Transportation Carbon Emission Information: The Effect of Format on Behavioural Intention

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Abstract
Climate change is a global problem and transportation contributes to it. In response, CO2 information on transport is being provided to the public to aid with informed decision-making. Including CO2 mass in choice experiments has found that it could influence choice, however, other research suggests that CO2 presented as mass is not fully understood and that the presentation of CO2 information affects interpretation. If presentation can affect understanding and interpretation, might it then affect choice? The problem with presentation is likely one of information content versus information context. CO2 mass is information content; without information context, it would be difficult to interpret the appropriateness of the mass. Context can highlight some aspect of the information to influence choice. That context could relate the CO2 mass to a societal goal. It could aid with analytical decision-making, or it could influence through emotion. A presentation format that provides context to information content is here termed a contextualized format. This research examined how people’s behavioural intention responses varied by three different contextualized formats and the information content format of simply CO2 mass.

Keywords
Behaviour change, climate change, information, carbon dioxide, design, context

Preferred Citation
1. Introduction

Due to concerns over climate change, transportation policy around the world has looked at ways to reduce transportation’s contribution to the problem (European Commission, 2011a, 2011b). The solution will likely require a number of changes including technology, infrastructure, and behaviour. Behaviour (choices included) can relate to what information is available and how that information is presented. Travel information can be both a service to travellers and a tool to influence their behaviour. Linking the impact to climate change of one’s travel behaviour could influence transportation choices (Gaker et al., 2010). However, it is not just the content of information that might affect behaviour – its context, or the format in which it is being presented can also affect interpretation. Previous work highlighted that how CO₂ information is presented affects interpretation (Avineri and Waygood, forthcoming; Waygood and Avineri, 2011), and that CO₂ information can have an impact on choice (Gaker et al., 2010), but it has not examined whether presentation might affect intention.

Although it would be ideal to examine actual behaviour change, the intention to perform an action explains considerable variation in behaviour. Behavioural intention is argued to be the strongest explanatory variable in behavioural models such as the Theory of Planned Behaviour (Ajzen, 1991). As Ajzen writes,

“a central factor in the theory of planned behavior is the individual’s intention to perform a given behavior. Intentions are assumed to capture the motivational factors that influence a behavior; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior. As a general rule, the stronger the intention to engage in a behavior, the more likely should be its performance.”

It is with this in mind, that this paper examines how different presentation formats of CO₂ might be associated with increased levels of intention to change travel behaviour.

2. Background

Although CO₂ information was found to have an impact on travellers’ choices (Gaker et al., 2010; Gaker et al., 2011), that influence could be affected by its interpretation, perception and understanding. Gaker et al.’s work (2010, 2011) used CO₂ information presented as a mass to affect individuals’ choices in stated choice experiments. However, in some previous qualitative research, Coulter et al. (2009) found that many people, including people who investigated their CO₂ impacts online, stated that they did not understand CO₂ amounts when presented as a mass.

Coulter et al.’s finding has significant impacts to the value of CO₂ information in producing more environmentally sustainable travel. According to the Theory of Planned Behavior (Ajzen, 1991), behaviour is affected, in part, by the evaluation of positive or negative outcomes of a choice. Although other factors will affect choice such as the person’s belief that they could change behaviour (i.e. perceived behaviour control), if a person is unable to evaluate the CO₂ information, than the information may not affect choice. Further, if they try
to apply such information, but they do not understand it with respect to appropriate levels, they might respond incorrectly (too weakly or too strongly) (Gärling and Fujii, 2009). These problems highlight the importance of taking into account both information content and information context in the design of information on carbon emissions. Without proper context, the appropriate response to the information may not occur.

When CO₂ information is presented in its scientific measure of mass, it is being presented as information content. In order to evaluate the information as having a positive or negative consequence an individual needs some information context. As CO₂ information is a relatively new concept and is quite abstract, many people likely lack the necessary knowledge that would act as the information context to interpret CO₂ information presented simply as a mass.

To help explain the difference between information content and context, we offer this example. Considering financial or time attributes of a trip, an individual will take the information content (e.g. $3 for a bus ticket; 15 minutes travel time) and interpret it with respect to their financial and time budgets. Those budgets act as the information context by which they make their judgements of the information content. However, for CO₂ information, such contextual information is not readily available for many people.

