# Applying goal framing to enhance the effect of information on transport-related $CO_2$ emissions

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## Abstract

The provision of information on transport-related carbon dioxide ($CO_2$) to the traveller can be seen as an instrument to increase the likelihood of more sustainable choices being made by individuals. However, the choice between travel alternatives according to their environmental effects can be considered as a social dilemma; as transport-related $CO_2$ emissions are largely seen as a 'social' cost rather than a 'private' cost to the individual, the effect of providing information on behavioural change might be therefore limited. Framing effects, studied in a range of contexts, can be used to enhance the evaluation of choice attributes and highlight desirable choices. This paper reports on a survey that was developed to examine the effect of goal framing of $CO_2$ amounts on the perceived differences between alternative travel modes. Through the use of positive and negative terms, the information was framed to focus attention either on the potential of a travel mode to provide environmental benefit (positive frame) or on its potential to reduce an environmental loss (negative frame). Survey participants' responses to positive and negative framing of the same information on $CO_2$ amounts were compared using an ordered logit (OL) model. The findings imply that negative framing is more effective than positive framing in highlighting differences between $CO_2$ amounts of alternative travel modes and therefore is more likely to influence travel-related choices.

## Keywords

Carbon Emissions, Goal Framing, Travel Information, Nudge

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## 1. Introduction

Growing concerns over climate change and environmental issues are leading governments and citizen groups to take action to change the way people travel. Providing individuals with information about transport-related attributes such as travel time, travel costs or risks might be seen not only as a service provided to the public, but as an instrument to change travel behaviour. The presumption is that informed travellers will make 'better' choices which will be to their personal advantage and potentially that of the transport system as a whole. The provision of information on carbon dioxide ($CO_2$) and other greenhouse gases (GHG) emissions generated by transport can be seen as an instrument to increase the likelihood of more sustainable travel choices being made by the individual. While there is little empirical evidence on the effect of such information, it is widely accepted that without providing information on $CO_2$, it is less likely that individuals will make climate-friendly travel choices. At a system level it is desirable to see travellers moving collectively to more sustainable travel choices – i.e. those that reduce the carbon footprint of travel. At the level of the individual traveller, their behaviour in this regard will be governed in part by the extent to which they consider 'environmental impact' to be an attribute of travel alternatives that has relevance to their selection of a preferred alternative, and how they *perceive* the differences between amounts of carbon emissions associated with alternative travel choices (usually presented in mass, i.e. grams or kilograms).

The effects of climate change have external costs rather than personal 'loss' to the traveller and therefore sustainable mobility choices could be seen as a social dilemma. Moreover, transport-related $CO_2$ emissions is a relatively new concept which most people are not likely to have experience with; many are not familiar with GHG measure units, and with their contribution to the 'climate change' problem; the levels of individual GHG emissions to meet environmental goals are largely unknown to many. Therefore, whether the provision of information on $CO_2$ is likely to contribute much to a desirable modal shift could be questioned, even among travellers who have positive attitudes towards environmental issues and that are motivated to reduce GHG emissions generated by their travel.

Evidence on systematic deviations from rational models have mainly emerged from studies on consumer choice behaviour, financial behaviour, health behaviour and more recently – travel behaviour (Avineri, 2012). An emerging body of work seeking to understand behaviour by incorporating insights from behavioural sciences into travel behaviour research, giving more weight to what are sometimes called 'irrational' motives and behaviours. The '*predicted irrationality*' (a phrase coined by Ariely, 2008) of individuals could (and some argue - should) play a role in the design of behavioural change interventions. Thaler and Sunstein (2008) advocate the use of '*choice architecture*' to influence behavioural change; '*nudges*', small features designed in the environment of choice making, to help individuals to overcome cognitive biases, and to highlight the better choices for them and increase the effect of behavioural change – without restricting their freedom

of choice, and without making structural changes to the physical environment, or to the economic attributes of the choices.

It can generally be argued that the design of travel information systems has often ignored the psychological environment of travel choice making. While rational man theory suggests that individuals base choices on the attributes of the choice set ("*information content*"), the way information is being presented ("*information context*") can also have a strong effect on travellers' use of and reaction to information – a particular focus of this study. However, little research has been done on the effectiveness of the design of travel information context. Following recent studies in cognitive psychology and behavioural economics, we explore how the concept of *valence framing* (and a specific category of it, *goal framing)* might be applied to enhance the effect of information on transport-related $CO_2$ emissions. Through the use of positive and negative terms, such information can be framed to focus attention either on the potential of a travel mode to provide environmental benefit (positive frame) or on its potential to reduce an environmental loss (negative frame). Through the study of survey participants' responses to goal-framed information on $CO_2$ emissions associated with alternative journey options, this study aims to test which framing (negative or positive) is more effective in highlighting differences between $CO_2$ amounts of alternative travel modes and therefore more likely to influence travel-related choices.

