This paper was first published in ECEEE summer study proceedings as:
Waygood, E.O.D., Binsted, A., Clark, A, and E. Avineri (2011). Developing an online tool for behavioural change in urban transport. ECEEE Summer Study, Toulon, France, 6-11 June, 2011.

Developing an online tool for behavioural change in urban transport

Dr Owen Waygood
Centre for Transport & Society, University of West of England, Bristol
Email: owen.waygood@uwe.ac.uk

Dr Erel Avineri
Centre for Transport & Society, University of West of England, Bristol
Email: erel.avineri@uwe.ac.uk

Anne Binsted
TRL
Email: abinsted@trl.co.uk

Dr Anna Clark
Polis
Email: aclark@polis-online.org

Abstract

If carbon reduction emission targets are to be met, then travel behaviours must change. There are many technological developments that help in reducing emissions from the sector, but these reductions are being offset by increases in demand for travel. This paper is based on research being conducted within the CATCH project, an EC FP7 project that is in the process of developing an online portal that aims to increase awareness of the impacts of travel behaviours, suggest ways that they can be changed, and indicate the impact that these changes could have. It is focused on climate change mitigation in the urban transport sector, but will also communicate other social, economic and environmental impacts of low carbon intensity travel behaviours. This paper will focus on grounding research from the project, which indicates that behavioural change can be encouraged by framing messages in a particular way. Carefully thought out information provision can 'nudge' individuals into making small steps on the path towards full behavioural change. It provides a brief overview of concepts relating to behaviour change through information provision and contextualises some of the findings in terms of the development of the CATCH online tool for behavioural change in transport.

Introduction

This paper is based on the interim findings of the FP7 CATCH project (Carbon Aware Travel CHoice). It was commissioned in recognition of the fact that in their 2007 Green Paper on urban mobility, the EC highlighted that urban transport is 'an important facilitator of growth and employment' but that it is responsible for 40% of CO_2 emissions from road transport (European Commission 2007). It therefore identified the need to rethink urban mobility to optimise the use of all modes of transport and to manage transport demand.

Background

The need to reduce the amount of energy that we consume and to change the way that we use it is becoming increasingly acknowledged. The increasing prominence of the need for improved energy efficiency has been linked largely to the United Nations Framework Convention on Climate Change (UNFCCC) process. The UNFCCC is working to keep average global temperature increases below 2^{o}C on pre-industrial levels (and preferably below 1.5^{o}C). This target is based on scientific assessments compiled by the Intergovernmental Panel on Climate Change (IPCC) and it has become an internationally recognised goal that can be said to have guided, and continue to guide, scientific and political discussions regarding climate change and the need for enhanced energy efficiency.

Meeting the 'two degree target' poses a considerable challenge that cannot be addressed by any actor or sector in isolation. The current global average temperature is already between 0.7 to 0.8^{o}C above pre-industrial levels, and

owing to the time lag between emissions entering the atmosphere and having an impact upon temperatures it is said that based on historic emissions alone temperatures are expected to increase by approximately 1.2°C above pre-industrial levels by the end of the 21st Century. The IPCC research that introduced the two degree target details the consequences of failing to meet this target. Negative impacts will be social, economic and environmental and range from water availability (drought and flooding) to ecosystem weakening (including the risk of extinction of numerous species), and the changed distribution of factors such as health vectors and food availability (IPCC 2007).

It is apparent that considerable reductions in emissions will be required from all sectors to meet the two degree target, but it has been explicitly recognised that it cannot be met without climate change mitigation from the transport sector (European Environment Agency 2010a). The transport sector is estimated to be responsible for approximately 60% of all oil consumption in OECD countries and it represents a large and rapidly growing source of energy use in non-OECD countries with projections showing a growth of energy use (based largely on fossil fuels) of 2.6 percent per year from 2007 to 2035 (International Energy Agency 2010).