Increasing contextual information could potentially improve behavioural response to CO₂ information, reducing the chance that the CO₂ information is ignored or incorrectly applied in the decision process. One means of increasing information context would be mass education of all individuals so that they possess the necessary knowledge to personally evaluate CO₂ information as mass. Another possibility would be to include contextual information in the presentation, or format, of the CO₂ information. A format that includes contextual information could be termed a contextualised format.

A contextualised format would include not only information content, but would also place that content within a context to aid (or influence) interpretation. In the case of CO₂ information, there are numerous different methods of presentation. However, not all methods are likely as useful as others for interpretation or influencing behaviour. For example, presenting a large amount of CO₂ as being equivalent to an elephant may contextualise the mass, but the information is not contextualised with respect to environmental or societal goals.

Waygood and Avineri (2011) tested people’s ability to give a sustainability ranking to three contextualised formats for CO₂ information versus CO₂ information presented as a mass. Participants were asked to rank CO₂ information about a five-mile trip on a seven-point Likert scale. Taking into account the findings by Coulter et al. (2009) that people struggled to interpret CO₂ information, the option of providing a “don’t know” response was also included. Waygood and Avineri found that a contextualised format, “carbon budget”, improved the likelihood that a person would at least give a sustainability ranking to the CO₂ information. The carbon budget format presented the CO₂ amount as a percentage of a recommended limit which related to a societal goal contextualisation. They suggested that such a budget could relate to a government or authoritative recommendation as to appropriate levels (e.g. the limit suggested by a cap-and-trade program).

If a more contextual format can improve the likelihood of a CO₂ amount being “ranked” (as
per the exercise described by Waygood and Avineri, 2011), then it should follow that there would be greater behavioural response to the information. This assumes that better understanding, or at least greater confidence in one’s interpretation (as judged by the ability to give a sustainability ranking) of the information should increase its influence in the decision process. Taking into consideration that previous research has found that CO₂ information presented as a mass can affect travel behaviour choices in experimental settings (Gaker et al., 2010), we anticipate that (H1) using the “carbon budget” format would increase the likelihood of a behavioural response towards more sustainable choices over simply CO₂ mass information.

However, contextualising information as a societal goal is not the only way to goal frame information. Goal framing highlights the consequences of the behaviour (Levin et al., 1998) and goals can be classified into three types (Lindenberg and Steg, 2007): normative, gain, or hedonic. The carbon budget format used above contextualised the information with respect to what is appropriate behaviour, or normative goals which relate to injunctive norms (Schultz et al., 2007). Information about time or money would relate to gain goals as the individual is trying to preserve, protect, or improve their own resources. CO₂ mass information could relate to a gain goal if a person had a personal goal of reducing CO₂ production. The third goal framing relates to hedonic goals, or how the behaviour will make the person feel (e.g. emotionally).

In addition to the “carbon budget”, Waygood and Avineri (2011) also experimented with tree-equivalent and earth-equivalent formats. The tree-equivalent format represented the CO₂ mass as the number of trees required to sequester the CO₂. The earth-equivalent format represented the number of earths required to maintain such behaviour if all people on earth behaved the same way. The earth-equivalent format relates to a normative goal, environmentally appropriate behaviour. The tree-equivalent should also relate to a normative goal, but without a clear “limit”, it is more open in its evaluation. However, in addition to the normative norm aspect, in a separate report, Waygood and Avineri (2010), reported qualitative research that suggested there was emotional response to the two equivalents formats. That finding would suggest that there is also potentially a hedonic goal aspect to those formats.

As opposed to the mass format or the carbon-budget format, the two equivalents had more emotional reactions (Waygood and Avineri, 2010). Trees were linked with environmental issues and are something that people would likely see on a day-to-day basis. It was generally well received, though concerns about its ability to clearly represent sustainable levels exist. The earth is conceptually more difficult, and the research participants were split on their response to it. Some people felt that is was a powerful message, clearly indicating what was unsustainable. Others though found it frightening, confusing, or simply did not understand the conceptualisation of using more than one earth.

According to Epstein (1994), the brain has two systems that relate to decision-making: one is very fast and automatic; the other is reflective. The fast and automatic system applies heuristic “short-cuts” and relates to emotions and feelings. The reflective system is slower and more deliberative and could be termed a more “rational” response to the information. The carbon budget format was found to be better in an analytical exercise (Waygood and Avineri, 2011) and if influencing behaviour was purely rational, it follows that it would result in more
behavioural change. However, it may be that (H2) the additional emotional aspect of the tree- and earth-equivalents could improve their influence on behaviour beyond what would be expected purely due to analytical measures.

