ANALYTICAL OR EMOTIONAL? WHICH STIMULATES GREATER SUSTAINABLE TRAVEL INTENTION?

Revised version submitted Nov. 15, 2012

E. Owen D. Waygood*
Assistant Professor
École supérieure d’aménagement du territoire et de développement régional (ÉSAD)
Université Laval
2325 rue de Bibliothèques, Local 1622,
Québec, QC Canada G1V 0A6
Phone: +1-418-656-2131 x. 3740
Fax: +1-418-656-2018
E-mail: owen.waygood@esad.ulaval.ca

Erel Avineri
AFEKA, Tel-Aviv Academic College of Engineering
218 Bnei Efraim Tel Aviv
69107 Israel
Phone: +972 (0)3-7668777
Fax: +972 (0)3-7688668
Avineri@afeka.ac.il

*Corresponding Author
ABSTRACT

Climate change is a global problem and transportation is a major contributor to it. In response to that problem, information on transportation generated CO₂ information on transportation is being provided to the public to aid with informed decision-making. Choice experiments have found that CO₂ information given as a mass could influence choice. However, other research suggests that CO₂ information presented as mass is not fully understood and that how the information is presented, the format, affects interpretation. If a format can affect understanding and interpretation, might it then affect intention (and choice) to perform sustainable travel? It can be argued that without context, it would be difficult to interpret CO₂ information presented as mass with respect to sustainable levels. Information context provided through formats can highlight some aspects of the information to influence intention and choice. It could affect decisions in an analytical or emotional manner. If a format uses context that performs better in an analytical task, does it follow that it would have greater impact on influencing intention? Or might a format that includes emotional context result in stronger intention? This research examined how people's behavioral intention responses for car use varied by three different contextualized formats (carbon budget, tree-equivalent, and earth-equivalent) with varying analytical and emotional contexts in comparison to responses based purely on CO₂ information presented as a mass without direct context.
INTRODUCTION

Due to concerns over climate change, transportation planners and policy makers around the world have looked at ways to reduce transportation’s contribution to greenhouse emissions (1,2). The solution will likely require a number of changes including technology, infrastructure, and behavioral change. It can be argued that behavioral intentions and choices are related to available information on the impact of travel choices on the environment (3). However, it is not just the content of information that might affect behavior – its context, or the format in which it is being presented, might also affect interpretation, intention and travel choice. Previous work highlighted that how CO$_2$ information is presented affects interpretation (4,5), and that CO$_2$ information can have an impact on choice (3), but it has not examined whether presentation might affect intention to travel more sustainably.

Although it would be ideal to examine actual behavior change, it is not always possible to have it directly observed or explained. In that aspect, the intention to perform an action is of specific relevance and importance as (according to many studies in behavioral sciences) it explains considerable variation in behavior. Behavioral intention is argued to be the strongest explanatory variable in behavioral models such as the Theory of Planned Behavior (TPB) (6). As Ajzen (6) 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 CO$_2$ might be associated with increased levels of intention to change travel behavior.

BACKGROUND

Although CO$_2$ information was found to have an impact on travelers’ choices (3,7), that influence could be affected by its interpretation, perception and understanding. Gaker et al.’s research (3,7) used CO$_2$ information presented as a mass to affect individuals’ stated choices. However, in some previous qualitative research, Coulter et al. (8) found that many people, including individuals who investigated their CO$_2$ impacts online, stated that they did not understand CO$_2$ amounts when presented as a mass.

Coulter et al.’s finding has significant impacts to the value of CO$_2$ information in producing more environmentally sustainable travel. According to the Theory of Planned Behavior (6), behavior 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 that behavior (i.e. perceived behavioral control), if a person is unable to evaluate the CO$_2$ information, then 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) (9). 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 CO$_2$ 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 CO$_2$ 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 CO$_2$ information presented simply as a mass.

To help explain the difference between information content and context, we offer the following example. Considering financial or time attributes of a trip, an individual will take the information content (e.g. $3 for a bus ticket; 15 minutes travel time) and interpret it with respect to their financial and time budgets. Those budgets act as the information context by which they make their judgments of the information content. However, for CO$_2$ information, such contextual information is not readily available for many people.

Increasing contextual information could potentially improve behavioral response to CO$_2$ information, reducing the chance that the CO$_2$ 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 CO$_2$ information as mass. Another possibility would be to include contextual information in the presentation, or format, of the CO$_2$ information. A format that includes contextual information could be termed a contextualized format.

A contextualized 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 CO$_2$ information, there are numerous different methods of presentation. However, not all methods are likely as analytically useful as others. For example, presenting a large amount of CO$_2$ as being equivalent to an elephant may contextualize the mass, but the information is not contextualized with respect to environmental or societal goals.

In an experiment on analytical usefulness, Waygood and Avineri (5) tested people’s ability to give a sustainability ranking to three contextualized formats (carbon budget, trees equivalent and earth equivalent) for CO$_2$ information versus CO$_2$ information presented as a mass. All presentation formats were used to present the same critical information, carbon emissions generated by an individual through transportation over one year. The carbon budget format represented a limit on individual carbon emission, such as might exist with cap-and-trade system. The tree-equivalent format represented the CO$_2$ mass as the number of trees required to sequester the CO$_2$ produced by the individual. The earth-equivalent format represented the number of earths required to maintain such behavior if all people on earth behaved the same way.