The structure of this article consists of six sections. Following the introduction, section 2 provides a brief discussion regarding the two above-mentioned paradigms, namely information content and information context, the effect of information content and information context on the evaluation of travel choices, and how these paradigms stemmed from thinking in neoclassical economics and psychology. It is followed by section 3 which reviews the literature on valence framing effects. Section 4 presents the research methodology and the design of a survey design to test the effect of negative vs. positive goal framing of information on $CO_2$ emissions. The results and analysis of the survey responses are provided in section 5. A summary of findings from a focus group conducted to gain in-depth understanding of public's responses to valence framing is presented in Section 6. With respect to the results, the potential to apply valence framing to influence transport choices is discussed in section 7. Conclusions and some further research and implementation are also presented in this section.

## 2. Providing travellers with information on carbon emissions: Two paradigms

It can be argued that the main thinking in transport planning and policy making stem from neoclassical economics in which travellers are largely assumed to make choices which are rational, consistent, and efficient, and apply cognitive processes to maximise their economic utility (Avineri, 2012). The behavioural assumptions on responses of individuals to information on the attributes of travel choices can be traced back to economic theory and the paradigm of rational man. For example, Ben-Akiva and Lerman (1985, p.32) describe the theory of choice as a collection of procedures that are defined by the following elements: (i) decision maker, (ii) alternatives, (iii)

attributes of alternatives, and (iv) a decision rule. The attractiveness of an alternative in the mind of the decision maker (the individual traveller) is described as 'utility', a function of the attribute values.

Travel choices can relate to many utility components associated with the attributes of alternatives: travel time, travel cost (real or perceived), comfort, convenience, safety, and so on. With rising awareness about and shifting attitudes towards environmental issues, carbon emissions generated by transport might also be important to individual travellers when making choices (such as selecting a mode of choice for a journey, or purchasing a new vehicle, for example, Gaker et al., 2011).

As, according to rational choice theory, information concerning the attributes of a travel choice mode can stimulate change, providing information on things that people value may help swing the pros and cons of the decisional balance. For example, providing information on the amounts of carbon emissions generated by alternative travel choices might influence the choices of individuals and increase the likelihood of sustainable choices to be made by them. For example, Gaker et al. (2010) have conducted experiments on route-choice and automobile purchase. Their conclusion was that information on GHGs like $CO_2$ could affect choice. Such effects would likely increase for individuals who value such information more.

In some programmes and initiatives, information on $CO_2$ emissions is being given to individual travellers in the hopes that it will raise awareness among those who have less familiarity and experience with travel-related emissions, change their attitudes, and help them to make informed (and more sustainable) travel decisions. Based on the assumption that better informed people will make more sustainable travel choices, $CO_2$ information is being provided to influence choice. A range of web-based tools provide transport-related $CO_2$ information to individual travellers; these include carbon calculators and journey planners - such as, for example, the UK national journey planner, Transport Direct (www.transportdirect.info). $CO_2$ information is also provided to participants of travel programs such as Travel Blending in Australia (Rose and Ampt, 2001) and Travel Feedback Program in Japan (Taniguchi et al., 2003). Despite the increasing presence of $CO_2$ information, there seems to be little research on whether people understand or perceive that information. Coulter et al. (2007) found that both users and non-users of carbon calculator websites reported not really understanding the results when presented in units of mass. The interpretation of information likely depends on the users' background knowledge and the provided context.

If individuals are expected to act as rational human beings, and specifically to exhibit consistency and transitivity in their choices, then the way alternatives and attributes are presented to the traveller should not matter much, and individuals should not be affected by irrelevant context (Avineri, 2012). However, neoclassical economics and psychology have different views of choice making. Simon (1956) created doubt on the use of economic theories of rational behaviour as a bases for explaining the characteristics of human rationality. He argued that the behaviour of an individual should be understood relative to their *environment*, and that "no utility function needs to be postulated for the organism, nor does it require any elaborate procedure for calculating marginal rates of substitution among different wants". Recent

research in behavioural sciences indicates that individuals' choices in a wide range of contexts deviate from the predictions of the rational man paradigm – inspiring research on travellers' bounded rationality (see, for example, the review of '*cognitive anomalies*' in McFadden, 1999).

## 3. Valence framing effects

One category of cognitive anomalies is context effects (McFadden, 1999): the format in which information is presented could effect how it is been processed by the individual. Over the past two decades, studies of so-called 'faming effects' in a range of contexts have explored how individuals respond differentially to equivalent descriptions of the same situation, presented in different formats. This section reviews the main evidence on valence framing effects, and the relevance of goal framing to the design of information on $CO_2$ amounts.

The theory of rational choice assumes that preferences are not affected by how the information is presented; that no matter the framing, the individual will always have the same interpretation of the information. However, research on how information is presented, or framed, suggests that highlighting differences can increase the perception of those differences and affect choice. *Framing* is the semantic manipulation of rationally identical problems. In *semantic framing* only alternative phrasing is used, while in *valence framing*, information is put in either a positive or negative light (Hallahan, 1999). Semantic framing may reorganize a sentence so that a key point comes at the beginning rather than the end. Valence framing attempts to put information in a positive or negative light (e.g. the spin on a story) such as renaming "tax cuts" as "tax relief" because "relief" has positive connotations. In a transport decision process, a project may be described as "reducing $CO_2$ emissions by 10%" which highlights the positive impact of the project in relation to the current situation. Through the use of positive and negative terms, the same critical information can be framed to focus attention either on the positive or the negative aspects of it, and enhance the effectiveness of such information. For $CO_2$ emissions information it is important to know which framing will better highlight differences between choices.