Policy instruments exist to address increasing emissions in the transport sector through technological solutions with, for example, new passenger cars in the EU being required (although non-bindingly) to meet an average CO_2 emission limit of 95 grammes per kilometre by 2020. Demand for travel is, however, projected to increase at the same rate that associated emissions are predicted to fall through technological measures (EEA 2010a), thus negating those potential savings. There is therefore the need to change behaviours if emission reduction targets are to be met. Any failure to do so will risk a continuation of the current trend in the transport sector, whereby energy efficiency improvements are offset by growth in demand for travel. Indeed two of the six factors that the EEA has identified as being responsible for increasing total sector-wide emissions are: increasing demand for passenger and freight travel; and increasing share of private motorised vehicle transport compared with other transport modes (EEA, 2010b).

Carbon Aware Travel CHoice (CATCH)

If behavioural change is to reduce the demand for passenger transport and also the carbon intensity of modal choice, then there is the need for appropriate and trusted information to be made easily accessible and presented in a format that is directly tailored to the purpose of reducing the energy intensity of travel. This is the aim of the CATCH project, which seeks to provide information to policy makers but also to individuals and other mobility stakeholders about the impact of travel behaviours and ways that negative impacts can be reduced. The project is creating an online resource that will help these groups of stakeholders to make sense of the number of ways that cities can respond to climate change mitigation in the transport sector and the different impacts of these available options. A wide range of approaches and initiatives exist, many supported by the EC, and, in commissioning the project, the EC identified a need to create a trusted and easily accessible resource that can provide support to practitioners and policy makers, but also individuals and other mobility stakeholders to help them to determine appropriate actions for addressing the increasingly negative environmental impact of urban transport. Another related aim of the project is to provide additional information to these three distinct audiences by increasing awareness of why travel behaviours need to change, and also of the impact of making these changes. The resource will primarily be a climate change mitigation tool, acting itself as a form of information policy support, but in line with the findings of grounding research conducted by the project, it seeks also to inform about wider benefits of adopting more energy efficient travel behaviours relating to factors such as health, budget, time, safety and urban environments.

The next sections report on the main findings from the grounding work that the CATCH project has undertaken to improve knowledge about how individuals can be motivated to change their behaviours through information provision (Avineri and Waygood, 2010; Waygood and Avineri, 2010a). This recognises the role of behavioural change in reducing emissions from the urban transport sector, and the fact that the project is developing an online tool which provides information. The project focuses on the European level, but its findings are relevant to efforts to enhance energy efficiency on an international level in both developed and developing countries.

Human behaviour and transport and climate change

The threat of climate change is not tangible and so it is difficult for individuals to both understand the threat related to climate change and to take appropriate action. The 'stages of change' behavioural model, developed in the public health field (Prochaska and Norcross 2001), and applied to transport in Tyler and Cook (2004) and MAX-SUCCESS (2009), asserts that if individuals are to be motivated to adopt more energy-efficient travel behaviours then they need to be concerned about climate change. This means that awareness of the problem (climate change) needs to be created if the transport choices of individuals are to reflect low carbon options. There are, however, numerous barriers that have been recognised to connecting the behaviour of individuals with climate change. These include: lack of awareness of the problem; uncertainty about the facts; uncertainty of how to act; lack of belief that the problem affects them; behavioural inertia; belief that others should change; belief that one's own actions are

inconsequential; societal acceptance of action; experience / lack of experience with certain modes; habit; perceived risks from change; and inappropriate action such as doing one "environmental" action but not changing CO_2 outputs (Avineri and Waygood, 2010). Although there are a lot of barriers, information provision – its type and the way that it is presented – can help to overcome some of these barriers that create resistance to behavioural change.

The role of information provision

It is often assumed that people will change their behaviour when provided with full information – for example in economic theory, the utility maximising fully rational individual is often assumed – but this view of the world does not take account of psychological and cognitive factors which affect how a person will behave when faced with information. With respect to transport, other factors such as socio-demographic attributes and cognitive factors (Lyons et al. 2007) or personal experience (Farag and Lyons 2008; Avineri and Prashker 2006; Chorus et al. 2006) will affect how the information is interpreted.

