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Engaging with energy reduction: Does a climate change frame have the potential for achieving broader sustainable behaviour?

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ABSTRACT

Reducing energy use is key in meeting ambitious climate change targets being set around the world. This research considers the psychological impact, and potential for behavioural spillover, resulting from receiving energy information framed in terms of financial costs or the environment. We utilised an online tool in order to present undergraduate participants with an energy display simulation of their own energy use and presented energy use in terms of kilowatt-hours, carbon dioxide (CO_2), or costs. Study 1 found increased motivations to save energy for climate change reasons and some indications that environmental behaviour might increase after participants received CO_2 information compared to alternatives. Study 2 found that CO_2 information increased climate change salience, which mediated effects observed on environmental behaviour intentions. Data suggest that highlighting climate change in relation to energy savings may be useful for promoting broader environmental behaviour.

1. Introduction

Given ambitious carbon dioxide (CO_2) reduction targets in the UK and many other countries, reducing energy demand is imperative. Extensive efforts are being undertaken to engage public(s) with reducing their personal energy use. For example in the UK the government is rolling out smart meters, along with energy displays, to all households by 2020, in part to help people reduce their energy usage (DECC, 2013).

This research aims to get at one important aspect of engaging people with energy – whether to communicate and frame energy reductions in terms of cost or CO_2 savings. Whilst costs are one of the clearest concepts that people understand in terms of energy use (Ofgem, 2011b) they can also be misleading or discouraging. Cost savings as a result of individual behaviours changed are often low and rises in energy prices can mask savings made (Bittle, Balesano, & Thaler, 1979–1980; Brandon & Lewis, 1999). In addition, environmental framings may have wider effects than cost framings. Framing energy reduction in environmental terms may prime particular social values (Schwartz, 1992), or reduce the psychological distance that people have with climate change (Spence, Poortinga, & Pidgeon, 2011a), both of which are associated with undertaking broader sustainable behaviour (Evans et al., 2013; Spence et al., 2011a). There is therefore the potential that engaging people with energy reduction in terms of CO_2 and climate change may result in an increase of environmental behaviours more broadly, termed behavioural spillover (Thøgersen, 1999). This research outlines two studies that investigate the impact of engaging with energy in terms of costs or CO_2 on relevant perceptions and behavioural intentions.

1.1. Behavioural spillover

Behavioural spillover in this context is the idea that encouraging an individual to change one particular behaviour for environmental reasons may result in that individual adopting additional environmental behaviours (Thøgersen, 1999). Notably, a recent study revealed that a communication campaign encouraging people to car share for environmental reasons had spillover effects on recycling rates. A similar message encouraging the same behaviour for financial reasons did not increase recycling rates (Evans et al., 2013). Understandably, there is a great deal of interest in the potential for behavioural spillover given that related interventions could be particularly cost effective and impactful. However supporting evidence is limited and the conditions that need to be in place for

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spillover to occur are not well established so far (Thøgersen, 1999; Thøgersen & Olander, 2003). A range of mechanisms have been proposed to explain behavioural spillover. For example, an initial behaviour may increase the salience of related mental constructs or social values relating to other behaviours, or it may increase learning and understanding about that behaviour. These processes would then facilitate further related behaviours (Thøgersen, 1999). Behavioural spillover effects remain poorly understood and are difficult to quantify, they are therefore often not considered or forgotten. However they may be an important aspect of new initiatives, such as the smart meter rollout, and should be considered when developing policy and public engagement campaigns.

1.2. Perceptions of smart meters and in home energy displays

Currently people in Britain are relatively uninformed about smart meters. Around half of the population say that they have heard of them and, of these, 75% said they knew nothing or only a little about them (DECC, 2012a). Smart meters are commonly defined as a new type of electricity meter that will allow two way communications with electricity suppliers, meaning accurate up to date information on electricity use and no need for metre readers or estimated billing (EMSIG, 2012). There is some confusion over what 'smart meter' refers to however and the term is often erroneously used to describe the, oft accompanying but independently available, in-home display (IHD). It is clear that the smart meter rollout will require extensive public engagement and accompanying communications introducing people to smart meters and displays, and on how to use these. Given that one in five people currently say that they are opposed to their introduction and a similar number could not think of any benefits of their installation (DECC, 2012a), the way that communications are framed will be crucial in determining public acceptance.

Previous research has indicated that deployment of IHDs that often accompany smart meters can help consumers to conserve energy. However reductions have been highly variable, some studies finding no changes and some very large changes (CER, 2011; Darby, 2006; Giordano et al., 2013; Ofgem, 2011b). Unfortunately most research in this field has not systematically varied the type of smart meter intervention trialled, has often confounded the introduction of smart meters with additional technologies or measures, e.g. time of use tariffs, (CSE, 2010; Ofgem, 2011b) and has neglected psychological determinants of changes observed (Abrahamse, Steg, Vlek, & Rothengatter, 2005). This makes it difficult to attribute changes to specific aspects of interventions and makes successful interventions difficult to replicate; however some general conclusions have emerged from the literature.

Many people who own an IHD do not use their devices. Indeed DECC's (2012a) recent survey on this topic indicated that a significant number of people said they had never looked at (22%) or installed (22%) their IHD. Importantly those people who do use an IHD, indicate that they feel more control over energy bills and that they are able to use information provided to reduce bills (CER, 2011; DECC, 2012a, 2012b). Similarly web based services, which provide further information such as historic feedback and generic advice, are seldom looked at. However when these are used, additional reductions in consumption have been observed (Ofgem, 2011b). Causality is difficult to determine here and is likely to be bi-directional: those who are already more engaged with their energy use may be more likely to seek further information.

The most effective energy information in terms of engagement and reduction highlights links between specific actions and effects so that people better understand where energy is being consumed (Abrahamse et al., 2005; Fischer, 2008). There is also a particular interest in advice on energy reduction; thought to make information received more useful (Ofgem, 2011b). However, whilst detailed information about appliance specific energy usage and historical data are appealing, there is also a clear desire for information to be presented in a clear and meaningful manner (Roberts & Baker, 2003). People tend to prefer IHDs that they can interact with and tailor how data is represented (Fischer, 2008) and simplistic representations of overall energy use are often popular (Ofgem, 2011b).