A strong intuition about preferences in risky environments is that people treat gains and losses differently. This observed risk-taking behaviour, called *loss aversion* (or *loss-gain asymmetry*) refers to the fact that people tend to be more sensitive to decreases in their wealth than to increases (this pattern of loss-gain asymmetry was also exhibited in choices made in other contexts such as personal safety, leisure). People tend to feel and behave differently when information is presented (or 'framed') in terms of gains or losses (Kahneman and Tversky, 1979). Across many contexts, the impact of negatively framed information has consistently been found to be stronger than the impact of the same information framed in positive terms of the same magnitude. The so-called *loss framing* refers to semantically restructuring (framing) a choice so that the tendency for people to avoid losses (loss aversion) guides them to a particular choice.

A consistent pattern of risk-taking behaviour emerges from a range of empirical studies of decision making: people are more likely to take risks when options focus attention on the chance to avoid losses than when options focus attention on the chances to realise gains (Kahneman and Tversky, 1979; Tversky and Kahneman, 1981; Gonzales et al., 1988; Levine et al., 1998; Edwards et al., 2001). Perhaps one of the best-known examples of systematic reversal of choice due to loss framing is the “Asian disease problem“ (Tversky and Kahneman, 1981). Participants were asked to choose between alternative programmes to combat Asian disease which is expected to kill 600 people. Two alternative programmes to combat the disease have been proposed. A first group of participants were presented with a choice between two programmes:

> *A: "200 people will be saved"*
>
> *B: "there is a one-third probability that 600 people will be saved, and a two-thirds probability that no people will be saved"*

A second group of participants were presented with a choice between two programmes:

> *C: "400 people will die"*
>
> *D: "there is a one-third probability that nobody will die, and a two-third probability that 600 people will die"*

Programmes A and C are equivalent (and so are programmes B and D). However, most participants of the first group preferred programme A, and most participants of the second group preferred programme D. The above demonstrates that the choices between a risky and a riskless options of equal expected value depends on whether positive (“*life saved*”) or negative (“*life lost*”) framing has been applied in the design of the information.

Based on observations of people’s stated choices between risky alternatives, Kahneman and Tversky (1979) developed ‘*Prospect Theory*’, a descriptive model of choice that assumes that (risky) outcomes are mapped as gains or losses relative to some reference point. Individuals were assumed to have an S-shaped value function which is concave in gains and convex in losses. To capture loss aversion, the value function is assumed to be steeper for losses than for gains, a pattern which is consistent with the experimental evidence on loss aversion (see Figure 1).

Studies from the health field (Kühberger, 1998) and home energy use (Gonzales et al, 1988) have found that framing affects choice. In the health field a meta-analysis of 136 empirical papers found that framing is a reliable phenomenon (Kühberger, 1998). However, both those fields deal with losses to the individual and with relatively familiar topics such as financial loss or negative health impacts. Loss aversion’s effect varies depending on the type of loss and the context in which risky choices are been made. Tversky and Kahneman (1991) summarized findings that the coefficient of loss framing (the effects of gain framing over loss framing) was greatest for safety, followed by money, and then leisure. They write, “the coefficient... reflects the importance or prominence of the dimension”. The importance of travel information to individuals is not clear, and the effectiveness of loss framing in that context is not known. Recently however, several studies explored loss

aversion associated with travel choices. The emerging evidence indicate that travellers exhibit aversion to loss and have a strong tendency to avoid choices associated with losses (Avineri and Prashker, 2004; van de Kaa, 2010; Rose and Masiero, 2010). Avineri (2006) demonstrated how changes to the perceived value of the reference point (as a form of 'nudge') in a route-choice problem could lead to improved traffic equilibrium.