Information is essentially a 'service' provided to citizens and can lead to behaviour change. To increase the effectiveness of information presented in tools such as carbon calculators (or the CATCH platform), attention should be paid not just to *what* (content) information is presented, but also *how* (e.g. context, framing, etc). For traditional transport considerations such as time and cost, context is provided through time and financial budgets respectively. However, for CO_2 emissions information (the content), most people do not have contextual information available to allow for interpretation. Thus, context and not just content is an important consideration when presenting information.

Providing people with personalised advice in the form of rational information on behavioural changes that they could make is a valued tool (Coulter et al, 2007). However, techniques relating to the presentation of information exist that could increase the likelihood of such changes occurring. These techniques are often referred to as forms of 'choice architecture,' which has emerged through the field of behavioural economics. Behavioural economics focuses more on how people actually act, as opposed to how they rationally should (Thaler and Sunstein, 2008). Researching choice architecture can indicate how information can help or 'nudge' people towards more energy efficient and sustainable travel behaviours. Nudges can help individuals to overcome biases they may have, and can be used to highlight certain choices for them, increasing the effect of behavioural change.

Key principles for communicating low carbon messages in transport

Information provision can be used to overcome barriers to behavioural change. This is because, apart from forced behavioural change (legislation or unavailability of alternatives), change can come about through beliefs and attitudes (Ajzen 1991), and information provision can play a role in changing these. Below are some concepts which can be used to incite behavioural change through information provision (Avineri and Waygood 2010). These methods relate to providing information particularly via online tools, such as the carbon calculators, trip planners and the CATCH platform.

Methods which can help to 'nudge' people to a particular behaviour can be used in communicating messages about low carbon or energy efficiency in transport. Based on these methods, messages were formulated relating to carbon reduction in transport, and discussed through a mixture of surveys, focus groups and interviews. Following this work, some key principles based largely on work conducted in other fields have been established in how to communicate energy efficiency messages in the land transport sector (Waygood and Avineri 2010a, Waygood and Avineri 2011b). These are summarised below along with an outline of how the principles are being applied in the design of the CATCH platform with specific reference to their relevance to the project's two target groups: the general public and 'informed users' (professionals working in the fields of transport and climate change).

Tie transport changes to co-benefit areas (quality of life factors)

Not everyone is motivated by environmental concerns to make the transport behaviour changes necessary to manage emissions from the sector. Where possible, other motivations to change should be highlighted. As far as possible, those motivations should relate to individual interests. Individuals become more concerned about their impact on climate change when changes in transport are linked with other benefits which represent quality of life factors that matter more immediately to them. For example, to promote low-carbon modes such as walking or cycling, the health benefits can be mentioned, with a link to the related energy-efficiency message (Waygood and Avineri 2010a).

In recognition of the need to link climate change mitigation with wider benefits the CATCH platform will incorporate six 'co-benefit' areas in its design. These are wider impacts on: health, planning, safety, time,

community and cost. In relation to individuals accessing the platform this will highlight links with impacts that could be more likely to motivate change, showing how they relate to individual mobility choices. In terms of practitioners the information provided on these co-benefit areas can be used in their communications with the general public, other policy makers, and also other departments. The health benefits of increasing modal share of low carbon modes of transport, such as walking and cycling, could, for example, be highlighted to health departments with the aim of generating synergies in policies and measures. To support the communication of these co-benefits indicators that can be used to illustrate the impact of travel behaviours data to represent each co-benefit will be collected and displayed in the CATCH platform.

Present CO_2 information as a loss

Prospect theory (Kahneman and Tversky 1979) observes that people prefer avoiding losses to acquiring gains. To help overcome some of the barriers to behavioural change, this knowledge on prospect theory can be used to help frame appropriate messages. An example of how this can be used to increase the likelihood of behavioural change in terms of transport is given in figure 1 below, where different ways of presenting commuting choices are given. Such gain/loss framing was shown to impact the understanding of CO_2 information in relation to transport (Waygood and Avineri 2011). For example, rather than say what the positive impact of changing a behaviour would be (e.g. you'll reduce your CO_2 impact by 15% if you do X action), the negative impact of not doing that action should be highlighted (e.g. you'll produce 15% more CO_2 by not doing action X). The information is the same, but people were found to notice the difference more often in the loss framing (Waygood and Avineri 2011).

i. *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).

ii. *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).

iii. *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).

iv. *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).