In the UK, all domestic consumers will be offered an IHD that will display data relating to energy consumption and price (DECC, 2012c). Currently, standards do not require these to display energy data in terms of CO_2 emissions, or have any information about environmental impacts. However data can be made available to further consumer access devices (CADs), e.g. an enhanced IHD or a smart appliance, which could display information in these terms. The government consulted stakeholders on whether to include CO_2 emissions as part of the minimum requirements for IHD standards and given mixed views and evidence that a significant proportion of consumers were not initially interested in this information (Ofgem, 2011b), it was omitted from requirements (Anderson & White, 2009; Ofgem, 2011a). There is currently no evidence on whether including CO_2 emissions within IHDs is a useful way of engaging consumers and encouraging sustainable behaviour. Indeed it is difficult to know how much people understand the idea of CO_2 and whether this will lead to a spontaneous link to climate change and environmental issues. It is also notable that a significant minority of people do not believe there is a link between CO_2 and climate change (e.g. Poortinga, Spence, Whitmarsh, Capstick, & Pidgeon, 2011); highlighting CO_2 to this group of people is likely to be ineffective in promoting behaviour change.

1.3. Financial motivations to save energy

When people think about energy issues, costs tend to come to mind first (Eurobarometer, 2007) and people tend to prioritise affordable energy prices over other socio-economic considerations, e.g. climate change (Demski, Spence, & Pidgeon, 2013). Additionally, cost has been identified as the most used and valued type of information provided within IHDs whereas information about CO_2 emissions was not widely noticed or perceived useful (Ofgem, 2011b). As cost is something we think about routinely, this unit of consumption should indeed be meaningful for consumers. Kilowatt hours and CO_2 are not generally understandable by, or familiar to people and therefore not as useful in helping gauge the impact of behaviour.

Empirical investigations of the effectiveness of engaging people with energy reductions have found little effect of financial motives however (Abrahamse et al., 2005; Fischer, 2008; Hutton, Mauser, Filiatrault, & Ahtola, 1986). It is possible that energy cost savings from individual actions are so low that consumers could be discouraged from taking action. This may even result in unanticipated effects, where people consider cost savings from energy reductions so small that they are justified in using more (Bittle et al., 1979–1980; Brandon & Lewis, 1999). Conversely though, some recent qualitative research highlights instances where people have noticed cost savings as a result of engaging with an IHD and that they are subsequently motivated to keep reducing energy use (DECC, 2012b). Note however this data is self-reported rather than objective and based on only a small sample. Specific additional financial incentives for energy reductions are found to be effective but indications are that these need to be high, and effects only last while the incentive is in place (Abrahamse et al., 2005; Ofgem, 2011b).

It is notable that as energy prices increase, cost savings resulting from energy conservation or efficiency measures may be masked. For this reason, referring to kilowatt hours or CO_2 may have some benefits in that these allow the effects of measures taken to be

observed more accurately over time. We also highlight that some people doubt that monetary savings are possible because they feel that energy companies would maintain a profit margin no matter how much energy usage was decreased (Butler, Parkhill, & Pidgeon, 2013; DECC, 2012b).

1.4. Environmental motivations to save energy

It is difficult to ascertain the effectiveness of appealing to environmental motives for energy saving given that research on this issue has often not been rigorous or systematic. Most has either been small scale and inconclusive (Bittle et al., 1979–1980; Brandon & Lewis, 1999) or has not compared environmental communications to any other alternative (Jensen, 2003). Nonetheless, meeting environmental standards have been highlighted as a basic social value that must be met for a future acceptable energy system in the UK (Parkhill, Demski, Butler, Spence, & Pidgeon, 2013). Energy policies in the UK are also broadly framed in terms of environmental as well as financial considerations (e.g. DECC, 2011) and a variety of energy visualisation use environmental frames, e.g. CarbonVisuals, ecoMeter.

Framing energy reduction in terms of CO_2 may simply be more likely to make environmental considerations salient. Merely priming a concept or idea can lead to the activation of that idea and related ideas and to subsequent changes in behaviour (Bargh & Chartrand, 1999; Harris, Bargh, & Brownell, 2009; Maio, Pakizeh, Cheung, & Rees, 2009). In this way, encouraging an individual to consider energy reductions in terms of CO_2 emissions may lead to thoughts about sustainability more generally and further related behaviours (though this should not be assumed). In a similar way, exposure to food advertising increases thoughts about food and the amount of snack food that people consume (Harris et al., 2009).

Additionally, the increased visibility of energy that feedback from an IHD provides may help to make the potential contribution that people can have towards climate change more tangible and less 'psychologically distant'. The idea of psychological distance stems from construal level theory, which proposes that any event or object is represented at different levels of construal (Liberman & Trope, 2008). Lower levels of construal are more concrete and contextualised and associated with reduced levels of psychological distance whilst higher levels are abstract and decontextualized and associated with an increased level of psychological distance. Research on public perceptions indicates that people tend to think of climate change impacts as happening to geographically distant locations, primarily affecting other people, and as uncertain in nature, with the worst impacts happening sometime in the future (Spence et al., 2011a). Importantly, research has also demonstrated that when people think about climate change as less (psychologically) distant, they feel more concerned about it and are more prepared to act on it (Spence et al., 2011a, Spence, Poortinga, Butler, & Pidgeon, 2011b). In particular, framing energy reduction data in terms of CO_2 emissions may act to link this usage and control to climate change, increasing the salience of climate change. By presenting people with contextualised, concrete data relating to climate change, this may help people consider climate change at a lower level of construal and reduce the psychological distance that people have with climate change. We acknowledge however that CO_2 itself is also an unfamiliar, possibly abstract, concept to most people and therefore relating energy use to CO_2 could also result in the impacts of energy saving becoming less relevant and clear.