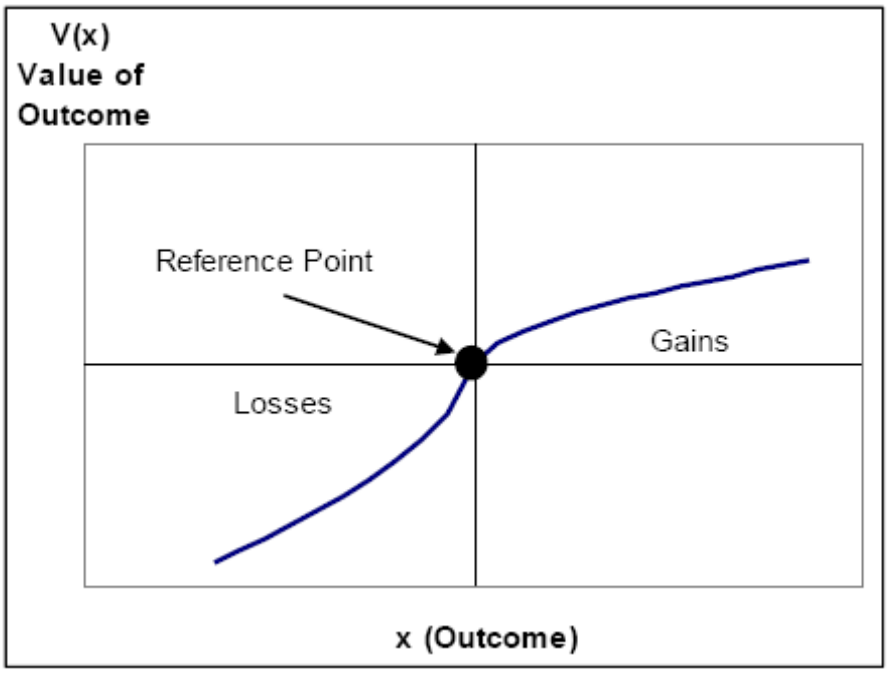


Fig. 1. A hypothetical value function.

(Based on Kahneman & Tversky, 1979)

As a result of valence framing's success in influencing choices in other fields, the need for an investigation on $CO_2$ emissions mass may seem limited. However, most research into valence framing did not consider social dilemmas, and the nature of impacts of framing might be different in such situations. In the context of transport, the problem of climate change can be considered a social dilemma as people might feel that their personal mobility is being restricted, while the benefits are to society. In contrast, considerations of personal health or finance have a direct impact on the individual so the desire to avoid risk may be greater than if one's actions do not have that direct personal impact, such as the case of $CO_2$ impacts.

Most of the studies of valence framing effects reported in the literature deal with situations in which information is directly relevant and familiar to the individual. However, for the common traveller $CO_2$ information is a relatively new issue; many travellers have little direct experience with its measurement and effect, and difficulty in interpreting it (Coulter et al., 2007; Waygood and Avineri, 2011). It is therefore not obvious that valence framing techniques successfully applied in other fields will be effective in a climate change context.

However, there is potential that effective goal framing could affect perceptions of $CO_2$ emissions as it might stimulate positive or negative associations of the environmental effects of alternative transport options, and highlight differences between them.

Levin et al. (1998) argue that the so-called valence framing effects are often treated as a "relatively homogenous set of phenomena explained by single theory", namely prospect theory (Kahneman and Tversky, 1979). Following a critical analysis of the evidence on framing effects, Levin et al. (1998) suggest typology of valence framing effects. They classify framing effects to three categorizes, all of them making use of positive or negative terms in the framing of objects or events: (i) risky choice framing, in which the options differ in risk level; (ii) attribute framing, in which a single attribute of an object is framed; and (iii) goal framing, in which the consequences of a behaviour are specified.

In goal framing, the consequence or implied goal of an addressed action or behaviour is framed. It can be framed to focus attention on the potential of an object to provide benefit or gain (positive frame) or on its potential to prevent or avoid loss (negative frame) (Levine et al., 1998). Both positive and negative frames should enhance the evaluation of the object, by 'nudging' towards a relatively attractive choice, or by making an inferior choice less attractive. Although both frames can be seen as enhancers of the evaluation process, according to the literature, a negatively framed message emphasizing losses tends to have a greater impact on a targeted behaviour than a comparable positively framed message emphasizing gains. For example, Meyerowitz and Chaiken (1987) studied the effect of information on BSE (breast self-examination). Messages such as:

> "*Research shows that women who do not do BSE have a decreased chance of finding a tumour in the early, more treatable stages of the disease*"

were included in a loss-framed pamphlet, while a gain-framed pamphlet used messages such as:

> "*Research shows that women who do BSE have an increased chance of finding a tumour in the early, more treatable stages of the disease*".

It was found that the loss frame pamphlet led women to stronger BSE attitudes, intentions and behaviours more than the gain frame pamphlet.

Loss aversion can occur not only in the presence of risk, but also in situations risk is absent or irrelevant to the choice. It might be argued that prospect theory's explanation of the effectiveness of the negative framing in a range of examples, such as the above one, might be limited. Levine et al. (1998) argued against applying risky choice framing explanation to goal framing. An alternative explanation was suggested by Meyerowitz and Chaiken (1987): a negativity bias in processing information; information presented in negative terms has a stronger impact on judgment than equivalent information presented in positive terms.

In order to explore valence framing effects in the context of transport-related $CO_2$ emissions, and gain better understanding of their potential effects, we argue that in the specific context of the problem (evaluation of or comparing

between $CO_2$ amounts) risky choices (as a direct, short time-delay impact to the individual) are not involved, and therefore the framing effects illustrated in this work are not explained by prospect theory. For example, faced with a choice set of travel modes, and choosing the less sustainable one among them (according to their contributions to GHG emissions), is not perceived as avoiding a 'risky' behaviour. Although there might be risks associated with climate change and its consequences, it can be generally argued that the perception and evaluation of sustainable choices by individual does not usually occur in the presence of personal (or other) risk.

To summarize, the evidence on $CO_2$ information being presented to individuals suggest that it does affect decisions, but the magnitude of its impact *could* potentially be increased through choice architecture tools such as valence framing. However, there are a number of differences between $CO_2$ information and previous applications of negative framing that may influence its effectiveness such as familiarity and indirect impact. Therefore, research that examines whether positive or negative goal framing could better emphasize the difference between the amounts of $CO_2$ produced by a choice set would help designers of information build more effective communication tools.

