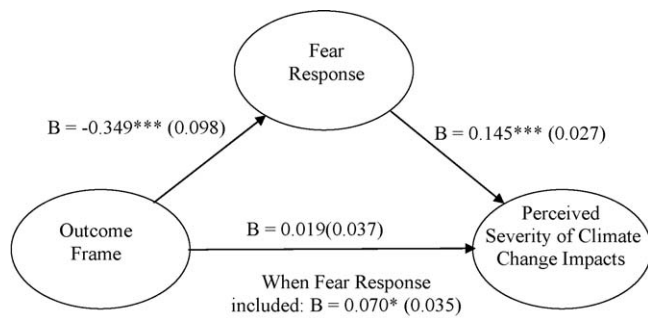


Fig. 2. Impact of distance framing on perceived severity of impacts of climate change and on attitudes towards climate change mitigation.

³ Note that untransformed means are reported for illustrative purposes only, all statistics were carried out on transformed data.

⁴ Perceived severity of climate change impacts was positively skewed and was therefore transformed using a square root function to achieve an approximate normal distribution prior to further analyses.



*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Note: Within Outcome Frame, 0 = Loss frame and 1 = Gain frame

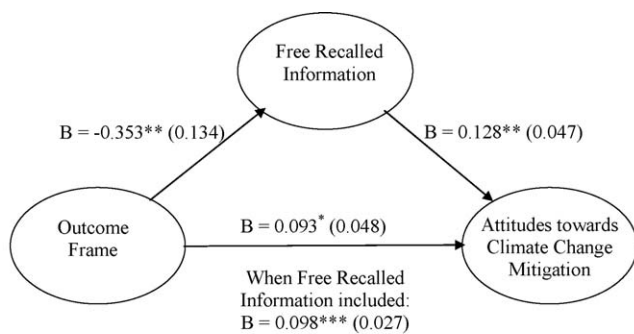
Fig. 3. Suppression of outcome framing effects on perceived severity of impacts of climate change by fear responses.

severity when the indirect impact of fear responses in the two experimental framing conditions is also controlled for. This analysis (see Fig. 3) demonstrated that the relatively greater influence on perceived severity of climate change that gain frames demonstrate over loss frames is *increased* when fear responses are controlled for; the influence of the fear response here is termed a suppression effect. A Sobel Test indicated that this suppression effect was significant, $z = 2.97$, $p < 0.01$.

Regarding climate change mitigation judgements, the direct impact of outcome framing was such that gain frames produced more positive attitudes towards mitigation. However, indirectly, and as predicted, loss frames produced a significantly higher recall of information and the amount of information recalled in turn had a positive association with attitudes towards climate change mitigation. The mediation analyses again demonstrated a suppression effect (see Fig. 4) whereby, when the amount of information recalled in each condition was controlled for, the relationship between gain frames and positive attitudes towards climate change mitigation also increased. A Sobel test indicated that this suppression effect noted was approaching significance, $z = 1.89$, $p = 0.06$.

4. Discussion

The study has demonstrated that the ways in which communications about climate change are framed will have a substantial impact on the way that they are received. Despite extensive commentary on this issue in the policy and academic literatures, there has been relatively little systematic experimental research



*** $p < 0.001$, ** $p < 0.01$, * $p = 0.05$

Note: Within Outcome Frame, 0 = Loss frame and 1 = Gain frame

Fig. 4. Suppression of outcome framing effects on attitudes towards climate change mitigation by free recalled information.

examining the impacts of framing climate change messages. The results of the present study hold a complex set of implications for climate communication—but ones which we believe are broadly in line with the existing wider literature on framing and communication of risk information. Whilst the issue of climate change has a unique set of characteristics and policy goals, we do believe that it is important to investigate where relevant parallels at a more generic conceptual level can be drawn with previous research in different domains and here we demonstrate some consistencies across domains. We point to the need for a much wider research agenda and effort around a number of these important issues in relation to climate risk communication.