1.5. Social values

Interestingly, previous research has demonstrated that financial and environmental motivations are linked to different social values (Schwartz, 1992). Empirical research has identified key social values that exist across cultures and finds that different social values are predictive of behaviour (Schwartz, 1996; Smith, Peterson, & Schwartz, 2002). In particular, values known as self-transcendence values (e.g. universalism, benevolence) are linked with sustainable behaviour whilst values known as self-enhancement values (e.g. ambition, success) are linked with perceptions of the importance of wealth. Social values are assumed to be relatively stable individual characteristics that may only change with significant life events or over relatively long periods of time (Bardi, Lee, Hofmann-Towfigh, & Soutar, 2009). However much previous research has found that experiences or messages, e.g. adverts, can prime specific values, making these temporarily salient and resulting in these having a greater influence on subsequent choices and behaviour (Evans et al., 2013; Maio et al., 2009; Verplanken & Holland, 2002). Repeated experiences or messages that make specific values salient may provoke longer-term changes. Importantly, self-enhancement values (related to financial motivations) and self-transcendence values (related to environmental motivations) directly oppose one other, implying that priming one set of values could decrease the influence of the other (Kasser, Cohn, Kanner, & Ryan, 2007; Maio et al., 2009; Schwartz, 1992). For example, Vohs, Mead, and Goode (2006) found that priming participants with money (e.g. through exposure to images of money) led to reduced helpfulness towards others. In addition, Bolderdijk, Steg, Geller, Lehman, and Postmes (2013) demonstrated that economic appeals resulted in lower subsequent sustainable behavioural compliance than an environmental appeal and that people tended to feel better about environmental appeals. These ideas have received a great deal of attention recently, with campaigners and researchers suggesting that framing sustainable behaviour in terms of financial savings may contradict the wider benefits of such messages by reinforcing a set of social values (self-enhancement values) that are in general opposed to pro-environmental behaviour (Corner & Randall, 2011; Thøgersen & Crompton, 2009). Conversely, communications promoting a particular behaviour in terms of environmental reasons may reinforce social values (self-transcendence values) that relate to environmental behaviour. Indeed self-transcendence values have been linked directly to pro-environmental values and behaviour (Schultz & Zelezny, 1999, 2003). So the activation of these values by a particular campaign could serve to go beyond the specific behaviour targeted by the campaign and influence environmental behaviour more broadly, resulting in what is known as 'behavioural spillover' (Thøgersen, 1999).

2. Current research

The current research aims to examine the psychological impact of engaging with energy reductions when communicated in terms of cost or CO_2 and the relative impact on behavioural intentions. Whereas previous research has primarily examined direct impacts on energy use, here we have a specific focus on sustainable behaviour intentions beyond immediate energy reductions. We also consider the psychological mechanisms by which behavioural spillover may occur so as to understand why behaviour change might occur and how best to develop sustainable communications in the future. This research has direct relevance to the smart meter rollout and associated communications but also has implications for wider energy policy developments and engagement efforts.

We present two studies investigating the impact of framing energy use in terms of energy (kWh), cost (sterling pounds £), or CO_2 on perceptions of energy and the environment, and sustainable behaviour. We expect that presenting energy in terms of CO_2 will be more likely to increase environmental behaviour intentions than

presenting it in terms of cost or energy, because people will link information about CO_2 to climate change. Furthermore, in each study we focus on different mechanisms, which could explain this. In study 1, we look at the impact of framing energy in terms of energy (kWh), cost (£), or CO_2 on social values. In study 2, we build on the findings of study 1, exploring effects on the psychological distance of climate change, interest in energy saving, and perceived salience of cost and climate change as potential psychological impacts of engaging with energy reduction in terms of different energy frames (kWh, £ or CO_2). Here, we also consider impacts of framing on a further measure of environmental behaviour intentions and directly on energy reduction intentions using a self-report checklist of likely future behaviour.

3. Study 1

3.1. Method

Participants were recruited through an email circulated to undergraduate students at a UK University that offered entry to a prize draw to win £100 shopping vouchers as an incentive to take part. Respondents completed a pretest questionnaire that measured baseline social values (Schwartz, 1992) and then were subsequently emailed a link to the study. The study comprised three tasks, ostensibly unrelated and presented as separate studies from different researchers, grouped only for convenience. Participants were randomly allocated to one of three versions of an online energy calculator (Home Energy Calculator – HEC), which presented energy in terms of kilowatt hours/kWh (energy), carbon/CO_2 (climate change) or sterling pounds/£ (cost). They subsequently completed a questionnaire measuring social values (Schwartz, 1992), personal goals (Grouzet, 2005), and a budget allocation task designed to measure environmental behaviour.

Finally, participants received a full funnel debriefing. This type of debriefing asks participants a series of questions gradually increasing in level of specificity in order to probe participants' understanding of the aims of the research. Only 1 participant correctly identified that studies presented were related at a first stage and only 5 at a later stage; key analyses were conducted with and without these 5 people and this did not significantly affect results so they were included in the final sample. The full nature of the study was then explained, including the fact that tasks were related.

3.2. Participants

The study was advertised to all students in 6 different academic schools (Computer Science, Biology, Chemistry, Physics & Astronomy, Pharmacy and Politics) at the University of Nottingham, UK. A total of 367 participants entered the pre-test phase with 330 people completing this (37 dropouts at this phase). A follow-up email was sent between 24 and 48 h later to all participants who completed the pre-test and one reminder email was sent approximately a week later. Of participants contacted, 175 responded and completed the HEC task; 128 completed all subsequent tasks (note a high dropout rate is common during web experiments given that participants can be interrupted and it is easy to quit the task: Reips, 2000). Of 175 respondents who completed at least part of both sections of the study (pre-test and main section), a final total of 170 were matched between study sections and kept for the final analysis (5 participants could not be matched due to use of different email address identifiers). Within the final sample, participants consisted of 69 women and 84 men, with a median age of 20 and a range from 17 to 36. Energy, cost and CO_2 HEC conditions comprised 64, 50, and 56 participants respectively.

3.3. Materials

3.3.1. The home energy calculator (HEC)

The HEC[1] simulated the interaction that people may have with an IHD in the home. The HEC is a web tool that asks participants to think about their energy usage yesterday (or if yesterday was an unusual day, then their usage the day before) and to record what appliances they used and for how long. For example, if they watched television for 3 h, they would click on the television icon, and select a 3-h period of time. During the task, the usage was displayed so the participant could see and compare the energy usage of appliances. We created three different versions of the HEC displaying energy usage in different units (kWh, CO_2, or £). Within each version all text, including an introduction to the task and the heading of the page, described energy in terms of that unit, and the display and numbers presented were all in the units relevant to that condition.