In addition to how the information is presented, characteristics of the person who is interpreting the information will likely affect reaction. Different people will attach different values to attributes with respect to the format in which information is presented. In climate change, attitudes and opinions have been found to differ along a number of personal characteristics (Eurobarometer, 2009). According a report on European’s attitudes towards climate change (ibid), people that are more likely to consider climate change a serious problem are: women over men, aged 25 to 39, and have higher education. It is therefore plausible that those characteristics might influence how individuals would respond to climate change information. Assuming that greater concern about climate change would result in stronger reactions, we anticipate that (H3a) more people with the aforementioned socio-demographic characteristics will respond that they would change their travel behaviour to be more sustainable.

Further, the application of particular information in a decision process likely depends on the individual valuing that information. If a person does not care how about when they arrive at a destination, then they might ignore information about the duration of the trip, or at least lower the weight of the its influence. The findings of Eurobarometer suggested aggregate differences on about how concerned people are about climate change, but it would be useful as well to understand at an individual level to what extent they are concerned about climate change, as that should affect the strength of their reaction. We anticipate that (H3b) individuals who are more concerned about climate change will have stronger responses to CO₂ information associated with their travel alternatives.

According to the theory of Stages of Change (Prochaska and Norcross, 2001), how people view information will depend on their stage of change towards the new behaviour. People who do not consider their current behaviour to be a problem, or those who may consider it be a problem, but are not considering a change are “pre-contemplators”. Considering a change in the near future would be classified as the contemplation stage or possibly the preparation stage. Those conducting an action could be either at the preparation stage (testing out different behaviours) or the action stage (regularly performing an action). The balance between pros and cons of the different behaviours shifts between stages. Those at the pre-contemplation weigh the cons of changing stronger than the pros. During the contemplation stage, the weighting is shifting towards the pros of changing. In the preparation and action stages, the pros of changing are weighted more than the cons. In this way, information about CO₂ should have a greater influence on those who are in those latter two stages. Thus, participants were asked whether they “are:

- Not concerned about climate change (pre-contemplation stage);
- Concerned, but don’t know what to do (contemplation stage);
- Concerned and will do something in the next 6 months to reduce my impact (preparation stage);
- Concerned and have done something the last 6 months to reduce my impact (action stage).”
Finally, in addition to personal characteristics such as gender, age, education, or environmental stage of change that might influence responses, the participants were asked how they usually travelled. The question pertaining to travel behaviour change related to car use (described in the Survey section), so car use is an important influence on any stated behavioural response to the information. It is anticipated that (H3c), as they may already be less reliant on cars, individuals who do not use cars regularly would be more willing to change or reduce their car use to become more sustainable.

We therefore form these specific hypotheses of this work as follows:

**Hypothesis 1:** Contextualised information will increase the likelihood of sustainable travel choices among respondents.

**Hypothesis 2:** Formats which incorporate some emotional context will increase respondents’ intention to travel more sustainably.

**Hypothesis 3:** Personal characteristics will explain responses to information on sustainable travel alternatives. Specifically, the following will have an effect:

- a) Gender, age, and education level;
- b) Stage of change (associated with climate change related behaviour);
- c) Usual travel mode.

3. **Experiment**

3.1 **Experiment Design**

The fundamental objective of this research was to examine the effect of different CO₂ formats on people’s behavioural intention to travel more sustainably. The experiment was conducted through a paper survey. Four different formats were chosen based on different characteristics: mass, tree-equivalent, earth-equivalent, and carbon budget. The mass of CO₂ was included as it is the scientific measure and an example of simple information content. It is the most commonly used format for the results of on-line carbon calculators (Avineri and Waygood, 2010). To examine the effect of contextual information void of emotional associations a carbon-budget format based on a fictional limit was included. The tree-equivalent format was chosen as a common equivalent that related to the carbon cycle and was associated with environmentalism. It represents a contextualised format that should contain an emotional context, but with less analytical basis (as it lacks a clear limit). The earth-equivalent format was chosen as it was based on a concept of equality, (was thought to\(^1\)) clearly conveyed sustainability and was used by well-known environmental groups such as the World Wildlife Funds’ Footprint calculator ([http://footprint.wwf.org.uk](http://footprint.wwf.org.uk)). It represents a contextualised format that is more analytical than the tree-equivalent format as it suggests a limit and has emotional associations.