A first clear finding concerns the outcome framing manipulation used. In line with our initial expectations from health and behavioural decision theory research gain framed information was more effective than loss framed information in promoting positive attitudes towards climate change mitigation, particularly when reported fear responses and the level of information processing (measured by amount of information recall) is held constant. As a result of their extensive review of the health and other literature, Rothman et al. (2006) conclude that gain and loss frames do have systematic impacts upon both behavioural intentions and actual behaviour, but that this crucially depends upon the way in which the recipient construes the behaviour in question. Consistent with prospect theory, where an outcome or frame is construed as low in risk, or safe, there is a systematic advantage when framing information about outcomes in terms of gains. In proposing this, Rothman et al. (2006, p. 205) do not operationalise risk as probability or uncertainty, but in terms of the “extent to which people perceive the behaviour will afford an unpleasant outcome”. By this account prevention behaviours in particular are construed as low in risk, and hence better promoted through gain frames. Our results are fully consistent with such an explanation, on the assumption that climate mitigation is conceptualised by our participants as a safety-oriented activity (or in effect a set of prevention behaviours), because they are being offered a means of avoiding bad consequences.

In addition to being associated with more positive attitudes towards mitigation, exposure to gain framed information also resulted in judgements of climate change impacts as more severe. This latter result is more difficult to reconcile theoretically, although it could be a function of other intervening heuristic judgements and beliefs. For example, presenting climate mitigation in a gain frame might cue a sense of personal or societal efficacy (in that participants then believe there is something which can be done about the problem), a condition known to be more conducive to the acceptance and processing of emotional or value-laden messages (Witte, 1992; Witte and Allen, 2000; Moser, 2007). Alternatively, the belief that society and governments are even contemplating such measures might suggest to participants that the problem must be very serious indeed. This aspect of our findings clearly deserves further detailed empirical investigation. A very general conclusion then is that, all other things being equal, communications promoting climate change mitigation should focus on what can be gained by mitigation efforts rather than dwelling on the potential negative impacts of not taking action. We label this the ‘gain frame advantage’.

An equally important finding of the study, however, is the existence of significant interaction effects, pointing to the underlying complexity. In particular, the gain frame advantage was to an extent suppressed both by fear responses and the amount of information that was remembered from communications. Loss frames were found to produce higher levels of fear responses which in turn increased perceptions of severity of climate change impacts. Controlling for fear responses led to an increased advantage for the gain over the loss frame in judgements of severity of climate change. This highlights an important

methodological issue, in that future studies should also include measures of fear responses when investigating loss–gain framing effects. It also points to some of the complexities when considering frames for climate communication, and in particular the need to consider objectives of communication carefully. It may be easier to generate support for specific mitigation policies through gain framing than it is to impart a general belief in the severity and urgency of the situation (where, under some circumstances, loss frames might still hold the advantage).

Further boundary conditions on the present findings are also suggested by the distinction made in the health literature between prevention and detection behaviours. The former involves undertaking actions to avoid risk, whilst the latter (e.g. screening to detect an underlying health condition) according to Rothman et al. (2006) is a risky behaviour, in the short-term at least, because it involves the possibility of people finding out that they are ill. Research finds a clear loss frame advantage for communications designed to impact attitudes towards and uptake of detection behaviours (see Banks et al., 1995; Edwards et al., 2001). Following this line of reasoning, it is again possible that there will be circumstances where loss frames might be more effective than gain frames, if this involves attitudes towards detection of climate change or its impacts. For example, given the multiple uncertainties involved, both climate science and impact modelling could both be considered processes of detection, whilst at the individual level seeking information on whether one's home might be at risk from future flooding, for example, could also be construed in this way.

Loss frames were also found to generate a better recall of the information provided, something in turn associated with more positive attitudes towards climate change mitigation. The latter, in particular, suggests that in circumstances where information recall is particularly important (e.g. when consumers are about to make a significant one-off energy purchase) loss frames, or a combination of frames, may yet again be the more useful communication strategy. All of this suggests the need to clarify climate communication objectives, as well as to systematically evaluate potential message frames and their impacts in advance of major communication campaigns.