After recording energy use in the HEC, participants clicked the SUBMIT button and were given a summary of their day's usage. They were then asked to revisit the HEC and consider how they could reduce their energy usage by 5% by adjusting their actions during that day. Feedback was then given highlighting the amount they could save (in kWh, CO_2 or £) by implementing these changes. For our study they were also asked to describe (free text) why reducing this amount of energy (in appropriate units: kWh, £ or CO_2) was important to them and given an opportunity to provide feedback on the tool itself (free text). Finally, participants were given a little more information about the HEC.

3.3.2. Social values

Social values were assessed by a questionnaire encompassing a 45-item scale assessing social values (Schwartz, 1992) and 19 items taken from the Aspiration Index that measures personal goals (Grouzet, 2005). Items assessing goals are unrelated to current research questions and not analysed further here. Question wording for social values replicated that of the original questionnaire and asked participants to rate the importance of presented values as a life-guiding principle for themselves. Ratings of values were given on a 9-point scale from 'Not important' to 'Of supreme importance' with a further 'Opposed to my values' option given, in line with recommendations (Schwartz, 1992). In particular 18 items measured self-transcendence values (both universalism and benevolence, e.g. equality, helpful) and 12 items measured self-enhancement values (both power and achievement, e.g. wealth, successful). According to Schwartz's (1992) model of values, self-transcendence values are related to the concern for the welfare of close others (benevolence) and understanding, appreciating, tolerating and protecting the welfare of all others and nature (universalism) which encompasses considerations of the environment. Self-enhancement values are related to self-esteem including the demonstration of competence (success) and the attainment of a dominant position on society (power), which encompass considerations of money. Pre-test questions were restricted to a subsample of 4 items from each of the self-transcendence value items and self-enhancement value items, selected for their centrality to the value in question. A subsample was used to limit time taken and so as to avoid participants noticing the duplication of questions between the pre- and post-tests.

All items measuring values were centred around the participant's mean rating across all values completed as recommended by Schwartz (2009); centring involves subtracting the participant's overall mean score of values from each of the individual value

[1] A demonstration version of the HEC is available at http://homecalcdemo.appspot.com/.

scores and accounts for participant variation in responding to value questions of this kind, allowing analyses to focus on differences between items. Pre-test subscales of self-transcendence and self-enhancement were created by combining the relevant items; scale reliabilities were slightly low with Cronbach's α of 0.65 and 0.66 respectively. Full scales of self-transcendence and self-enhancement were created from items that participants responded to within the main study; here reliabilities were good with Cronbach's α of 0.90 and 0.86 respectively.

3.3.3. Environmental behaviour

Participants then completed a budget allocation task at a further website (cf. Effron, Cameron, & Monin, 2009). This asked participants to imagine they are in a panel that decides how the National Lottery allocates its profits to charity. They were asked to distribute £100,000 between 5 different charities from a list of 20. A pilot questionnaire ($N = 10$) was used to identify charities that were most known for working on climate change issues and these (Friends of the Earth and Greenpeace) were included as key targets of interest within the list. Amount of money donated to these charities was used as an indication of environmental behaviour.

3.4. Results

3.4.1. Effects of the HEC on reasons to save energy

We first examined the qualitative reasons for reducing energy obtained immediately after filling in the HEC. This open-ended question asked participants why reducing this amount of kWh/£/CO_2 was important to them. Two independent coders thematically coded responses and five clear codes emerged from the data: energy reasons, financial reasons, environmental reasons, financial and environmental reasons together, and the idea that reducing energy use was not worth the effort. A small amount of ad hoc responses were coded as a sixth category (Other), which included ambiguous responses such as 'I didn't realise how much energy the hot water uses...' that often didn't directly answer the question. Agreement between coders was initially high ($r = 0.90$, $p < 0.001$) and further discussion resolved discrepancies. Agreed codes were used for subsequent analysis.

Exploring frequency of codes between HEC conditions showed that participants often mentioned both financial and environmental reasons, emerging as the highest category in both energy and cost conditions, see Fig. 1. A chi-square examined the effect of HEC conditions on the types of reasons expressed. We excluded the 'Other' category from analysis given low numbers of responses here (a total of 11 across conditions) and given that chi-square tests require that expected frequencies of responses should generally be above 5. HEC condition had a significant impact on the types of reasons expressed ($\chi^2(6) = 37.73$, $p < 0.001$) and further chi-square tests comparing individual frames with one another (whilst excluding the third from analysis) were also conducted and indicated that each was significantly different from one another (CO_2 vs cost: χ^2 (3) = 26.31, $p < 0.001$; CO_2 vs energy χ^2 (3) = 20.41, $p < 0.001$; energy vs cost $\chi^2(3) = 8.83$, $p < 0.05$). Cost reasons were more likely to be mentioned within energy and cost conditions, whilst environmental reasons were most likely to be mentioned in the CO_2 condition overall, and in the energy condition compared to the cost condition. Interestingly, participants were more likely to indicate that reducing energy was not worth the effort in the cost condition compared to the other two conditions.

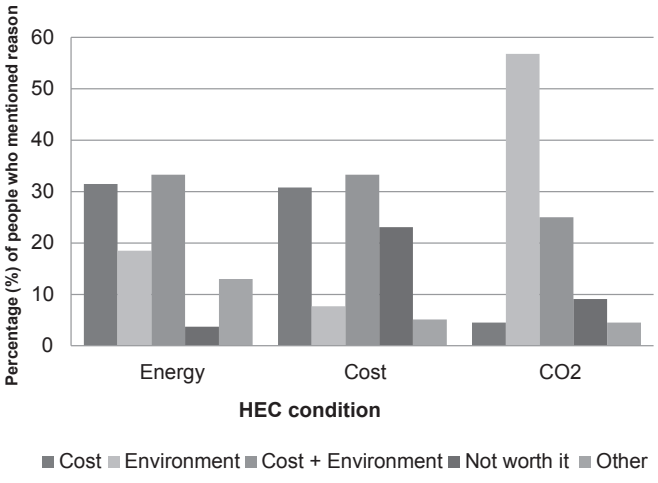

Fig. 1. Reasons expressed as to why reducing energy use is important across different HEC conditions.