The responses examined in this research were part of a larger survey conducted for the Carbon Aware Travel Choices (CATCH; [www.carbonaware.eu](http://www.carbonaware.eu)) project. In all four cases

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\(^1\) Prior to conducting the research presented in Waygood and Avineri (2010, 2011).
(Table 1), the information related to four tonnes of CO₂. Each question was on a separate page (i.e. one format per page). Relevant to this research, individuals were asked about their travel behaviour response to information presented in the four different formats.

The responses available were influenced by research into Stages of Change (Prochaska and Norcross, 2001). The theory of Stages of Change suggests that committing to a change in the future is quite a weak commitment. The available behavioural response choices were:

1) No change;
2) Consider some change in the future;
3) I would change:
   a. Reduce trips by car;
   b. Shorten trips;
   c. Change vehicle (e.g. better mileage);
   d. Stop driving.

The adjustments to car travel such as reducing trips, distances, or a technological change are commitments to change, but are not as complete as a cessation of driving. Thus, with respect to the Stages of Change described in the Background section, no change or considering some change in the future are related to pre-contemplation and contemplation stages of behavioural change. The first three choices (a,b,c) relate to behaviours that should result in a reduction of CO₂ outputs, while the final choice is a complete behaviour change.

### Table 1 Formats and information presented in the experiment.

<table>
<thead>
<tr>
<th>Format</th>
<th>Information presented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass</td>
<td>4 tonnes of CO₂</td>
</tr>
<tr>
<td>Tree-equivalent</td>
<td><img src="image" alt="Tree" /></td>
</tr>
<tr>
<td>Earth-equivalent</td>
<td><img src="image" alt="Earth" /></td>
</tr>
<tr>
<td>Carbon budget</td>
<td>111% of your carbon budget</td>
</tr>
</tbody>
</table>

### 3.2 Experiment Participants

As mentioned, the experiment was conducted through a survey. 194 individuals participated in this experiment. Individuals were recruited through recruiting agencies in the UK (47), with the remainder recruited from companies. The resulting sample was more likely to have higher education than what would be expected from the general population. Characteristics relevant to this research are shown in Table 2.

### Table 2 Sample characteristics of the participants. The total number of responses for each characteristic is given in brackets.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (n = 189)</td>
<td>47%</td>
</tr>
<tr>
<td>Age, average (years) (n = 190)</td>
<td>39</td>
</tr>
</tbody>
</table>
Age, range (years) 19 to 76
Higher education (n = 186) 61%
Usual mode is car (n= 173) 78.6%
Level of environmental concern (n=176)
Not concerned about climate change; 13%
Concerned, but don’t know what to do; 22%
Concerned and will do something in the next 6 months to reduce my impact; 28%
Concerned and have done something the last 6 months to reduce my impact. 28%

4. Analysis

The first hypothesis was that CO₂ information presented as carbon budget would result in greater intended behavioural response to the CO₂ information. As the other two formats are also contextualized formats, their results are also presented here (Table 3). The responses are categorical, so an appropriate statistical analysis is the chi-square test of independence. Descriptive results with respect to format and response are presented in Table 3. To measure whether there was a difference as compared to the mass format, the other three formats were analysed in turn against the mass format responses. In all cases, the results were highly significant (p-value < 0.001). Not all participants responded to all questions, and non-responses were considered as “no change”, so as to err on the side of “no impact”. From these results, it would appear that increasing context can improve stated behavioural intention to perform more climate-friendly behaviour.

Table 3 Results of travel behaviour responses to CO₂ information related to H1. The n shown for each format relates to the total number of people who answered the question.

<table>
<thead>
<tr>
<th>Type of change</th>
<th>Mass (n = 192)</th>
<th>Tree-equivalent*, (n = 191)</th>
<th>Earth-equivalent*, (n = 187)</th>
<th>Carbon budget*, (n = 190)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No change</td>
<td>18.0%</td>
<td>5.7%</td>
<td>10.8%</td>
<td>6.7%</td>
</tr>
<tr>
<td>Future change</td>
<td>24.7%</td>
<td>13.9%</td>
<td>20.6%</td>
<td>15.5%</td>
</tr>
<tr>
<td>Car behaviour change</td>
<td>55.2%</td>
<td>66.0%</td>
<td>56.2%</td>
<td>68.0%</td>
</tr>
<tr>
<td>Stop driving</td>
<td>2.1%</td>
<td>14.4%</td>
<td>12.4%</td>
<td>9.8%</td>
</tr>
</tbody>
</table>

* Responses are statistically distinct from those of the mass format using chi-square independence tests (degrees of freedom: 3; chi-square: 38.3, 18.5, and 26.6 respectively for tree-equivalent, earth-equivalent, and carbon budget).