Figure 1 An example of gain / loss framing (adapted from Waygood and Avineri, 2011a).

This principle has been incorporated in the CATCH platform where messages presented to the general public will be framed in order to 'nudge' visitors to low carbon mobility behaviours. The way that the messages are presented could also be adopted by practitioners to help them to communicate with citizens and policy makers.

Social norms can encourage change

People have been found to reduce energy consumption when given information on others' behaviours (Schultz et al. 2007; Nolan et al, 2008). For example, when customers were given information about the energy consumption of other users, although those above the average consumption were seen to reduce their consumption, those below increased theirs (Schultz et al. 2007). Rather than follow the 'rational' choice of keeping energy consumption (and costs) down, this tendency to the average means that other means of presenting information should be used. One example is, rather than the presentation of average figures, the inclusion of a 'smiley' face for customers performing well, and a 'sad' face for those performing poorly. According to the rational choice approach, it is not "logical" that people saving money by having lower energy use would increase their use when they see that others spend more, but it happened. It is not "logical" that a smiley face would then prevent such change, but it was found to be effective (Schultz et al. 2007).

Relevant comparisons should be used as far as possible, relating to demographics such as income, life stage (e.g. single, married, or retired), and location (e.g. ward, city, region, or national). The more refined these comparisons, the more relevant they become. Testimonials from individuals on the need for energy efficiency in transport will also help to create links between individuals and their social groups and networks. This also has the potential to motivate change, and the ability of individuals to share testimonials on the CATCH platform will also be explored along with options for incorporating, and making links with, existing social networks (e.g. Facebook, LinkedIn). In a similar vein the CATCH platform will support transport professionals to identify cities that have similar characteristics to themselves, but that are performing better with respect to CO_2 emissions per capita. The CATCH platform aims to collate information on cities so that a practitioner could investigate why another city is performing better. It is hoped that this will motivate change and enhance awareness of the type of policies and measures that could facilitate change.

Carbon dioxide emissions should include contextual information

Waygood and Avineri (2011b) found that people had more trouble giving a sustainability ranking to just the weight of CO_2 emissions than to a tree (see figure 2), earth, or carbon budget (related to the concept of cap-and-trade) equivalents. However, in a separate report (Waygood and Avineri 2010a) they report that people who participated in focus groups discussing those formats had different impressions of the earth format in particular. Although some individuals felt that it was useful in highlighting the problem of climate change, numerous others voiced opinions that seeing more than one earth was "unbelievable", "overwhelming", and "makes me feel like giving up". Although the earth format may be considered to give a sustainability context to CO_2 weight information, it may overwhelm some individuals creating a defeatist attitude.

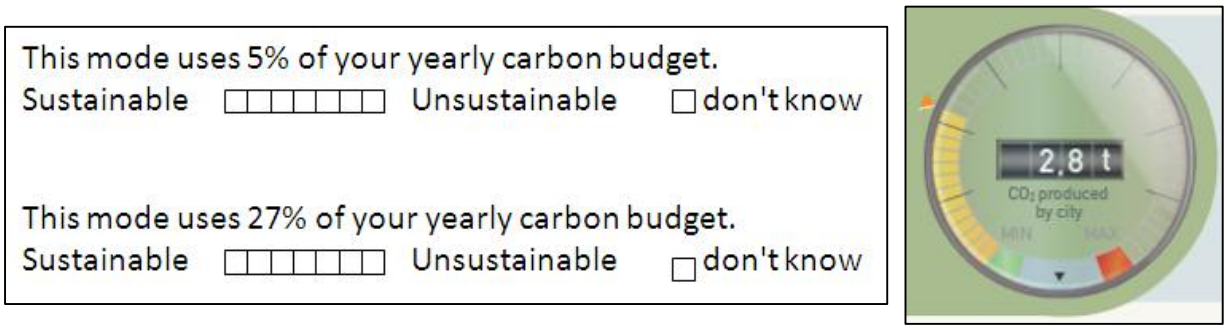

Figure 2 Examples of contextualising CO_2 information from CATCH. Experimental question from Waygood and Avineri (2011b). Concept developed by Systematica from recommendations in Waygood and Avineri (2010b).