3.4.2. HEC Influence on values

To examine the effects of the HEC on the levels of people's values expressed we conducted a repeated measures 3 × 2 × 2 MANOVA with HEC condition as a fixed factor (3: energy, CO_2 or cost) and with repeated measures on value type (2: self-enhancement or self-transcendence) and on measurement point (2: pre-test or study). The HEC calculator condition did not significantly affect measures of values between time points, $F(2, 132) = 0.52$, $p =$ n.s. Given the slightly low reliability of pre-test scales used, a further 3 × 2 MANOVA was conducted with HEC condition as a fixed factor (3: energy, CO_2 or cost) with only the full value scales measured at the second time point within the study as dependent variables (2: self-enhancement or self-transcendence values). Again, the HEC condition did not significantly affect values ($F(4, 294) = 1.150$, $p =$ n.s.) when the full final scales were considered only.

3.4.3. HEC Influence on environmental behaviour

Amounts that participants donated to the two key charities relating to action on climate change (Friends of the Earth and Greenpeace) were combined to obtain a mean donation amount. Only a subsample of our participants chose to donate to our key climate change charities ($N = 20$), however these participants were split fairly evenly across HEC conditions (energy = 7; cost = 8; $CO_2 = 5$). In energy, cost and CO_2 conditions, participants donated mean amounts of £18,357 (range = £24,000), £15,000 (range = £28,000), and £30,000 (range = £25,000) respectively to environmental charities, see Fig. 2. Given the small sample in question we used a Kruskal–Wallis independent samples test (which requires a minimum number of 5

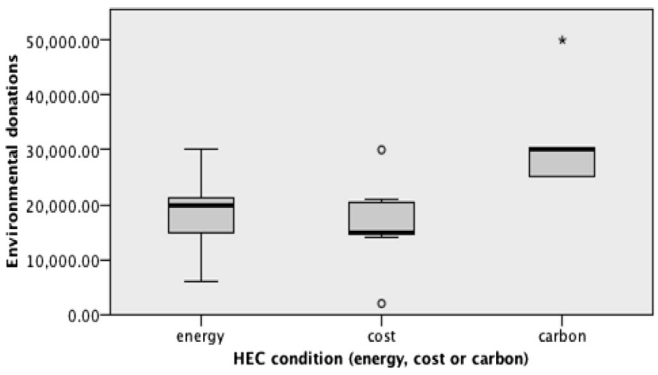

Fig. 2. Amounts of money (£) participants proposed to donate to environmental charities by participants in each HEC condition. Median amounts of money are represented by the heavy dark line; boxes represent the interquartile range of the data; lines extending from boxes indicate the full range of data within 1.5 × the interquartile range; points represented by circles and stars are outlying points for different conditions.

participants per group examined) to examine the differences in donations made between HEC condition (energy, cost, CO_2). Amounts donated to environmental charities differed significantly across HEC conditions, $H = 7.84$, $p < 0.05$. Follow up pairwise comparisons indicated that CO_2 and cost conditions differed from one another ($p < 0.05$) but comparisons of CO_2 and energy conditions and energy and cost conditions were non significant.

3.5. Conclusions

Study 1 indicated that interaction with the HEC calculator significantly affected participants' motivations for reducing energy. When participants considered their energy consumption in terms of energy or cost they were subsequently more likely to give financial reasons for reducing energy whereas when they considered their energy use in terms of CO_2 they were more likely to give environmental reasons for reducing energy. However, energy frames did not significantly impact levels of social values reported. We did find that participants who had previously considered energy in terms of CO_2 were likely to prefer donating larger amounts of money to charities that are known for campaigning on climate change. We acknowledge however that these findings were only evident within a small subsample of our participants (those who chose to donate money to charities relevant to climate change) which limits the generalisability of this data. These results provide some initial indications that engaging with energy in terms of CO_2 could have spillover effects on other types of environmental behaviour. However, it is still unclear what underlying mechanisms might be responsible for these effects.

4. Study 2

In study 2, we again consider the effects of framing energy use in terms of energy, cost or CO_2 on behavioural intentions and also consider additional conceptual variables that may explain any effects found. In particular we examine salience of financial issues and salience of climate change to examine how much the differences in information were taken on board by participants. Examining the salience of climate change allows us to consider more directly to what extent participants are likely to link the CO_2 frame provided to the topic of climate change. We also examine participant's interest in saving energy to interrogate the idea that energy saving may be more or less engaging when expressed in different forms. Finally we measure participant's psychological distance with climate change to examine whether the expression of energy savings in terms of CO_2 might result in the topic of climate change becoming more real and tangible. Study 2 utilises the same budget allocation task as in study 1 with the aim of replicating findings. However given the limitations of this measure we also include a more extensive measure of self-reported environmental behaviour. We additionally include self-report items of energy behaviour in order to examine more direct effects of energy engagement.

4.1. Method

Participants were recruited through the Experiment Management System at the University of Nottingham where students complete studies in exchange for course credit. Participants were subsequently emailed a link to the experimental study that consisted of three ostensibly unrelated tasks organised by different researchers. Participants were randomly allocated to one of three versions of the HEC in a similar manner to Study 1. These again encouraged participants to think about their energy use in terms of kWh (energy), CO_2 (climate change) or £ (cost). Participants subsequently completed a linguistics task (aimed at developing an indirect measure of climate change salience not analysed further here) and a short questionnaire, which measured perceptions of environment and energy use, the same budget allocation task utilised in Study 1 designed to measure environmental behaviour, and self-report measures of intended future energy and environmental behaviour. Participants received a final debriefing in order to explain the nature of the study.

4.2. Participants

A total of 102 undergraduate students in the School of Psychology completed all tasks: 35, 32 and 35 participants completed the energy, cost, and CO_2 HEC versions respectively. Participants consisted of 86 women and 16 men, with an age range from 18 to 21 with a median of 18.

4.3. Materials

4.3.1. The home energy calculator

The HEC was identical to that used in the first study though follow-up questions were removed for speed of completion (these asked participants why reducing this amount of energy was important to them and for general feedback on the calculator).