All three contextualized formats performed better than the simple information content format of mass, but is one “better” than the others? In Table 3 it can be seen that the highest responses to “stop driving” were with the tree- and earth- equivalents respectively, with the mass format performing by far the worst. That suggests that those formats may stimulate the greatest motivation to make a major change. However, if the responses are simplified to “some change” versus “no present change”, then the results (Table 4) suggest that to
encourage change the tree-equivalent (>80%) or the carbon budget (>77%) would be most effective to create some change, while mass is verging on 50/50.

Table 4 Combined (no change + future change; driving behaviour change + stop driving) travel behaviour responses to CO₂ information.

<table>
<thead>
<tr>
<th>No change or some change</th>
<th>Mass (n = 192)</th>
<th>Tree-equivalent, (n = 191)</th>
<th>Earth-equivalent, (n = 187)</th>
<th>Carbon budget, (n = 190)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No present change (weak response)</td>
<td>42.8%</td>
<td>19.6%</td>
<td>31.4%</td>
<td>22.2%</td>
</tr>
<tr>
<td>Some or complete change (desired response)</td>
<td>57.2%</td>
<td>80.4%</td>
<td>68.6%</td>
<td>77.8%</td>
</tr>
</tbody>
</table>

With respect to the second hypothesis, that contextualized formats with emotional aspects would increase behaviour change responses, the answer is not completely clear. The results seen in Table 4 suggest that the tree-equivalent format resulted in more people stating that they would change their travel behaviour than compared with the carbon budget format, but the same was not true for the earth-equivalent format. However, from Waygood and Avineri (2010), it might be that the earth-equivalent format was effective for more environmentally minded individuals (tested below) and may be have been more analytically difficult (tested next).

Considering the mixed results of Table 4, it would be useful to examine whether interpretability of the format influenced responses. As mentioned above, the experiment included other tasks such as giving a “sustainability ranking” to CO₂ information presented in various formats and the potential answers included a “don’t know” choice (Waygood and Avineri, 2011). Here, the responses of people who performed all ranking exercises (separate section of the survey for each format) are compared with the responses of people who answered “don’t know” to at least one of those tasks.

The results are shown in Table 5. Applying chi-square tests of independence to each format, the tree-equivalent format had a p-value of 1.0 (absolutely no impact), but the earth-equivalent format had a p-value of <0.05, suggesting that confidence in understanding may have an effect for that format. The other two formats had p-values of 0.238 and 0.354 for mass and carbon budget formats respectively. The results suggests that the tree-equivalent is an exceptionally strong format for motivating change regardless of whether the individual struggled to use it in an analytical question or not, while the earth-equivalent format is more dependent on the individual’s ability to understand it. This would suggest that the ability of a format to improve responses in an analytical task does not necessarily correspond to behavioural intention to become more climate-friendly.

Table 5 How confidence in understanding of format affected rates of response. In the format heading the overall response rate of would make some change is shown in italics inside
brackets. The percentage of individuals who gave a “don’t know” response to a sustainability ranking question (separate section of the survey (see Waygood and Avineri, 2010 or Waygood and Avineri, 2011)) for each format is given in non-italicized brackets.

<table>
<thead>
<tr>
<th>Would change something</th>
<th>Mass (57.2%)</th>
<th>Tree-equivalent (80.4%)</th>
<th>Earth-equivalent* (68.6%)</th>
<th>Carbon budget (77.8%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Didn't answer all ranking questions for that format</td>
<td>50.8% (32%)</td>
<td>80.5% (21%)</td>
<td>59.2% (26%)</td>
<td>71.9% (17%)</td>
</tr>
<tr>
<td>Answered all ranking questions for that format</td>
<td>61.1%</td>
<td>82.0%</td>
<td>75.4%</td>
<td>81.0%</td>
</tr>
</tbody>
</table>

* Yate’s chi-square = 3.854; Yate’s p-value < 0.050.

Considering hypothesis 2, the results of Table 2 suggest that the more emotional icons of tree-equivalent and earth-equivalent produced the strongest responses (stop driving). Further, the results presented in Table 5 would suggest that despite not being able to give a ranking as frequently as with the carbon budget (17% of respondents did not answer at least one ranking question using the carbon budget format), the tree-equivalent format (21%) was the strongest motivator. The results in Table 4 would suggest that overall, the earth-equivalent did not motivate as many people to respond that they would make some change and it did not work well for the one in four people who struggled to understand it.