The study also varied the attribute of personal relevance through manipulation of the distance at which impacts might occur, describing a similar sea level rise in Cardiff or Rome respectively. Whilst much previous commentary has argued that focusing on the local, personal impacts of climate change will be a useful strategy for increasing the salience of the issue for people, the current data develop and qualify suggestions that communications should make climate change personally relevant in order to promote action (Rayner and Malone, 1997). Whilst making climate change personally relevant may help to situate it within people's everyday lives, it might also lessen the extent to which impacts are viewed as severe and requiring action. Our results, demonstrating that distant frames resulted in climate change impacts being perceived as more severe than in local frames, are in line with previous findings on climate change as a psychologically distant phenomenon (Leiserowitz, 2005) with impacts likely to be perceived as more severe for people in other countries than for people in Britain (Kirby, 2004; Palutikof et al., 2004). However, no impact of distance framing on attitudes towards climate change mitigation was found, and here it is possible that the frames were producing more mixed effects. In particular, perceived benefits are known to be an important determinant of the acceptability of risk and risk management options (Slovic, 2000). Whilst distant frames may emphasise the importance of climate change mitigation, they do not necessarily emphasise any personal benefits which might come from action. These opposing influences may similarly explain why levels of information processing did not differ between distant and local frames.

Interestingly, differences did emerge in the repeated measures frame which asked participants to consider social or personal aspects of mitigation: focusing on social aspects of mitigation resulted in more positive attitudes being expressed than when participants were asked to consider personal aspects. It is possible that differences between local/distant frames and personal/social frames reflect differences between thinking about benefits for other people where this may have (intrinsic) little benefit for the individual, and thinking about benefits for society (encompassing, and more likely to provide benefits for, the individual), highlighting a further possibility for new research. Whilst we remain of the view that making climate change personally relevant is likely to be a useful communication strategy, our data indicates that it may also be important to highlight the distant impacts of climate change because these are perceived to be more severe than local impacts (at least in Britain) as well as the social benefits of climate change mitigation because these are thought to be greater than personal benefits.

This study also opens up a number of promising avenues for further research. Whilst some previous research on communicating climate change has focused on the effectiveness of fear framing, this is the first study (to our knowledge) to compare the relative impacts of gain and loss framing of climate change. It will be important to examine in more depth the superiority of gain frames in comparison to loss frames, the conditions under which this does and does not hold, including where gain frames are compared with more extreme loss (extreme fear provoking) frames. A further and obvious extension of this work is to examine the effectiveness of gain and loss frames for different types of climate change information and impacts. Here, policy relevant information from the IPCC (2007) fourth assessment report was used but we do need to examine whether similar framing effects occur for different informational content and media. In particular, the current gain frame advantage was noted with regards to attitudes towards climate change mitigation which may be conceptualised (using terminology from the domain of health psychology) as a prevention behaviour. We have argued above that a loss frame advantage may be found with regards to attitudes towards 'more risky' detection behaviours, such as the science of examining climate change impacts or seeking information about personal vulnerability.

A further research implication is the need to examine how information framing effects translate into actual behaviour, and whether this might persist over time. Again, the analogy drawn with health psychology findings suggests that this might well prove to be the case. In particular, current results imply a possibility of linking the benefits of personal actions taken to mitigate climate change to impacts in distant locations and to society as a whole when promoting sustainable behaviour. It would be particularly useful to put these ideas into practice and examine the real impacts of these in an ecologically valid situation.

We note that our results are based on mean levels of perceptions and attitudes across groups examined when in fact there are likely to be key individual differences in the ways risky climate change impacts and climate change mitigation efforts are perceived by people. Prospect theory (Tversky and Kahneman, 1981) would lead us to expect corresponding differences in the effectiveness of utilising gain or loss frames within specific communication effects, and it may be possible to disentangle key social groups or individuals who may respond differently to framing effects. Similarly there may be individual differences in the personal relevance and perceived severity of climate change. For example, individuals who have recently experienced an extreme weather incident (e.g. Whitmarsh, 2008) may respond differently to local or distant framed communication efforts. Furthermore, people with different value orientations are likely to

respond differently to particular climate change communications (see, e.g. Kahan et al., 2007). A recent audience segmentation analysis of the US public identified six key groups within the American public who differ in the way that they respond to climate change (Maibach et al., 2009). Whilst levels of media engagement were similar across groups, members in different groups clearly attend to and trust quite different forms and sources of information on climate change.