4.3.2. Perceptions of environment and energy use

A further website asked participants to complete a questionnaire assessing a range of perceptions relating to environmental issues and energy use (see Appendix for full item wordings). Interest in reducing energy use was assessed by 2 items measuring concern about saving energy and perceived importance of reducing energy (Cronbach's $\alpha = 0.72$). Psychological distance of climate change was assessed by a 10-item scale (Cronbachs $\alpha = 0.76$) based on items from Spence et al. (2011a, 2011b). This incorporated items assessing temporal distance (i.e. when the impacts of climate change are likely to be felt), social distance (i.e. whether climate change impacts are likely to affect me or those close to me), geographic distance (i.e. whether climate change impacts will affect my local area), and uncertainty (including uncertainty over whether climate change is really happening as well as the causes, and the effects of climate change). Salience of financial issues and climate change were assessed by asking participants to what extent they felt the HEC made them think about these issues (both 3 items; Cronbachs $\alpha = 0.92$ and 0.74 respectively). Note that this goes beyond a simple manipulation check by examining the extent to which information presented to participants activated broader ideas beyond that relating to energy saving.

4.3.3. Behavioural proxies

We utilised the same budget allocation task used in Study 1. We also asked participants to indicate the extent to which they were willing to undertake common, everyday actions relating to energy reduction and environmental conservation, developed and adapted from Whitmarsh and O'Neill (2010). These included six behaviours relating to energy reduction, e.g. 'turn off lights you're not using', which formed a scale of energy behaviour intentions with a slightly low reliability, Cronbach's $\alpha = 0.60$. Also included were 16 further behaviours relating to more general environmental conservation, e.g. 'buy environmentally friendly products', which formed a highly reliable scale of environmental behaviour intentions, Cronbach's $\alpha = 0.91$; see Appendix for full question wording.

4.4. Results

4.4.1. Impact of HEC condition on perceptual variables

To examine the influence of engaging with the HEC on perceptions, we conducted a 3×4 MANOVA with HEC condition as a fixed factor

(3: energy, cost, and CO_2) and perceptions as dependent variables (4: interest in reducing energy use, psychological distance of climate change, salience of climate change, and salience of financial issues). The HEC condition had a significant influence on perceptions, F (8, 194) = 3.29, $p < 0.01$, $\eta^2 = 0.12$, and follow up tests indicated that salience of climate change was significantly different between HEC conditions (F (2, 99) = 4.93, $p < 0.01$, $\eta^2 = 0.09$) whilst none of the other perceptions differences between conditions reached significance (all $ps > 0.05$), although salience of financial issues approached significance (F (2, 99) = 2.64, $p = 0.08$, $\eta^2 = 0.05$). Climate change salience was significantly higher in the CO_2 HEC condition, compared with energy and cost conditions ($ps < 0.05$), whilst the energy and cost conditions did not differ significantly, see Fig. 3.

4.4.2. Impact of HEC condition on behavioural proxies

Subsequently, we considered whether interaction with the HEC would affect behavioural proxies. Within the budget allocation task, again only a subsample of participants chose to donate to our key charities of interest ($N = 33$) though these were fairly evenly split across HEC conditions (energy = 14; cost = 8; $CO_2 = 11$). The mean amount of money donated to environmental charities in the energy, cost and CO_2 conditions was £7250 (range = £24,000), £12,500 (range = £27,000) and £15,000 (range = £21,500) respectively. A Kruskal–Wallis independent samples test indicated that amounts did not differ significantly across conditions, $H = 1.70$, $p =$ n.s.

With regard to energy behaviour intentions, participants in energy, cost and CO_2 HEC conditions indicated mean intentions of 3.35 (sd = 0.51), 3.40 (sd = 0.49), and 3.27 (sd = 0.41) respectively. For environmental behavioural intentions in the energy, cost and CO_2 conditions, participants indicated mean intentions of 2.55 (sd = 0.59), 2.61 (0.48), and 2.51 (sd = 0.47) respectively. A 3 × 2 MANOVA with HEC condition as a fixed factor (3: energy, cost and CO_2) and behavioural intentions as dependent variables (2: energy, environmental) indicated that differences were not significant, $F(4, 198) = 0.35$, $p =$ ns.

4.4.3. Mediation of effects of HEC condition on intentions by perceptual differences

Given mixed results between studies 1 and 2 with regards to environmental behavioural proxies, we utilised mediation analyses to examine whether our perceptual measures could explain why framing interventions may or may not result in change. Given the small sample of data obtained from our budget allocation task, exploration of this was only possible within measures of intentions to undertake energy and environmental behaviour.

We took a general linear model approach to modelling the mediation effect so as to retain group differences of interest within the HEC conditions, and used MPlus statistical software to model the data (see Hayes & Preacher, in press). Helmert coding was used to represent the different HEC conditions so we could compare the cost condition relative to the energy and CO_2 conditions combined (represented by D_1) and also compare the CO_2 condition to the energy and cost conditions combined (represented by D_2), see Fig. 4. Due to the strict assumption of normally distributed data within the product-of-coefficients approach to mediation, we used bootstrapping to resample the data 10,000 times in estimating the indirect effects. There were no missing data in the variables of interest. There was no significant interaction between HEC condition and salience of climate change indicating homogeneity of regression is established (and mediation analysis can be conducted: Keppel & Wickens, 2004).

Analyses revealed that when comparing the cost HEC conditions with the energy and CO_2 conditions combined there is no significant difference in climate change salience ($b = 0.05$), however when comparing the CO_2 condition with the energy and cost condition combined, the CO_2 frame significantly increased climate change salience ($b = 1.29$), confirming results of the previous MANOVA. A higher salience of climate change in turn was associated with higher levels of environmental behaviour intentions ($b = 1.33$). We found that the relative indirect effect for the first contrast comparing the cost condition to the energy and CO_2 condition was not significant ($b = 0.60$, $p =$ n.s.) and that the relative indirect effect for the second contrast comparing the cost and CO_2 conditions with one another was significant ($b = 1.71$, $p < 0.05$). So for those who interacted with the CO_2 version of the HEC, climate change became more salient than in other versions and this translated into higher intentions to undertake environmental behaviour.

Interestingly, the relative direct effect between the CO_2 HEC condition and environmental behaviour intentions (compared to the cost condition) was non-significant ($b = -1.37$), as shown in initial null results found within our MANOVA. The relationship between HEC condition and environmental behaviour intentions was entirely mediated by salience of climate change. This indicates that only when interaction with the CO_2 version of the HEC resulted in an increased salience of climate change than in other versions, did participants subsequently intend to undertake more environmental behaviours.