To increase the likelihood of more sustainable choices being made, techniques such as valence framing may help in highlighting the differences between $CO_2$ amounts. The question of whether valence framing is effective with $CO_2$ information despite it being a relatively unfamiliar concept and does not seem as personal a cost to the traveller is examined in this paper.

The next section will introduce the survey questions, the participants, and then end with descriptive results. In the following sections we present the statistical analysis of the survey responses, and the summary of findings from the focus group conducted to gain in-depth understanding of public's responses to positive and negative framing of information on $CO_2$.

## 4. Methodology

Information by itself is likely insufficient to substantially change travel behaviour. However, it can generally be argued that in combination with other measures (both 'soft' and 'hard') it can support rather than stimulates behaviour change. In the cognitive model for decision making, an individual's perceptions of choice attributes, her attitudes toward a behaviour, and a set of beliefs associated with it (such as social norms) all have roles in producing a choice. In the design and implementation of behaviour change interventions, the targeted behaviour can be addressed by a set of measures that address the different determinants of behaviour relevant in the context, ideally ensuring they are all pulling in the same direction. Individual choice to travel in a more sustainable way is a rather complex issue; the individual traveller's set of utilities, attitudes and beliefs regarding their transport options, as well as emotive content and habits are important determinants of travel behaviour - however they are not in the focus of this study which aims to explore the effect of framing on the perception of $CO_2$ emissions evaluated by an individual traveller. As travel behaviour is mediated by a range of cognitive processes that might either cancel or support each other, the effect

of framing is measured not by the rate of behaviour change (proportion of revealed or stated preferences of sustainable choices) but by its direct effect on the *evaluation* of $CO_2$ amounts by individuals (how they are compared with each other).

The survey was designed to examine which goal framing (positive or negative) better enhanced the *perception of differences* between the $CO_2$ emissions of alternative travel modes, presented in grams per 5-mile journey (the combination of metric and imperial units is a quirk of common use in the UK). The main question explored here is which type of goal framing (positive or negative) is a more powerful enhancer of the information content, and effectiveness of the frame is measured against participants' perception of the differences between travel-related $CO_2$ emission amounts.

To test the effectiveness of positive and negative goal framing, two comparison sets were semantically restructured so that environmental 'gains' and 'losses' were distinctly presented. As the literature report that negative framing is generally more effective than positive framing at influencing choice so, the anticipated result is that negative framing will have a greater impact on how $CO_2$ amounts are perceived and evaluated. In order to eliminate the impact of other considerations on choice (such as comfort, cost, etc.) this experiment only considers the perception of the difference between two $CO_2$ amounts. Thus, we hypothesize that negative goal framing will result in a greater perceived difference between the $CO_2$ amounts than positive goal framing.

The comparison sets were based on the per passenger amounts of $CO_2$ emissions produced over a five mile trip by a bicycle, full car, and single occupancy 4x4 (or sports utility vehicle). The amounts were 132g, 500g, and 3400g respectively and were calculated using www.travelfootprint.org. The resulting comparison sets were 132g versus 500g, and 500g versus 3400g. After semantically reorganizing the comparison sets, the resulting four sentences are shown in Figure 2.

Those four sentences were assigned to survey participants so that each participant provided a response to one message with gain framing and one with loss framing, but not of the same comparison set (e.g. *i* and *iv*, *ii* and *iii,* Figure 2). To avoid associations of sustainability with actual modes, mode names were excluded so that for each comparison, the participants were asked, "Compared to mode X, mode Y is…." The response choices were on an ordinal scale of "*about the same*," "*slightly different*," or "*much different*."

The survey sample included 194 adult participants who ranged in age from 19 to 76 (average 39) years old, 48.4% were female, and 57.5% had higher education. The questions were part of a larger survey that was administered through the Carbon Aware Travel CHoices (CATCH) project[2].

[2] www.carbonaware.eu

Set 1 (132g against 500g)

*i.* ***Gain framing for comparison set 1*:**
Mode X produces 500g of $CO_2$ for a 5 mile trip.
The amount produced by mode Y is 368g lower (i.e. better).

*ii.* ***Loss framing for comparison set 1*:**
Mode X produces 132g of $CO_2$ for a 5 mile trip.
The amount produced by mode Y is 368g higher (i.e. worse).

Set 2 (500g against 2400g)

*iii.* ***Gain framing for comparison set 2*:**
Mode X produces 3400g of $CO_2$ for a 5 mile trip.
The amount produced by mode Y is 2900g lower (i.e. better).

*iv.* ***Loss framing for comparison set 2*:**
Mode X produces 500g of $CO_2$ for a 5 mile trip.
The amount produced by mode Y is 2900g higher (i.e. worse).

Fig. 2. The gain and loss framing for two $CO_2$ emissions comparison sets.