The current study design was limited to a sample of young well-educated adults, albeit one (psychology majors) who would be expected to have no special environmental training or motivations. As a result we would expect a similar pattern of results with a more representative adult population sample. This is in part because our findings are supported by the wider theoretical literature (e.g. Rothman et al., 2006). We further acknowledge that our sample contained a high proportion of women. Previous research does indicate systematically higher levels of risk perception and concern for some environmental risks amongst women compared with men although effect sizes tend to be moderate or small (Davidson and Freudenberg, 1996; Henwood et al., 2008). Accordingly, gender may partly explain the high levels of perceived severity of climate change noted here. Whilst further research within a more representative sample of the UK population would be desirable, work within different cultural settings might also be of use. The perception that distant impacts of climate change will be more severe than local impacts are clearly culturally and geographically bounded, and therefore distance framing effects in particular are likely to have different effects for individuals in different countries of the world as well as locations which will be more vulnerable to climate change effects.

5. Conclusions

The way that climate change impacts and mitigation are presented has important ramifications for the way that

they are perceived. Results indicate that attitudes towards climate change mitigation may be effectively promoted by discussing the gains produced through climate change mitigation (as opposed to the losses of not mitigating climate change) and by focusing individuals on the social impacts (perhaps in addition to the personal impacts) of climate change mitigation. Further to this, perceived severity of climate change can be increased by focusing on the distant impacts of climate change and the gains associated with climate change mitigation.

The existence of suppression effects upon framing impacts, specifically those of fear responses, extends our current understanding of the potential role of fear appeals within climate change communication and policy. In particular, we cannot rule out the possibility that more extreme loss (or fear) frames may be superior to gain frames for some perceptions and behaviours. Findings also imply that loss frames may be useful within mitigation efforts when it is particularly important that individuals remember the information received. Overall, this study provides an important first exploratory study examining the effects of framing climate change communications, extending and clarifying certain findings within the current climate literature. We highlight the need to consider the relevance of existing research from other cognate domains, whilst at the same time pointing to some interesting directions for future systematic research in climate risk communication.

Acknowledgements

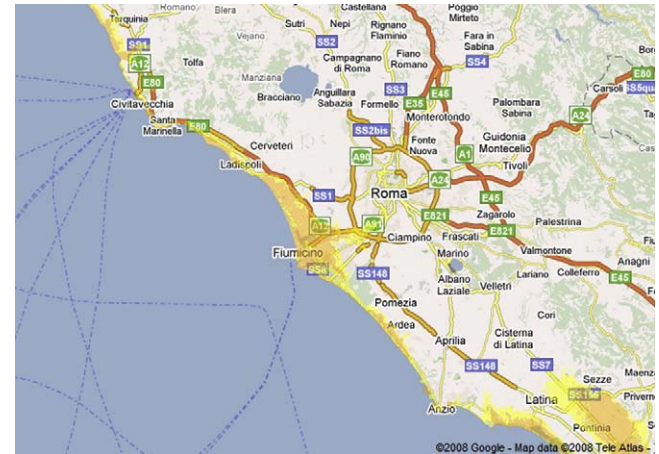
This research was supported primarily through a major grant to the Understanding Risk research group from the Leverhulme Trust (F/00 407/AG) and additionally by the Economic and Social Research Council (RES-066-27-0013). We thank Christina Demski for assistance with coding.