1. D_1 represents a contrast between the cost condition and the CO_2 and energy conditions jointly; D_2 represents a contrast between the CO_2 condition and the cost and energy conditions jointly 2. Values provided are unstandardised beta weights indicating the strength of the relationship between variables. * = $p < 0.05$, ** = $p < 0.01$. 3. Heavy lines indicate significant paths.

We replicated this mediation analysis to examine indirect effects of climate change salience on intentions to undertake energy behaviour. Here, a higher salience of climate change related to higher levels of energy behaviour intentions ($b = 0.42$). However, neither relative indirect effect, comparing the cost condition to the energy and CO_2 conditions combined or comparing the CO_2

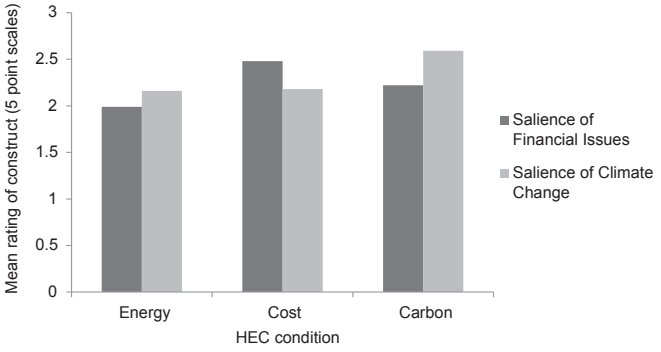

Fig. 3. Mean ratings of salience of climate change and financial issues between HEC conditions.

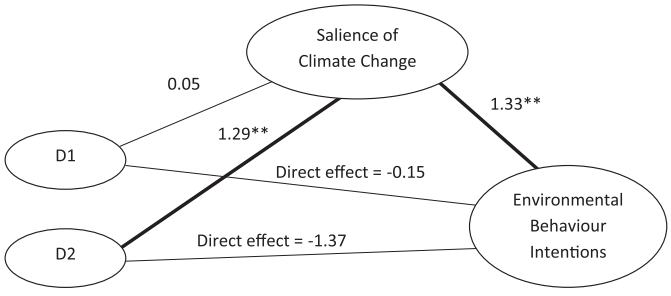

Fig. 4. Impact of HEC condition on environmental behaviour intentions mediated by salience of climate change.

condition to the energy and cost conditions combined were significant ($b = 0.02$ and $b = 0.53$ respectively, both p = n.s.).

5. Discussion

Communicating the need for reducing energy use and presenting new related policy initiatives requires a good understanding of how the public are motivated to be sustainable. In particular the issue of whether to discuss energy reduction in terms of costs or in terms of climate change has arisen frequently, both in the context of smart meters (Ofgem, 2011a) and in wider debates (Corner & Randall, 2011). We found that a CO_2 framing of energy reduction led to climate change becoming more salient for our participants. Increased salience of climate change in turn resulted in increased intentions to undertake environmental behaviour. Our results are limited by the use of only behavioural proxies within this study and our use of a student sample. Nonetheless, results imply that whilst costs may be a more tangible outcome of energy reduction for many people, the environmental motivation for reducing energy use should not be ignored and may be a more significant driver for environmental behaviour beyond energy behaviour.

5.1. Financial framing of energy reduction

Cost is often found to be a primary concern with regards to energy (Ofgem, 2011b; DECC, 2012b) and is a recognisable unit of measurement that people understand. It is likely to be a driver for behaviour change as energy prices increase however importantly energy reduction behaviours often produce only small financial benefits. Indeed we found that our participants were frequently likely to report that reducing energy use was 'not worth it' when energy feedback was provided in pounds and pence (study 1). This supports previous research that indicated that financial savings from energy reductions were so small that people may have felt justified in using more (Bittle et al., 1979–1980; Brandon & Lewis, 1999). However, in our second study the cost HEC condition did not decrease our participants' interest in reducing, or intended, energy use indicating that any demotivating effect of engaging with cost is likely to be small. We note that our study asked participants to interact with an online energy tool for just a short period of time though, less interaction than might be expected in reality with an IHD. This finding does indicate that aggregating cost savings, e.g. over time, may be a stronger impetus to act and further research should investigate the utility of cumulative energy feedback in motivating behaviour change.

5.2. Environmental framing of energy reduction

Our research demonstrated that framing energy reductions in terms of CO_2 led to a greater likelihood that people would consider climate change as a motivation to save energy and, in a subsample of participants, a higher propensity to donate to climate change related charities (study 1). For those participants for whom climate change became salient, we also found significantly higher intentions to act in a more broadly environmentally friendly manner (study 2). These findings support the idea that behavioural spillover can occur (Thøgersen, 1999); indicating that by intervening to change one behaviour, other further behaviours that are related on some level could also be influenced.

Interestingly, in our second study we found that indicators of spillover effects only occurred when climate change became salient for our participants. This is an important finding for several reasons. The fact that simply making climate change salient could influence behaviour to such an extent is noteworthy. It highlights the utility of simply engaging the public with the issue of climate change. It is possible that this is essentially a priming effect that may not last longer term and further research should explore longevity of effects. However, priming effects should not be dismissed as they have an important influence on much behaviour that is enacted in the context of some information or message received. Indeed, if an IHD does prime an individual with the idea of climate change, any continued interactions with the display could continue to influence behaviour. Furthermore, the framing of energy in our studies was quite subtle, primarily bound up with the units of the energy display. A more explicit framing of energy reductions may produce larger effects.

Notably, the measures of values we utilised within study 1 reported here found little changes in levels of values when compared pre and post our energy engagement task. On first glance these findings contradict previous research that finds relationships between priming environmental issues and activation of related values (Evans et al., 2013). However it is possible that the null effects found are due to the conceptualisation of the changes in values we expected. Reflecting on the way in which our engagement task may be likely to effect values it may be that actually *changing* levels of values held was unlikely, particularly in the short time frame of the current studies. However it is possible that the salience of certain values may have been altered within our manipulations. Indeed, our open ended measure investigating motivations for saving energy (study 1) and our measures of salience of climate change and financial issues (study 2) could be interpreted as some indication of value salience. We also acknowledge potential methodological points that may have impacted our results. In particular we note that the completion of the measures of values may have resulted in all values measured being activated which may then have dampened any differences in values primed by the different versions of the engagement task completed. In addition, participants in our first study were offered a financial incentive to take part, which could have primed self-enhancement values in all of our participants, also potentially attenuating effects. We propose that further research explores in more depth the role that values play in creating behaviour spillover effects whilst being careful to specify and conceptualise how values may be affected and how these are measured.