Participants were asked to rank CO$_2$ information about a five-mile trip on a seven-point Likert scale. Taking into account the findings by Coulter et al. (8) that people struggled to interpret CO$_2$ information, the option of providing a “don’t know” response was also included. Waygood and Avineri (5) found that a contextualized format, “carbon budget”, improved the likelihood that a person would at least give a sustainability ranking to the CO$_2$ information. The carbon budget format presented the CO$_2$ amount as a percentage of a recommended limit that related to a societal goal contextualization (10). The work (5) suggested that such a carbon 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 CO$_2$ amount being “ranked” (as per the exercise described in (5)), then it should follow that there would be greater behavioral 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 CO$_2$ information presented as a mass can affect travel behavior choices in experimental settings (3,7), it can be anticipated that:

H1: using the “carbon budget” format would increase the likelihood of a behavioral response towards more sustainable choices over simply CO$_2$ mass information.

However, contextualizing information as a societal goal is not the only way to goal frame information. The consequences of the behavior can be highlighted through three types of goals (10,11): normative, gain, or hedonic. A normative goal is one that relates to a societal goal, such as reducing crashes or CO$_2$ emissions. A gain goal is one where the individual is trying to preserve, protect, or improve ones resources, such as time or money. The third goal framing relates to hedonic goals, or how the behavior will make the person feel (e.g. emotionally).

The carbon budget format used above contextualized the information with respect to what is appropriate behavior, thus it is a normative goal, which relates to injunctive norms (12). Injunctive norms are information about behavior that society approves (e.g. recycling, being polite), regardless of actual behavior (descriptive norms). CO$_2$ mass information could relate to a gain goal if a person had a personal goal of reducing CO$_2$ production. The earth-equivalent format, like the carbon budget one, also represents a normative goal by suggesting what the earth is capable of sustaining assuming egalitarian distribution of carbon emissions. The tree-equivalent format, like the two previous, 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 (13), reported qualitative research that suggested there was emotional response to the two equivalents formats (earth and tree). 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 (13). 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 conceptualization of using more than one earth.

Although decisions can be made in very analytical ways, emotional response can surely play a role in influencing decisions. According to Epstein (14), 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 (5) and if influencing behavior was purely...
rational, it follows that it would result in more behavioral change. However, the
following might be hypothesized:

(H2): the additional emotional aspect of the tree- and earth-equivalents
could improve their influence on behavior beyond what would be
expected purely due to analytical measures.

To summarize, this work investigates two specific hypotheses:

Hypothesis 1: Information contextualized by environmental ‘capacity’
or ‘budget’ (such as carbon budget and earth-equivalent) will
increase the likelihood of sustainable travel choices among
respondents.

Hypothesis 2: Formats that incorporate some emotional context (in
specific, tree-equivalent and earth-equivalent) will increase
respondents’ intention to travel more sustainably.

EXPERIMENT

Experiment Design

The fundamental objective of this research was to examine the effect of different CO₂
formats on people’s behavioral intention to travel more sustainably. The experiment was
carried out 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 without either environmental or emotional contextual information (Figure 1). It is
the most commonly used format for the results of on-line carbon calculators (15). 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 contextualized 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) clearly
conveyed sustainability and was used by well-known environmental groups such as the
‘World Wildlife Funds’ Footprint calculator (http://footprint.wwf.org.uk). It represents a
contextualized 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) project. In all four cases (illustrated in Table 1), the information related to four metric tonnes (4.4 short tons) of CO$_2$. Each participant was asked to respond to all four formats. Each question, with a corresponding format, and choice set were identical.

The choice set of responses available was influenced by research into Stages of Change (16). The theory of Stages of Change suggests that committing to a change in the future is a weak commitment. The available behavioral response choices were:

1) No change;
2) Consider some change in the future;
3) I would make a 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, “no change” or “consider some change in the future” are related to pre-contemplation and contemplation stages of behavioral change, while actual behavior change would relate to more advanced stages such as action (see (17) for how this relates to information use in transportation). The first three choices (a,b,c) relate to behaviors that should result in a reduction of CO$_2$ outputs, while the last choice (d) is a complete behavior change.

<table>
<thead>
<tr>
<th>Format</th>
<th>Information presented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass</td>
<td>4 tonnes of CO$_2$</td>
</tr>
</tbody>
</table>

FIGURE 1 Visual representation of how the four formats tested relate to emotional and environmental context (note: emotional context of formats was not directly measured)
Experiment Participants

The experiment included 194 individuals who were recruited through recruiting agencies in the UK (47), with the remainder recruited from various workplaces (13). The resulting sample was more likely to have higher education than what would be expected from the general population. The sample characteristics 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>
<tr>
<td>Age, range (years)</td>
<td>19 to 76</td>
</tr>
<tr>
<td>Higher education (n = 186)</td>
<td>61%</td>
</tr>
</tbody>
</table>

ANALYSIS

The first hypothesis was that CO₂ information presented as a carbon budget would result in greater intended behavioral 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 analyzed 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 behavioral intention to perform more climate-friendly behavior.