## 5. Results and analysis

The descriptive results of the responses to the four questions are shown in Figure 3. There are several observations that can be made from this figure. First, for both comparison sets, there is an apparent increase in the number of participants perceiving the alternative transport modes to be "much different," among participants who responded to a question framed in negative terms. This suggests that negative goal framing can accentuate the perceived difference between $CO_2$ amounts. Second, the responses to the two questions framed in positive terms (*i, iii, Figure 2*) are extremely similar despite different people completing the questions and comparison sets with different magnitudes of $CO_2$ being compared. Third, the effect of negative goal framing is more pronounced in the second comparison set with larger amounts being compared. Those last two observations suggest that the effect of scale, or magnitude, might be considered in the statistical analysis.

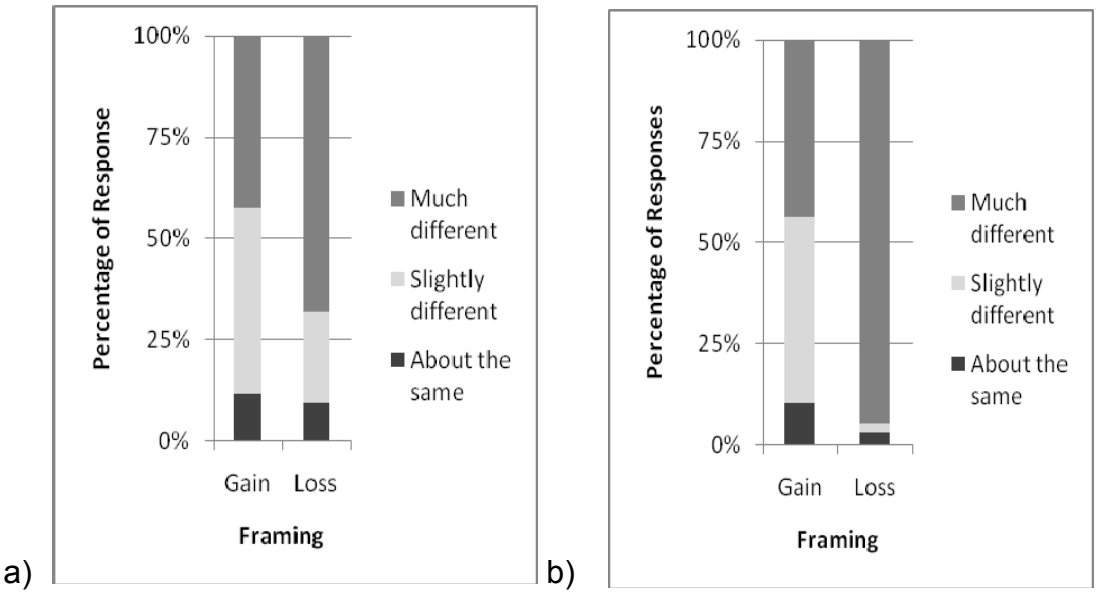


Fig. 3. Generalized response to gain and loss framing.

a) 132 g and 500g example (i, ii), b) 500g and 3400g example (iii, iv).

The descriptive results suggest that there might be impacts from both negative goal framing and the scale of the $CO_2$ being compared on how people perceived difference. In order to test whether these differences were statistically significant, an ordered logit (OL) model was used with the dependent variable being the response on perceived difference. OL models are used to examine ordinal scale dependent variables (such as "high, medium, low") and therefore are appropriate for this type of analysis (see Ben-Elia and Ettema, 2009 for a more detailed description of OL models). The models were estimated with the BIOGEME software (Bierlaire, 2003), version 1.6 (Bierlaire, 2008). To allow for analysis, the responses regarding differences between the $CO_2$ amounts presented to the participants, "*about the same*", "*slightly different*", and "*much different*" were coded as 0, 1, and 2, accordingly.

From the descriptive results, the scale of the comparison ('small' $CO_2$ outputs presented as set 1, or 'large' $CO_2$ outputs presented at set 2, see Figure 3) appeared to be relevant, so a dummy variable was included.

Although the primary focus of this paper is the effect of negative vs. positive goal framing, to check for any impact of gender, or education, those variables were also included in an initial model (Fagley and Miller, 1997 showed that in some situations gender may influence framing effects; according to other studies, education was found to have an effects on the impact of framing, with more impact of framing among participants who had less than a college education – see for example Armstrong et al., 2002). Table 1 presents the results of the OL estimation for perception of differences between $CO_2$ amounts of the transport alternatives. As both gender and education were found to be highly insignificant ($p=0.49$ and $p=0.82$ respectively), they were removed from the model. The final model results are shown in Table 2.

Table 1

Results of the OL estimation for perception of difference with gender and education included

| **Coefficient definition** | **Value** | **Std err** | ***t*-Test** | ***p*-Value** |
|---|---|---|---|---|
| Negative goal framing | 1.59 | 0.229 | 6.97 | <0.001 |
| Large $CO_2$ emissions (choice set 2) | 0.62 | 0.217 | 2.84 | <0.001 |
| Higher education | 0.15 | 0.218 | 0.69 | 0.49 |
| Male | -0.05 | 0.217 | -0.23 | 0.82 |
| Threshold 1 (from “about the same” to “slightly different”) | -1.35 | 0.206 | -6.53 | <0.001 |
| Threshold 2 (from “slightly” to “much different”) | 0.54 | 0.179 | 3 | <0.001 |
| Number of estimated parameters | 6 | | | |
| Number of observations | 380* | | | |
| Null log-likelihood | -426.3 | | | |
| Final log-likelihood | -316.2 | | | |
| Likelihood ratio test | 220.0 | | | |
| $\rho^2$ | 0.258 | | | |
| Adjusted ρ2 | 0.244 | | | |

* Four respondents did not include their gender or educational level.