Overall, despite not clearly presenting a sustainable limit clearly, the tree-equivalent format was a stronger motivator than the analytical carbon budget format. This suggests that first, more attention to the context (e.g. presentation) of information could improve responses to climate change information, and second, that consideration to emotional context could improve responses further.

4.1 Responses with Respect to Personal Characteristics

The following analyses consider hypothesis 3 that different individual characteristics might influence responses to the formats. This section contains important information to anyone communicating CO₂ information to specific audiences, such as marketing by population segments. All questions relating to individual characteristics were asked at the end of the survey, so that individuals were not “primed” to answer in agreement with some characteristic such as “environmental stage of change”.

4.1.1 Gender

Differences in gender responses are valuable for any communication aimed either at the general population or specific target groups. More women in Europe were found to consider climate change a serious problem (Eurobarometer, 2009). Thus, the anticipated result would that women would respond stronger to the CO₂ information. As can be seen in Table 6, a considerable difference (more than 5%) is only evident for mass where women were 8% more likely to report motivation to change behaviour. For both sexes, the tree-equivalent was the
strongest motivator and mass the weakest. None of the formats had statistically different response rates between the genders.

**Table 6** The impact of gender on motivation to do something in response to CO₂ information in different formats (n = 187). The overall response for making some change (as described in Table 3) for each format is given in brackets.

<table>
<thead>
<tr>
<th>Would change something</th>
<th>Mass (57.2%)</th>
<th>Tree-equivalent (80.4%)</th>
<th>Earth-equivalent (68.6%)</th>
<th>Carbon budget (77.8%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (n = 88)</td>
<td>63%</td>
<td>82%</td>
<td>73%</td>
<td>78%</td>
</tr>
<tr>
<td>Male (n = 99)</td>
<td>55%</td>
<td>85%</td>
<td>71%</td>
<td>82%</td>
</tr>
</tbody>
</table>

**4.1.2 Education**

One’s educational level may affect knowledge about climate change or the ability to understand such an abstract concept. In a European study, people with more education and people still studying were more concerned about climate change (Eurobarometer, 2009). Thus the anticipated result would be that people with higher education would respond stronger to the CO₂ information. The impact of education can be seen in Table 7. People with higher educations were overall more motivated to make a change in response to the information. Here, the lowest impact is seen for the carbon budget (9% difference), while the greatest impact is seen for trees (21%). People with higher education were statistically more likely to be motivated by the tree- and earth-equivalents.

**Table 7** The impact of education on motivation to do something in response to CO₂ information in different formats (n = 182). The overall response for making some change (as described in Table 3) for each format is given in brackets.

<table>
<thead>
<tr>
<th>Would change something</th>
<th>Mass (57.2%)</th>
<th>Tree-equivalent*** (80.4%)</th>
<th>Earth-equivalent** (68.6%)</th>
<th>Carbon budget (77.8%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard education</td>
<td>50%</td>
<td>68%</td>
<td>57%</td>
<td>73%</td>
</tr>
<tr>
<td>Higher education</td>
<td>60%</td>
<td>89%</td>
<td>77%</td>
<td>82%</td>
</tr>
</tbody>
</table>

** Yate’s p-value <0.01

*** Yate’s p-value <0.001

**4.1.3 Age**

Age could affect responses in a number of ways. The younger cohort may have been more exposed to the problem of climate change in their education and might feel that the negative impacts would more likely affect them in their lifetime. In some studies young people have been found to be more concerned than the older cohorts (Eurobarometer, 2009). On the other hand, the oldest cohort may feel responsibility to the following generations, or have a greater sense of duty to the common good through years of austerity following World War II
Based on the findings of the Eurobarometer, it is anticipated that younger people would have a stronger response to the CO₂ information.

The impact of age on motivation to change behaviour in response to CO₂ information is shown in Table 8. Contrary to the anticipated results, in nearly all cases, the youngest cohort (20 to 34 year olds) reported the least motivation to change their behaviour, whereas the oldest cohort (60 years or more) reported the most motivation. In all cases except for the carbon budget format with the youngest cohort, the tree-equivalent was the strongest motivator. The effect of age resulted in statistically different results for the mass and earth-equivalent formats.

**Table 8** The impact of age on motivation to “do something” (change behaviour – combined responses) in response to CO₂ information in different formats (n = 182). The overall response for making some change (as described in Table 3) for each format is given in brackets.