### TABLE 3 Results of travel behavior 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 behavior 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 intention 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 the mass format is verging on 50/50.

<table>
<thead>
<tr>
<th>Table 4 Combined travel behavior responses to CO₂ information (no change + future change; driving behavior change + stop driving)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No change or some change</strong></td>
</tr>
<tr>
<td>No present change (“weak response”)</td>
</tr>
<tr>
<td>Would change something (“desired response”)</td>
</tr>
</tbody>
</table>

With respect to the second hypothesis, that contextualized formats with emotional aspects would increase behavior 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 behavior than compared with the carbon budget format, but the same was not true for the earth-equivalent format. However, from Waygood and Avineri (13), it might be that the earth-equivalent format was effective for more environmentally minded individuals and may be have been more analytically difficult.

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. In that task, the participants were asked to rank on a seven-point Likert scale how sustainable a trip was based on the CO₂ information. For each format, there were three example CO₂ amounts. The participants were also given the option of answering, “don’t know” (5). That option was used as a proxy measure of whether the information failed to communicate. In Table 5, the responses of people who performed all of those ranking exercises were 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 of answering “don’t know” in analytical task on behavioral intention response), but the earth-equivalent format had a p-value of <0.05, suggesting that confidence in understanding may have had 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 suggest that the tree-equivalent is an exceptionally strong format for stimulating intention to 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 behavioral intention to become more climate-friendly.

TABLE 5 How confidence in understanding of format affected rates of response

<table>
<thead>
<tr>
<th>Would change something</th>
<th>Mass</th>
<th>Tree-equivalent</th>
<th>Earth-equivalent*</th>
<th>Carbon budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Didn't answer all ranking questions for that format</td>
<td>50.8% (32%(^1))</td>
<td>80.5% (21%(^1))</td>
<td>59.2% (26%(^1))</td>
<td>71.9% (17%(^1))</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>

\(^1\) The percentage of individuals who responded “don't know” to a sustainability ranking task given in a separate section of the survey (see (13) or (5)).

* 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 answered “don’t know” or did not answer at least one ranking question using the carbon budget format), the tree-equivalent format (21%) had the strongest effect on intentions to change travel behavior. The results in Table 4 would suggest that overall, the earth-equivalent did not stimulate as many people towards behavioral change intentions 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 contributor to behavioral change intentions than the analytical carbon budget format.

DISCUSSION

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 behavior. 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 potential change in driving behavior. However, we
do not assert that the tree format is the definitive means of communicating CO₂ 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 stimulate behavioral change
intentions 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 (13), 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 research fields such as communication.

This work has also suggested that 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 behavior is a
product of intention. Indeed, the Theory of Planned Behavior and other frameworks that
incorporate intentions in models of individual behavior provide powerful explanation of
behavior in a wide range of contexts. However it can be also argued that some behavior
occurs with little or no pre-planned intent. In that aspect behavior can be seen as
impulsive, habitual or emotional rather than planned (see, for example 18). In order to
increase the effectiveness of contextual design of information on transportation-related
emissions, information ‘architects’ could apply so-called nudges (19) and other insights
from cognitive psychology and behavioral economics to address unintentional/automatic
behaviors (for a review, see 20). For example, Waygood and Avineri (5) 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 (4), 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.

Next stage research could build upon the findings here in several ways. One
consideration would be whether the larger visual impact of the trees format had an effect.
This could be accomplished by using the trees format along with a multiplication factor
(e.g. Tree format x 14.5). The interpretation difficulty with the earth format could
potentially also be addressed in a similar fashion. To reduce the effect of socially
desirable responses, each participant should only be presented with one format. Some
means of objectively measuring the emotional content of formats would increase support
of the findings here.

Practitioners can take several things away from this and other research. The first
is to provide context, but to be aware that what context is provided and how it is
presented will have an effect (see 4, 5, 13). Further, do not ignore quick, intuitive
decision making as emotional contextualization may have a stronger impact on
sustainable choices than purely analytical ones.

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 behavior, or may
unintentionally distort what was intended to be communicated. We encourage researchers
and practitioners to keep these techniques in mind when presenting information.

CONCLUSION

The findings of this research suggest that the current dominant format of presenting CO₂
information (as a mass) is not as affective as other presentation formats. More attention to
the context (e.g. presentation) of information could improve responses to climate change
information, and, additionally, consideration to emotional context could improve
responses further.

However, research was not conducted on finding the format to use, but compared mostly
existing formats. Future work should take into consideration the findings here and test
whether improved emotionally contextualized formats could be developed. As well,
different segments of society may respond better to different formats, and there may not
be a single “best” format.
ACKNOWLEDGEMENTS

This research was funded in part by a grant from the European Commission’s Framework 7 Programme through the Carbon Aware Travel Choice project (CATCH; www.carbonaware.eu). The authors would like to thank the anonymous reviewers for their support, valuable suggestions, and contributions.
REFERENCES