We acknowledge our sample relied on university students and therefore the generalisability of our results are limited. However this sample was homogenous across conditions, giving assurance to the reliability of results noted. In addition, given that a young and well educated sample is already likely to be more environmentally concerned (Jones & Dunlap, 1992), we would suggest that framing effects observed might be stronger in a broader cross-section of the population. It is interesting to consider findings in terms of natural frames and viewpoints that exist across society; when climate change is salient either within a particular context or social group, then our findings suggest that this might in itself be enough to promote sustainable behaviour.

5.3. Practical implications

Findings demonstrate that most of our framing effects were observed only when climate change became salient. That this did not happen to the same extent for all our participants is evident given the lack of direct effect of HEC conditions on our behavioural indicators. The implication is that different people are likely to perceive communications on energy reductions in quite different ways from each other. There is therefore unlikely to be a simple message that can effectively engage everyone. The reasons why climate change became salient for some of our participants to a greater extent than others remains unexplained and potential individual differences that may explain why our energy tool may have affected people differently should be explored further (cf. population segmentation work, e.g. DEFRA, 2008; Maibach, Leiserowitz, Roser-Renouf, & Mertz, 2011). For example, people who are already environmentally aware may be more likely to be influenced

by engaging with climate change framed communications. It is also important to consider whether an environmental framing might disengage some people (Mohr, Eroglu, & Ellen, 1998).

Overall we find an environmental framing is useful in engaging people with energy reductions and could result in greater levels of environmental behaviour given the outcomes of our proxy measures. This data highlights the importance of considering and accounting for the potential for behavioural spillover (or lack of) in the potential impact of in-home energy displays and other policy measures and communications.

In addition, the possibility of utilising both cost and environmental framings in engaging people with energy reduction should be considered and empirically examined. The main argument against combining cost and environmental frames in engaging people in reducing energy use is that theoretically these frames oppose each other in terms of social values (Corner & Randall, 2011). Further research within literature on extrinsic and intrinsic motivations (which could be considered to align with financial and environmental motivations) supports the idea that financial and environmental motivations are likely to clash given that extrinsic motivations are found to undermine intrinsic motivations (Deci, Koestner, & Ryan, 1999). There is some evidence that extrinsic motivations can be internalised, particularly if in enacting the behaviour people feel supported and autonomous (Deci, Eghari, Patrick, & Leone, 1994; Weinstein, Przybylski, & Ryan, 2013), however there is no known evidence to date demonstrating that monetary rewards can be internalised and empirically it would be useful to investigate this in the domain of energy reduction.

We also found little evidence that engaging with energy when framed in terms of the environment when compared to costs has an impact on psychological distance or on interest in reducing energy use. Of course, we were concerned with examining the influence of different communication frames here rather than the overall influence of engaging with energy displays; it is possible that all of the displays had an equal impact on these factors and this should be considered in further studies. In addition, as previously noted, our frames were fairly subtle so a stronger frame may have a greater impact.

6. Conclusion

Given the urgent need to reduce CO_2 emissions, the way in which energy reduction behaviour is encouraged and communicated is an important issue. We suggest that costs are not ignored in communications but that environmental considerations should also be highlighted because engagement in these terms has the potential to promote sustainable behaviour to a greater extent. Our data provide support for the idea that energy displays should have an option to display energy information in terms of CO_2.

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Appendix

Construct	Question	Response Options
Interest in saving energy	How concerned, if at all, are you personally about saving energy?	Very concerned – Not at all concerned (4 point scale)
	How important do you think it is to reduce energy consumption in the UK?	Very important – Not at all important (4 point scale)
Psychological Distance	Considering the potential impacts of climate change, how far away in time do you consider these to be?	Very close – Very far away (5 point scale)
	Climate change is likely to have a big impact on people like me.	Strongly agree – Strongly disagree (5 point scale)
	Climate change is unlikely to have an impact on people in my social group.	
	Climate change will mostly affect areas that are far away from here.	
	My local area is likely to be largely unaffected by climate change.	
	I think the causes of climate change are uncertain.	
	The impacts of climate change are mostly going to be felt in other	

	countries.	
	My friends and family are likely to be largely unaffected by climate change.	
	It is uncertain what the effects of climate change will be.	
	I am uncertain that climate change is really happening.	
Salience of financial issues	To what extent did the Home Energy Calculator make you think about the following issues?	Not at all – Very much so (5 point scale)
	Financial issues?	
	How much you spend?	
	Money?	
Salience of Climate Change	To what extent did the Home Energy Calculator make you think about the following issues?	Not at all – Very much so (5 point scale)
	The environment?	
	Climate change?	
	How much carbon you emit?	
Energy Behaviour Intentions	The following is a list of common, everyday actions. Please indicate the extent to which you are willing to undertake the following actions?	Never – Always (4 point scale). Not Applicable option also provided.
	Turn off lights you're not using	
	Turn off computers/tvs/stereos etc. when not being used	
	Put on layers of clothes rather than use electric heating/blanket	
	Disconnect phones/other devices when finished charging	
	Fill the kettle with the amount of water I need rather than filling it completely	
	Wait to have a full load before using the washing machine	

Environmental Behaviour Intentions	The following is a list of common, everyday actions. Please indicate the extent to which you are willing to undertake the following actions?	Never – Always (4 point scale). Not Applicable option also provided.
	Drive economically (e.g. braking or accelerating gently)	
	Walk, cycle or take public transport for short journeys (i.e. trips of less than 3 miles)	
	Use an alternative to travelling (e.g. shopping online)	
	Share a car journey with someone else	
	Cut down on the amount you fly	
	Buy environmentally friendly products	
	Eat food which is organic, locally grown or in season	
	Avoid eating meat	
	Buy products with less packaging	
	Recycle	
	Reuse or repair items instead of throwing them away	
	Compost your kitchen waste	
	Save water by taking shorter showers	
	Turn off the tap while you brush your teeth	
	Speak to someone in authority (e.g. employer, MP) about an environmental issue	
	Take part in a campaign or protest about an environmental issue	

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