Appendix A. Framed information presented

Frame	Information extracts
Gain	<p>"By mitigating climate change, we can prevent further increases in winter floods in maritime regions and flash floods throughout Europe."</p> <p>"The mitigation of climate change will prevent further significant warming, which is projected to be greater in the winter in the north and greater in the summer in south and central Europe."</p> <p>"By preventing further sea-level rises, we can prevent the inland migration of beaches and save up to 20% of coastal wetlands, maintaining the habitat availability for several species that breed or forage in low lying coastal areas."</p> <p>"Reducing further changes in the climate helps to defend against the reaching of certain tipping points for significant key events. The safeguarding of the North Atlantic Thermohaline Circulation, the West Antarctic Ice Sheet (WAIS), and the Greenland Ice Sheet (GIS) has enormous effects on temperature and sea level."</p>
Loss	<p>"Without mitigating climate change, we will see further increases in winter floods in maritime regions and flash floods throughout Europe."</p> <p>"Without mitigation of climate change further significant warming will occur; this will be greater in the winter in the north and greater in the summer in south and central Europe."</p> <p>"With further sea-level rises, beaches will migrate inland and threaten up to 20% of coastal wetlands, reducing the habitat availability for several species that breed or forage in low lying coastal areas."</p> <p>"Ongoing changes in the climate have the potential to reach certain tipping points at which key significant events may be triggered. For example the collapse of the North Atlantic Thermohaline Circulation, the West Antarctic Ice Sheet (WAIS), or the Greenland Ice Sheet (GIS) would have enormous effects on temperature and sea level."</p>
Local	<p>"The warming trend and spatially variable changes in rainfall have affected people all over Britain."</p> <p>"Many areas in Britain are expected to change dramatically, both in terms of landscape and climate, over the next 25-50 years."</p> <p>"Those most likely to be impacted are the West coast of Scotland, Northern Ireland, the East Midlands coast, South Wales and the South East of England."</p> <p>"Extensive flooding in many parts of the UK have caused millions of pounds worth of damage as well as causing human health problems."</p>
Distant	<p>"The warming trend and spatially variable changes in rainfall have affected people all over Europe."</p> <p>"Many areas of Europe are expected to change dramatically, both in terms of landscape and climate, over the next 25-50 years."</p> <p>"Those most likely to be impacted are Denmark, Belgium, Holland, and Northern areas of France and Germany."</p> <p>"Extensive flooding in many areas around the world has caused millions of pounds worth of damage as well as causing human health problems."</p>

Appendix B. Maps used for distance framing

B.1. Local frame—Cardiff



Sea level projection images are Copyright 2008 Michael Kosowsky. All rights reserved. Used with permission.

Appendix C. Photographs used of flooding

C.1 Local frame



C.2 Distant frame



Appendix D. Socio-cognitive questions

Construct	Question	Scale
Attitude	Overall how do you feel about climate change mitigation?	Very positive–Very negative
Attitude in terms of self	In terms of personal considerations only, do you feel overall positive or negative about climate change mitigation?	Very positive–Very negative
Attitude in terms of society	Thinking about climate change mitigation in social terms, i.e. with regard to being a member of society, do you think that climate change mitigation is overall a positive or a negative thing?	Very positive–Very negative
Perceived severity of climate change impacts	The consequences of climate change will be severe. Impacts of climate change are likely to be extreme. The effects of climate change are unlikely to be too serious.	Agree–Disagree