<table>
<thead>
<tr>
<th>Would change something</th>
<th>Mass** (57.2%)</th>
<th>Tree-equivalent (80.4%)</th>
<th>Earth-equivalent* (68.6%)</th>
<th>Carbon budget (77.8%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 to 34 years</td>
<td>48%</td>
<td>78%</td>
<td>66%</td>
<td>81%</td>
</tr>
<tr>
<td>35 to 59 years</td>
<td>64%</td>
<td>85%</td>
<td>73%</td>
<td>76%</td>
</tr>
<tr>
<td>60 or more years</td>
<td>82%</td>
<td>100%</td>
<td>95%</td>
<td>95%</td>
</tr>
</tbody>
</table>

* p-value <0.05  
** p-value <0.01

### 4.1.4 Environmental Stage of Change

Personal values could influence how people respond to the information. If someone does not worry about climate change, then CO₂ information may not have any impact on her. Thus, the next influence considered here is the level of self-reported climate change concern and action. It is anticipated that people who are considering a change, or who have made a change would response stronger to CO₂ information.

The responses have been grouped into “not environmentally active” for the first two choices (“not concerned about climate change” or “concerned, but don’t know what to do”) and “environmentally active” for the latter two choices (“concerned and will do something in the next 6 months to reduce my impact” or “concerned and have done something in the last 6 months to reduce my impact”).

In Table 9 it can be seen that for motivation to change some travel behaviour aspect, the tree-equivalent was the strongest motivator for both people who were not environmentally motivated and those that were. In all cases, people who reported planning some action or having done some action to reduce their climate impact reported higher motivation to change behaviour. The greatest influence of being environmentally active was on the mass and earth-equivalent formats where there was nearly a 20% difference in reported motivation to change behaviour. Only those two formats had results that were statistically significantly different for motivating individuals who were “not environmentally active” versus those who
were “environmentally active.”

Based on the results shown in Table 9, it could be that people who are already planning to reduce or reducing their impacts on climate change have greater knowledge and are able to respond better to the content-only format of mass. However, as mentioned in the Background, Coulter et al. (2007) found that even people who were sufficiently environmentally motivated to investigate their CO₂ impacts online did not necessarily understand the information when presented as mass. Thus, it is possible that such people respond to CO₂ information regardless of comprehension. That interpretation might also explain why those individuals responded better to the earth-equivalent format than others.

Table 9 Response of some change to travel behaviour by environmental concern measure (n = 176). The overall response for making some change (as described in Table 3) for each format is given in brackets.

<table>
<thead>
<tr>
<th>Would change something</th>
<th>Mass* (57.2%)</th>
<th>Tree-equivalent (80.4%)</th>
<th>Earth-equivalent* (68.6%)</th>
<th>Carbon budget (77.8%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not environmentally active (n = 67)</td>
<td>45%</td>
<td>76%</td>
<td>58%</td>
<td>73%</td>
</tr>
<tr>
<td>Environmentally active (n = 109)</td>
<td>63%</td>
<td>86%</td>
<td>77%</td>
<td>83%</td>
</tr>
</tbody>
</table>

*Yate’s p-value <0.025

4.1.5 Usual travel mode

Considering that the car is not the usual mode for at least 20% of the respondents, it is important to consider whether a difference exists in responses between those who commonly use the car to travel, and those who mainly travel by other modes (public transport, walking and cycling). People who do not usually travel by car may be more able to further reduce or adjust driving behaviour. Therefore, we anticipate that such people will be more likely to choose to make a change.

In Table 10, it can be seen that people who do not usually use a car are more likely to respond that they would change driving behaviour in response to the CO₂ information. However, the tree-equivalent format is still associated with the most number of people who usually drive reporting that they would change and it is the only one where the two groups are not statistically different. In all cases, people who do not normally travel by car were more likely to report some intention to change.

Table 10 Response of some change to travel behaviour by whether the car is the respondent’s usual mode or not. The overall response for making some change (Table 3) for each format is given in brackets.