Table 2

Results of the OL estimation for perception of difference (final model)

| **Coefficient definition** | **Value** | **Std err** | ***t*-Test** | ***p*-Value** |
|---|---|---|---|---|
| Negative goal framing | 1.59 | 0.229 | 6.97 | <0.001 |
| Large $CO_2$ emissions (choice set 2) | 0.62 | 0.217 | 2.84 | <0.001 |
| Threshold 1 (from “about the same” to “slightly different”) | -1.35 | 0.206 | -6.53 | <0.001 |
| Threshold 2 (from “slightly” to “much different”) | 0.538 | 0.179 | 3 | <0.001 |
| Number of estimated parameters | 4 | | | |
| Number of observations | 388 | | | |
| Null log-likelihood | -426.3 | | | |
| Final log-likelihood | -316.5 | | | |
| Likelihood ratio test | 219.5 | | | |
| $\rho^2$ | 0.258 | | | |
| Adjusted ρ2 | 0.248 | | | |

The relevant interpretations of the model shown in Table 2 are that both the use of positive/negative goal framing and scale differences explained a significant amount of the variation, and that framing had the larger overall effect. The parameters were both positive, confirming the interpretation of the descriptive results, that negative goal framing of $CO_2$ amounts and larger $CO_2$ values increase the likelihood of alternative transport options to be perceived as "much different." Using the adjusted rho squared, the model explained nearly 25% of variation.

Odds ratios can be used to determine the likelihood of the transport modes perceived to be "*much different*" in comparison with being perceived as either "*about the same*" or "*slightly different*." For the comparison between 132g and 500g $CO_2$ amounts, the odds ratio that the difference will be interpreted as "much" for negative goal framing versus positive goal framing is 2.84 (Fisher's exact test $p < 0.001$). For the comparison between 500g and 3400g $CO_2$ amounts, the odds ratio that the difference will be interpreted as "much" is 22.89 (Fisher's exact test $p < 0.001$). Considering that, it is likely that the scale of the emission figures has a significant effect on the interpretation of the difference. This result is further discussed in the Discussion section.

## 6. Findings from a focus group discussion

A potential application of valence framing would be for designers of behavioural change measures to highlight more socially and environmentally desirable choices, and being as transparent as possible, individuals would likely become aware of its use. It would therefore be of interest to practitioners what the public's opinion on its application would be.

Although the technique of negative goal framing was found to be an effective means of increasing the perceived difference between two $CO_2$ amounts, the acceptability of its application with the public is a different matter; people might interpret it as manipulation, which is likely not acceptable, or at least not desirable. To investigate this assumption, the technique and the results of this experiment were discussed with a group of individuals who had completed the survey described in section 4.

Six individuals participated in the focus group held in Bristol, UK: three men and three women; with and without higher education; and in the age range of 23 to 65 years old. Before showing the survey results or mentioning "framing", the concept of *framing* was first introduced and an example using money was given to help improve understanding. The example given was:

> *"If you buy this ticket you'll have the chance to win £100"*
> *"If you don't buy this ticket, you'll miss the chance of winning £100"*

The participants were asked which they felt would work better to motivate purchase of the ticket. Four participants felt that the positive framing would work better. People commented that (they believed) positive associations or benefits would be a stronger motivator. This suggests that people think they are more influenced by positive framing.

The concept of loss aversion was then verbally introduced and the different examples used in the survey were shown (see section 3). Following that, the results of the analysis (Figure 3) were shown where the negative goal framing resulted in more people perceiving $CO_2$ amounts to be 'much different'. The participants were allowed some time to digest the results and allowed to ask questions to clarify. The participants were then told that governments might use this technique to highlight more sustainable choices. They were then asked if they felt it was appropriate for government to do so.

The general response was that it felt like manipulation and that government institutes shouldn't apply such techniques and that information from the government should be straight forward. The focus group facilitator then commented that such techniques were used by companies to improve sales, and asked how they felt about that. The general feeling was that it was fine for private businesses to use it, but not for government. One woman (aged 26) commented that, "*I'll take advertising with a grain of salt, but I feel like the government should be clear*."

The facilitator further highlighted that information is often framed, such as stating that a certain project will reduce time expenditures. The information does not say time will change from 30 minutes to 29 minutes. The participants were asked to consider that such framing was common, but perhaps applied without consideration to its impacts. With that in mind, would it be better to consciously highlight a more desirable choice for society? The response by the participants was still that information shouldn't be manipulated.