References

- Banks, S.M., Salovey, P., Greener, S., Rothman, A.J., Moyer, A., Beauvais, J., Epel, E., 1995. The effects of message framing on mammography utilization. *Health Psychology* 14, 178–184.
- Baron, R.S., Logan, H., Lilly, J., Inman, M.L., Brennan, M., 1994. Negative emotion and message processing. *Journal of Experimental Social Psychology* 30, 181–201.
- Bord, R.J., Fisher, A., O'Connor, R.E., 1998. Public perceptions of global warming: United States and international perspectives. *Climate Research* 11, 75–84.
- Cacioppo, J.T., Petty, R.E., 1981. Social psychological procedures for cognitive response assessment: The thought-listing technique. In: Merluzzi, T.V., Glass, C.R., Genest, M. (Eds.), *Cognitive Assessment*. Guilford Press, New York, pp. 309–342.
- Carvalho, A., Burgess, J., 2005. Cultural circuits of climate change in the UK broadsheet newspapers, 1985–2003. *Risk Analysis* 25, 1457–1470.
- Chaiken, S., Eagly, A.H., 1976. Communication modality as a determinant of message persuasiveness and message comprehension. *Journal of Personality and Social Psychology* 34, 605–614.
- Chaiken, S., 1980. Heuristic versus systematic information processing and the use of source versus message cues in persuasion. *Journal of Personality and Social Psychology* 39, 752–766.
- Committee on Climate Change, 2009. Meeting Carbon Budgets—The Need for a Step Change; Progress Report to Parliament, 12 October 2009. TSO, London.
- Davidson, D., Freudenberg, W.R., 1996. Gender and environmental concerns. A review and analysis of available research. *Environment and Behaviour* 28, 302–339.
- De Hoog, N., Stroebe, W., de Wit, J.B.F., 2005. The impact of fear appeals on processing and acceptance of action recommendations. *Personality and Social Psychology Bulletin* 31, 24–33.
- Dessai, S., Adger, N., Hulme, M., Turnpenny, J., Köhler, J., Warren, R., 2004. Defining and experiencing dangerous climate change. *Climatic Change* 64, 11–25.
- Eagly, A. H., & Chaiken, S., 1993. *The psychology of attitudes*. Fort Worth, TX: Harcourt Brace Jovanovich.
- Edwards, A., Elwyn, G., Covey, J., Matthews, E., Pill, R., 2001. Presenting risk information—a review of the effects of 'framing' and other manipulations on patient outcomes. *Journal of Health Communication* 6, 61–82.
- Energy Saving Trust, 2007. Green barometer: Measuring environmental attitudes. Energy Saving Trust, London.
- Ereaut, C., Segnit, N., 2006. Warm Words: How Are We Telling The Climate Story and Can We Tell It Better? Institute for Public Policy Research, London.
- Eurobarometer, 2007. Attitudes on issues related to EU Energy Policy—Analytic report (Flash Eurobarometer 206a). European Commission, Europe.
- Gardner, G.T., Stern, P.C., 2008. The short list: the most effective actions U.S. households can take to curb climate change. *Environment* 50, 12–24.
- Google, 2008. Maps of Cardiff and Rome, retrieved on 14 October, 2008 from website <http://maps.google.com/maps>.
- Hardisty, D., Weber, E.U., 2009. Discounting future green: money vs. the environment. *Journal of Experimental Psychology: General* 138, 329–340.
- Hass, J.W., Bagley, G.S., Rogers, R.W., 1975. Coping with the energy crisis: effects of fear appeals upon attitudes toward energy consumption. *Journal of Applied Psychology* 60, 754–756.
- Hassol, S.J., Udall, R., 2003. A change of climate. *Issues in Science and Technology* 19, 39–46.
- Henwood, K.L., Parkhill, K.A., Pidgeon, N.F., 2008. Science, technology and risk perception: from gender differences to the effects made by gender. *Equal Opportunities International* 27, 662–676.
- Hine, D.W., Gifford, R., 1991. Fear appeals, individual differences, and environmental concern. *Journal of Environmental Education* 23, 36–41.
- Hulme, M., 2008. The conquering of climate: discourses of fear and their dissolution. *The Geographical Journal* 174, 5–16.
- Hulme, M., 2009. *Why we disagree about climate change: understanding controversy, inaction, and opportunity*. Cambridge University Press, New York.
- IPCC, 2007. Summary for Policymakers. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Eds.). Cambridge University Press, Cambridge, UK, pp 7–22.
- Janis, I.L., 1967. Effects of fear arousal on attitude change: Recent developments in theory and experimental research. In: Berkowitz, L. (Ed.), *Advances in Experimental Social Psychology*, vol. 3. Academic Press, New York, pp. 1676–2225.