Representing carbon information as equivalents, such as proportion of a carbon budget, increased the ability to give a sustainability ranking (Figure 2). Equivalents are therefore being incorporated in the CATCH platform, with carbon budgets always being presented in this way. Several different alternatives have, and are continuing to be, tested for their effectiveness in this respect.

Conclusions

Behavioural change in transport is required if carbon reduction emission targets are to be met. Behavioural change can be encouraged by framing messages in a particular way. Carefully thought out information provision can 'nudge' individuals into making small steps on the path towards full behavioural change. A review of some of the concepts that can be used to 'nudge' individuals in terms of information provision have been introduced in this paper, along with examples of how they can be used with regard to the specific case of messages for energy efficiency in transport. These concepts are being used in the development of an online tool for behavioural change in transport, the CATCH platform, which will include tools to help individuals and practitioners to reduce their carbon emissions from the urban transport sector.

Acknowledgements

This work was supported by the European Commission, DG RTD, grant number 234094.

References

Abrahamse, W., Steg, L., Vlek, C. and Rothengatter, T. (2005) A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology* [online]. 25(3), 273-291. Available from: http://www.sciencedirect.com/science/article/B6WJ8-4HJ482W-2/2/6e5870081ce8572015fae70203a31988.

Ajzen, I. (1991) The theory of planned behavior. *Organizational behavior and human decision processes* [online]. 50(2), 179-211. Available from: http://www.sciencedirect.com/science/article/B6WP2-4CYG336-DJ/2/9acb128fd8ccf9877db6da912e884f25.

Avineri, E. and Prashker, J. (2006) The Impact of Travel Time Information on Travelers' Learning under Uncertainty. *Transportation* [online]. 33(4), 393-408. Available: http://dx.doi.org/10.1007/s11116-005-5710-y.

Avineri, E. and Waygood, E.O.D. (2010) *Behavioural Inception Report.* [online]. Carbon Aware Travel Choices (CATCH). (D1.1). Available from: http://www.carbonaware.eu/fileadmin/user_upload/Deliverables/CATCH_DEL_DOC_D1.1_20Behavioural_20Inception_20Report_orginal_V1.pdf. [Accessed 22 July 2010].

Chorus, C.G., Molin, E.J. and Wee, B.v. (2006) Travel information as an instrument to change cardrivers' travel choices: a literature review. *European Journal of Transport and Infrastructure Research* [online]. 6(4), 335-364. Available from: http://www.sortclearinghouse.info/cgi/viewcontent.cgi?article=1376&context=research. [Accessed 22 July 2010].

Coulter, A., Clegg, S., Lyons, G., Chatterton, T. and Musselwhite, C.B.A. (2007) *Exploring public attitudes to personal carbon dioxide emission information.* London: Department for Transport.

Darby, S. (2006) *The Effectiveness of Feedback on Energy Consumption: A review for DEFRA on the literature on metering, billing and direct displays.*

European Commission (2007) Green Paper. Towards a new culture for urban mobility. Available from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0551:FIN:EN:PDF.

European Environment Agency (EEA) (2010a) Climate change "mitigation impossible" without transport. Available from http://www.eea.europa.eu/articles/climate-change-mitigation-impossible-without-transport.

European Environment Agency (EEA) (2010b) The European environment – state and outlook 2010: synthesis. Available from http://www.eea.europa.eu/soer/synthesis/synthesis.

Farag, S. and Lyons, G. (2008) Explaining public transport information use when a car is available: attitude theory empirically investigated. Transportation Research Record: Journal of the Transportation Research Board 206985-92.