## 7. Discussion and conclusions

$CO_2$ emissions are a relatively new concept for many travellers; even among those who have a high level of awareness and are concerned about travel-related emissions, perceiving or valuing the differences between alternatives might be a challenging task. Climate change can be considered a social dilemma, rather than an individual problem. The latter point suggests that people may not have as strong a tendency to personally avoid environmental "losses" associated with transport alternatives, thus lowering the potential effectiveness of negative goal framing. Further to that, most individuals have little or no experience with $CO_2$ emissions; research suggests that such information may not be useful as people may not be able to interpret it or perceive the differences between $CO_2$ amounts. As individuals do not consider transport-related $CO_2$ as a personal gain or loss, they have little experience dealing with $CO_2$ emissions information, and the dominant format of mass is not well understood then it may be difficult for individuals to attend to a difference between $CO_2$ amounts.

In light of the above, it might be argued that the findings reported in this work might not be obvious. If individuals do not consider $CO_2$ emissions as a 'loss', and have difficulties in interpretation of $CO_2$ information, than why should valence framing be of relevance to the design of such information? However, our argument in favour of considering framing of $CO_2$ information (supported by the findings presented in this paper) centres on the persuasive effectiveness of (negative) goal framing reported in the literature and further

tested in this study. Rather than relating the effect of valence framing in this context to prospect theory and to risky choice framing effects, we argue that the alternative explanation suggested by Meyerowitz and Chaiken (1987) and further developed by Levine et al. (1998): the negativity bias in processing information enhanced the impact of transport-related $CO_2$ information presented in negative terms on perception and judgment than equivalent $CO_2$ amounts presented in positive terms, highlighting and enhancing the perceived differences between alternative transport choices.

The findings reported in this work imply that negative goal framing of $CO_2$ emission amounts was an effective means of increasing the perceived difference and statistically better than gain framing of the same information at highlighting the difference between two $CO_2$ amounts. Although the $CO_2$ amounts do not have a direct private cost, the technique was still found to affect interpretation. Considering the effectiveness of loss framing in other fields, and the specific findings reported here, it can be suggested that valence framing information on transport-related $CO_2$ emissions can be applied to situations where $CO_2$ information is being presented to better highlight desirable choices. This includes transport related tools and measures, such as journey planners, Personal Travel Plans (PTPs), or $CO_2$ tax bands on cars. Future research should apply these findings in choice set experiments that relate to transport situations like mode choice or car purchase to test whether applying a negative framing of travel information to highlight the less (socially or environmentally) desirable choices has a positive effect on the likelihood of an individual perceiving a difference between alternatives, and making more sustainable choices.

However, the results of the focus group though would suggest that to improve carbon-friendly choices, a judgement system would be preferential to valence framing if applied by the government. If, however, the designers of information are not a government institute, but a business, there seems to be greater acceptance of “manipulative” techniques such as goal framing.

Comparing the responses to the two sets of $CO_2$ amounts, it looks like negative goal framing exhibited in participants’ responses was accentuated by an increase in scale which suggests that larger comparisons may be more effective at increasing the perceived difference than smaller ones. As the mode choices will limit what could be shown on a trip-by-trip basis, potentially accumulated amounts like yearly outputs could be more effective. This would be an important question for future studies.

The different impacts of the negative goal framing due to the scale were not anticipated, but several interpretations are suggested here. The first is that the ratio between the two amounts within each comparison set is different with the first being 1:3.8 (132:500g) and the other 1:6.8 (500:3400g). However, the odds ratio is nearly ten times larger. The second is the absolute difference between the amounts with the first comparison set differing by 368g (500-132), whereas the second differs by 2900g (3400-500). Here, the amounts nearly differ by a scale of 1:7.8 (368:2900) which is closer to the difference seen. The third is the unit. Would the interpretation have varied if kilograms were used rather than grams? Negative goal framing would still likely have an effect, but the magnitude of that effect may vary depending on if the differences were expressed as 0.368kg and 2.90kg rather than 368g

and 2900g. In that situation, perhaps the first comparison set would not have seemed different. These questions fit well with those suggested above and further insights can be gained by future research.

Considering the finding that the size of the $CO_2$ amounts affects perceived differences, future experiments should examine whether trip-by-trip comparisons are less effective than combined amounts (such as weekly or yearly) at affecting perception and choice.

Beyond valence framing there is potential for a range of contextual effects to enhance the effect of information. The potential application of such effects would be for governments (and other travel information providers) to enable, highlight and 'nudge' more sustainable travel choices. More consideration should be given to how travel information is presented. Recently there has been increasing interest in the influence of psychological and social aspects on travellers' behaviour. The so-called 'softer' side of transport policy was implemented in the UK under the name 'Smarter Choices' (see, e.g., Cairns et al., 2004). Somewhat inspired by social psychology (although not applying systematic frameworks in the design and evaluation of measures), Smarter Choices is a wide range of rather diverse measures including persuasive and information elements. On the other hand, Thaler & Sunstein (2008) and other behavioural economists suggest that through 'choice architecture', and the incorporation of the so-called 'nudges' into the choice environment, policy makers can devise interventions that help people make better decisions. Incorporating valence framing and other contextual effects in the design of information, to influence travel choices, could be seen as relevant techniques that are much in line with the concepts of both the 'smarter choices' and 'nudge' agendas. This calls for further investigation of contextual effects on individual perceptions and choices of travel alternatives, and for the development of tools to design and evaluate effective information formats.

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