<table>
<thead>
<tr>
<th>Would change something</th>
<th>Mass* (57.2%)</th>
<th>Tree-equivalent (80.4%)</th>
<th>Earth-equivalent* (68.6%)</th>
<th>Carbon budget* (77.8%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not car (n=48)</td>
<td>71%</td>
<td>90%</td>
<td>84%</td>
<td>91%</td>
</tr>
</tbody>
</table>
### 4.1.6 Summary of Influence of Personal Characteristics

The influence of personal characteristics is important for practitioners who want to develop tailored information to target groups and segments. This analysis highlighted several important points. First, gender does not seem to be a factor. Second, is the varying influences found that depend on the format. The mass format was sensitive to factors such as the usual mode of travel, environmental stage of change, and age. The earth-equivalent format was sensitive to all of the factors apart from gender. The tree-equivalent format was sensitive to education level, while the carbon budget format was sensitive to the usual travel mode. Depending on who, or how, the designer of information wishes to influence someone, this information could help direct the communication. For general appeals, the tree-equivalent or carbon-budget formats would be the recommended choice from this analysis, though a better format may exist or could potentially be developed.

### 5. Discussion

Previous research has found that providing CO$_2$ information as a mass can impact choice (Gaker et al., 2010). However, research into people’s understanding of CO$_2$ information has found that presenting it as a mass has problems (Coulter et al., 2009; Waygood and Avineri 2011). A contextualised format, “carbon budget”, was found to perform best with respect to a sustainability ranking exercise (Waygood and Avineri, 2011) out of the four formats used in this research. That suggests, that more contextualized information could better influence behaviour, but it was previously untested. Behavioural intention to perform an action is one of the strongest determinants of behaviour (TPB), thus this research examined whether contextualised information might increase stated behavioural intention in response to CO$_2$ information. It found that the carbon budget format improved reported motivation to change travel behaviour compared to only mass.

Influencing people’s decisions is not solely the domain of reflective, analytical considerations. Decisions can be made using a reflective process or an automatic/intuitive one. As well, information can be contextualized with respect to different goals. In this work, we examined whether a less analytical, but more emotional format might lead to increased stated intention to change travel behaviour. The results of this research suggest that despite not performing as well by analytical measures, the tree-equivalent was the most influential format to stimulate a change in driving behaviour. However, we do not assert that the tree format is the definitive means of communicating CO$_2$ and further work could use the fundamental concepts we have outlined here to develop better formats.

As a caveat, the earth-equivalent format did not motivate as strongly as the carbon budget, but more than the simple mass format. The earth-equivalent format increases context, but was perhaps not fully “accepted” by some participants. In qualitative work (Waygood and Avineri, 2010), it was found that for some individuals the earth-equivalent was a clear indication of sustainability, while others found it frightening, too abstract, or simply could not (would not) understand the concept of using more than one earth. Such information was not evident from
the quantitative work and perhaps highlights the importance of qualitative work in such fields as communication.

This work has also suggested that the simply providing information without consideration to its presentation or context is insufficient. That assumption requires that information is processed purely rationally and analytically. One cannot assert that showing 13 trees (with no reference to their value) versus stating that the CO₂ value is 111% of the recommended limit is a better rational or analytical format.

An argument presented at the beginning of this work was that behaviour is a product of intention. Indeed, the Theory of Planned Behaviour and other frameworks that incorporate intentions in models of individual behaviour provide powerful explanation of behaviour in a wide range of contexts. However it can be also argued that some behaviour occurs with little or no pre-planned intent. In that aspect behaviour can be seen as impulsive, habitual or emotional rather than planned (see, for example, Gärling et al., 1998). In order to increase the effectiveness of contextual design of information on transport-related emissions, information ‘architects’ could apply so-called nudges (Thaler & Sunstein, 2008) and other insights from cognitive psychology and behavioural economics to address unintentional/automatic behaviours (for a review, see Avineri, forthcoming). For example, Waygood and Avineri (2011) showed that the anchoring effect strongly influenced the sustainability ranking exercise mentioned previously. In that experiment, the interpretation of sustainability for the same CO₂ amount was greatly influenced by the values of the alternative choices. In Avineri and Waygood (forthcoming), loss framing was found to significantly influence people’s interpretation of the difference between two CO₂ amounts. By highlighting the negative difference (e.g. producing more CO₂) between two amounts, the participants more often reported that the amounts were “much different” rather than “slightly different”.

We do not assert that there is no room for rational, analytical information, but that consideration to context in the design of information could improve effectiveness. In fact, rational, analytical information may be more appropriate for deliberative processes, while formats that play to the automatic processes might be more appropriate for quick, everyday decisions. Further work here in separating out those influences is necessary to develop better communication tools.

Although we have focused our recent research on the communication of CO₂, these techniques are applicable to any communication of information. Ignoring their influence weakens the potential of information to influence behaviour, or may unintentionally distort what was intended to be communicated. We encourage researchers and practitioners to keep these techniques in mind when presenting information.

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6. References