Frey, B.S. (1997) A Constitution for Knaves Crowds out Civic Virtues. *The Economic Journal* 107(443), 1043-1053.

Heyman, J. and Ariely, D. (2004) Effort for Payment: A Tale of Two Markets. *Psychological Science* [online]. 15(11), 787--793. Available from: http://www.jstor.org/pss/40064046. [Accessed 22 July 2010].

International Energy Agency (IEA) (2010) Transport. Available from http://www.iea.org/subjectqueries/keyresult.asp?KEYWORD_ID=4121.

Kahneman, D. and Tversky, A. (1979) Prospect Theory: An Analysis of Decision under Risk. *Econometrica* 47(2), 263-291.

Lyons, G., Avineri, E., Farag, S. and Harman, S. (2007) *Strategic Review of Travel Information Brief.* [online]. Available from: http://www.transport.uwe.ac.uk/research/projects/srti%20-%20final%20report.pdf. [Accessed 25 Sept., 2009].

Madrian, B.C. and Shea, D.F. (2001) The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior*. *Quarterly Journal of Economics* [online]. 116(4), 1149-1187. Available from: http://dx.doi.org/10.1162/003355301753265543.

McKenzie-Mohr, D. (2006) *Fostering Sustainable Behavior: Community Based Social Marketing.* [Online]. Available from: http://www.cbsm.com/public/images/FosteringSustainableBehavior.pdf. [Accessed 4 August, 2010].

Nolan, J.M., Schultz, P.W., Cialdini, R.B., Goldstein, N.J. and Griskevicius, V. (2008) Normative Social Influence is Underdetected. *Personality and Social Psychology Bulletin* 34(7), 913-923.

Schultz, P.W., Nolan, J.M., Cialdini, R.B., Goldstein, N.J. and Griskevicius, V. (2007) The Constructive, Destructive, and Reconstructive Power of Social Norms. *Psychological Science* 18(5), 429-434.

Swim, J., Clayton, S., Doherty, T., Gifford, R., Howard, G., Reser, J., Stern, P. and Weber, E. (2009) *Psychology and Global Climate Change: Addressing a multi-faceted phenomenon and set of challenges.* [online]. American Psychological Association. Available from: http://www.apa.org/science/about/publications/climate-change.aspx. [Accessed 1 October, 2010].

Thaler, R.H. and Sunstein, C.R. (2008) *Nudge: Improving Decisions about Health, Wealth and Happiness.* New Haven, CT: Yale University Press.

Thaler, R. and Benartzi, S. (2004) Save More Tomorrow™: Using Behavioral Economics to Increase Employee Saving. *The Journal of Political Economy* [online]. 112(S1, Papers in Honor of Sherwin Rosen: A Supplement to Volume 112), pp. S164-S187. Available from: http://www.jstor.org/stable/10.1086/380085.

Waygood, E.O.D. and Avineri, E. (2011a) The Effect of Loss Framing on the Perceived Difference of CO2 Amounts: Implications for Advanced Travel Information Systems (ATIS). [Online]. *In:* Anon. *Milton Keynes, UK Jan. 5-7.*

Waygood, E.O.D. and Avineri, E. (2011b) Does "500g of CO2 for a five mile trip" mean anything? Towards more effective presentation of CO2 information. *Transport Research Board Annual Meeting*. Washington DC. Jan 24 2011.

Waygood, E.O.D. and Avineri, E. (2010a) *Research and Design Report.* [online]. Available from: http://www.carbonaware.eu/fileadmin/user_upload/Deliverables/D1.2_Research_and_design_report.pdf. [Accessed 13 Jan., 2011].

Waygood, E.O.D. and Avineri, E. (2010b) Visual Formats, Reference Points, and Anchoring Effects on Perceptions of the Sustainability of Travel Choices. *In:* Anon. *The 1st Workshop on Traffic Behavior, Modeling and Optimization (TBMO10), Madeira Sept. 19-22.*