- Kahan, D.M., Braman, D., Slovic, P., Gastil, J., Cohen, G., 2007. The Second National Risk and Culture Study: Making Sense of—and Making Progress In—the American Culture War of Fact. Yale Law School, Public Law Working Paper No. 154. Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1017189.
- Kahneman, D., Tversky, A., 1979. Prospect Theory: An analysis of decision under risk. *Econometrica* 47, 263–292.
- Kiesler, C., Collins, B., Miller, N., 1969. *Attitude Change*. Wiley, New York.
- Kirby, A., 2004. 'Britons unsure of climate costs', *BBC News Online*, at <http://news.bbc.co.uk/1/hi/sci/tech/3934363.stm> (accessed 3 August 2005). Full poll results also available at http://news.bbc.co.uk/nol/shared/bsp/hi/pdfs/28_07_04_climatepoll.pdf.
- Kosowsky, M., 2008. Sea level rise maplet, retrieved on 14 October, 2008 from website www.HeyWhatsThat.com.
- Leiserowitz, A.A., 2005. American risk perceptions: is climate change dangerous? *Risk Analysis* 25, 1433–1442.
- Leventhal, H., 1970. Findings and theory in the study of fear communications. In: Berkowitz, L. (Ed.), *Advances in Experimental Social Psychology*, vol. 5. Academic Press, New York, pp. 119–186.
- Levin, I.P., Schneider, S.L., Gaeth, G.J., 1998. All frames are not created equal: a typology and critical analysis of framing effects. *Organizational Behavior and Human Decision Processes* 76, 149–188.
- Liberman, A., Chaiken, S., 1992. Defensive processing of personally relevant health messages. *Personality and Social Psychology Bulletin* 18, 669–679.
- Lorenzoni, I., Pidgeon, N., 2006. Public views on climate change: European and USA perspectives. *Climatic Change* 77, 73–95.
- Lorenzoni, I., Nicholson-Cole, S., Whitmarsh, L., 2007. Barriers perceived to engaging with climate change among the UK public and their policy implications. *Global Environmental Change* 17, 445–459.
- Lorenzoni, I., Pidgeon, N.F., O'Connor, R., 2005. Dangerous climate change: the role for risk research. *Risk Analysis* 25, 1387–1398.
- Lorenzoni, I., 2003. Present Choices, Future Climates: A cross-cultural study of perceptions in Italy and in the UK. Doctoral Thesis, School of Environmental Sciences, University of East Anglia, Norwich, UK.
- MacKinnon, D.P., Krull, J.L., Lockwood, C.M., 2000. Equivalence of the Mediation Confounding and Suppression Effect. *Prevention Science* 1, 173–181.
- Maheswaran, D., Meyers-Levy, J., 1990. The influence of message framing and issue involvement. *Journal of Marketing Research* 27, 361–367.
- Maibach, E., Roser-Renouf, C., Leiserowitz, A., 2009. Global Warming's Six Americas 2009: An audience segmentation analysis. Available at: <http://www.climatechangecommunication.org/images/files/GlobalWarningsSixAmericas2009c.pdf>.
- Meijnders, A.L., Midden, C.J.H., Wilke, H.A.M., 2001a. Role of negative emotion in communication about CO₂ Risks. *Risk Analysis* 21, 955–966.
- Meijnders, A.L., Midden, C.J.H., Wilke, H.A.M., 2001b. Communications about environmental risks and risk-reducing behaviour: the impact of fear on information processing. *Journal of Applied Social Psychology* 31, 754–777.
- Meyerowitz, B. E. and Chaiken, S., 1987. The effect of message framing on breast self-examination attitudes, intentions, and behaviour. *Journal of Personality and Social Psychology*, 52, 500–510.
- Meyers-Levy, J., Maheswaran, D., 2004. Exploring message framing outcomes when systematic, heuristic, or both types of processing occur. *Journal of Consumer Psychology* 14, 159–167.
- Miller, C., 2000. The dynamics of framing environmental values and policy: four models of societal processes. *Environmental Values* 9, 211–233.
- Milne, S., Sheeran, P., Orbell, S., 2000. Prediction and intervention in health-related behaviour: a meta-analytic review of protection motivation theory. *Journal of Applied Social Psychology* 3, 106–143.
- Moser, S.C., 2007. More bad news: the risk of neglecting emotional responses. In: Moser, S.C., Dilling, L. (Eds.), *Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change*. CUP, Cambridge, pp. 64–80.
- Nisbet, M.C., 2009. Mixed messages: framing climate change to bridge perceptions. *Environment* 51, 12–23.
- Nisbet, M.C., Mooney, C., 2007. Framing science. *Science* 316, 56.
- Office of Management and Budget, 2009. A new era of responsibility: renewing America's promise. OMB, Washington, DC, p. 100.

- O'Neill, S.J., Hulme, M., 2009. An iconic approach for representing climate change. *Global Environmental Change* 19, 402–410.
- O'Neill, S., Nicholson-Cole, S., 2009. "Fear Won't Do It": promoting positive engagement with climate change through visual and iconic representations. *Science Communication* 30, 355–379.
- OST/MORI, 2004. Science in Society – findings from qualitative and quantitative research, conducted for the Office of Science and Technology, Department of Trade and Industry. London, UK: MORI Social Research Institute.
- Palutikof, J.P., Agnew, M.D., Hoar, M.R., 2004. Public perceptions of unusually warm weather in the UK: impacts, responses and adaptations. *Climate Research* 26, 43–59.
- Pelletier, L.G., Sharp, E., 2008. Persuasive communication and proenvironmental behaviours: how message tailoring and message framing can improve the integration of behaviours through self-determined motivation. *Canadian Psychology* 49, 210–217.
- Petty, R.E., Cacioppo, J.T., 1979. Issue involvement can increase or decrease persuasion by enhancing message-relevant cognitive responses. *Journal of Personality and Social Psychology* 37, 1915–1926.
- Petty, R.E., Wegener, D.T., 1999. The Elaboration Likelihood Model: Current status and controversies. In: Chaiken, S., Trope, Y. (Eds.), *Dual process theories in social psychology* (p. Guilford Press, New York, pp. 41–72).
- Poortinga W., Pidgeon, N.F., Lorenzoni, I., 2006. Public perceptions of nuclear power, climate change and energy options in Britain: summary findings of a survey conducted during October and November 2005. Technical Report (Understanding Risk Working Paper 06-02). Centre for Environmental Risk, Norwich.
- Rathzel, N., Uzzell, D., 2009. Changing relations in global environmental change. *Global Environmental Change* 19, 326–335.
- Rayner, S., Malone, E.L., 1997. Zen and the art of climate maintenance. *Nature* 390, 332–334.
- Risbey, J.S., 2008. The new climate discourse: alarmist or alarming? *Global Environmental Change* 18, 26–37.
- Rothman, A.J., Salovey, P., Antone, C., Keough, K., Martin, C.D., 1993. The influence of message framing on intentions to perform health behaviours. *Journal of Experimental Social Psychology* 29, 408–433.
- Rothman, A.J., Bartels, R.D., Wlaschin, J., Salovey, P., 2006. The strategic use of gain- and loss-framed messages to promote healthy behaviour: How theory can inform practice. *Journal of Communication* 56, 202–220.
- Slovic, P., 2000. *The Perception of Risk*. Earthscan, London.
- Spence, A., Pidgeon, N.F., 2009. Psychology, climate change and sustainable behaviour. *Environment* 51, 8–18.
- Stern, N., 2007. *The Economics of Climate Change: The Stern Review*. University Press, UK: Cambridge.
- Sweeney, M. (2009, October, 21). Government climate change ad investigated after 350 complaints. *The Guardian*. At <http://www.guardian.co.uk/media/2009/oct/21/climate-change-advertising-standards> (accessed 9 March 2010).
- Thaler, R.H., Sunstein, C.R., 2008. *Nudge: Improving Decisions about Health, Wealth, and Happiness*. Yale University Press, New Haven, CT.
- Trope, Y., Liberman, N., 2003. Temporal construal. *Psychological Review* 110, 403–421.
- Tversky, A., Kahneman, D., 1981. The framing of decisions and the psychology of choice. *Science* 211, 453–458.
- UKERC, 2009. Making the transition to a secure and low-carbon energy system: synthesis report, UKERC Energy 2050 Project. UKERC, UK.
- Uzzell, D., 2000. The psycho-spatial dimension to global environmental problems. *Journal of Environmental Psychology* 20, 307–318.
- Whitmarsh, L., 2008. Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response. *Journal of Risk Research* 11, 351–374.
- Wilson, D.K., Purdon, S.E., Wallston, K.A., 1988. Compliance to health recommendations: a theoretical overview of message framing. *Health Education Research* 3, 161–171.
- Witte, K., 1992. Putting the fear back into fear appeals: The extended parallel process model. *Communication Monographs* 59, 329–349.
- Witte, K., Allen, M., 2000. A meta-analysis of fear appeals: Implications for effective public health campaigns. *Health Education and Behaviour* 27, 591–615.
- Zwick, M. M. and Renn, O. (Eds.), 2002. *Perception and Evaluation of Risks. Findings of the Baden-Württemberg Risk Survey 2001*. Joint working report by the Centre of Technology Assessment in Baden-Württemberg and the University of Stuttgart, Sociology of Technologies and Environment, Germany.