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Making Small Numbers Count: Environmental and Financial Feedback in Promoting Eco-driving Behaviours

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Abstract Energy conservation results in environmental (reduced emissions) and financial (reduced costs) savings. Consumers' perception of the worthiness of changes in behaviour may differ depending on whether environmental or financial savings are emphasized. The current study investigated the effects of using either environmental or financial feedback in the context of eco-driving. Participants evaluated six scenarios describing different eco-driving behaviours. Participants in experimental groups were informed about either the environmental or financial savings realized by adopting the behaviours. A control group did not receive information on possible savings. Results indicated that, unlike commonly assumed, environmental savings are considered more worthwhile than commensurate financial savings. Yet, intentions to adopt eco-driving behaviours were mainly sensitive to the presence of feedback per se, rather than the content of feedback. We discuss the theoretical and practical implications of these findings.

Keywords Feedback framing · Eco-driving · Worthwhile · Effort

Introduction

In order to secure a sustainable future, consumers need to change their consumption practices (Dietz et al. 2009). One commonly applied method of promoting sustainable consumption

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behaviour is providing feedback: Given that consumers may not be aware of the (negative) consequences associated with their behaviour, providing feedback regarding these consequences could help to promote behaviour changes and reduce energy consumption, by enabling people to understand the effects of their behaviour on the environment (see Abrahamse et al. 2005 and Fischer 2008 for reviews). Recent technological advancements have paved the way for easy and fine-grained applications of feedback. For example, consumers can now hook up their iPads to smart plugs and thereby instantly check the kilowatts or monetary gains that are associated with flicking off specific in-home appliances. Similar technology has now allowed for various in-car devices to provide real-time feedback on fuel consumption.

Research suggests that the provision of feedback can effectively promote energy savings and thus reduce greenhouse gas emissions (see Abrahamse et al. 2005 and Fischer 2008 for reviews). The positive effect of feedback on reducing energy consumption has been demonstrated in various settings (e.g., Birrell and Young 2011; Dogan et al. 2011; Siero et al. 1989). However, relatively little is known on how the *content* of feedback influences motivation to conserve energy. As a case in point, consider the different ways of how feedback on eco-driving could be conveyed. Fuel savings as a result of eco-driving have both environmental and financial benefits. Eco-driving can therefore be promoted by emphasizing the environmental benefits (i.e., reducing CO₂ emissions) as well as by stressing financial benefits (i.e., saving money). But which type of benefits would be most appealing to drivers? According to conventional wisdom (Miller 1999), people are mainly motivated by (short-term) self-interest. They would therefore be more likely to change their consumption practices when some clear and tangible individual benefits are communicated, such as monetary benefits. From this perspective, one would expect that environmental feedback would be less effective than parallel monetary feedback. But would you really consider it worthwhile to change your behaviour for a couple of euro cents? Or would you consider the prospect of saving some CO₂ emissions to be more worth the effort? Drawing on prior research in behavioural economics and cognitive psychology (e.g., Gneezy and Rustichini 2000; Heyman and Ariely 2004; Hsee and Rottenstreich 2004), we reasoned that when potential financial benefits are too small to justify the effort, it may be more effective to stress the non-monetary (e.g., environmental) benefits associated with sustainable behaviour. We explain and test this reasoning in the context of eco-driving behaviours.

The Use of Feedback for Behavioural Change

Initial campaigns aimed at promoting eco-driving mostly emphasized financial aspects by stressing that eco-driving saves money. The assumption behind using a *financial* strategy to promote eco-driving (e.g., using monetary feedback, Stillwater and Kurani 2013, or introducing eco-driving as “economical driving,” CIECA 2007) seems to be that people consider the financial benefits of eco-driving more worth the effort than the environmental benefits and that drivers will be particularly motivated to adopt eco-driving when they are made aware of the financial (rather than environmental) benefits of doing so (Thøgersen and Crompton 2009; Bolderdijk et al. 2013). However, an important issue concerning eco-driving, and many other pro-environmental behaviours, is that specific eco-driving behaviours typically result in relatively modest benefits. For example, turning a car’s engine off during a single 10-min wait saves 0.14 l of fuel, which amounts to 25 euro cents.¹ An important question, then, is whether people indeed consider the financial benefits of specific eco-driving behaviours to be

¹ Financial savings were calculated based on oil price per litre in the Netherlands at the time of the study.

worth the effort. In this paper, we argue that in these cases, consumers may find environmental benefits more worthwhile than financial benefits. We explain our reasoning below.

We argue that, depending on the content of feedback, different types of motivations come into play. In essence, feedback content may induce different ways of thinking, so-called decision frames (Heyman and Ariely 2004; Lindenberg and Steg 2007; Tenbrunsel 1999; Vansteenkiste et al. 2004). These decision frames influence which aspects of a situation people consider, how they evaluate the different aspects of a situation (Lindenberg and Steg 2007), and how much effort they (are willing to) invest in a given situation (Heyman and Ariely 2004). In the current study, we argue that financial and environmental feedback may trigger different decision frames. The decision frame activated is in turn expected to influence how worthwhile people consider specific rewards and how much effort they are willing to exert in a behaviour as explained below.

Following Heyman and Ariely (2004), we propose that depending on the content of feedback (thereby conveying different types of possible rewards), different decision frames are elicited, reflecting the type of market relations people are in. Heyman and Ariely (2004) distinguish money and social markets to characterize how level of reward can be related to the effort people are willing to exert in a behaviour. In a money market, the amount of effort exerted is determined by reciprocity (Fehr and Falk 2002). That is, a behaviour is perceived to be worth the effort when the expected reward is proportionate to the effort: The lower the financial gain expected, the less effort a person will be willing to invest to receive the gain. Consequently, small rewards are not sufficient to motivate effortful behaviours. For instance, underpaid volunteers tended to perform worse than volunteers that were not paid at all (Gneezy and Rustichini 2000). Thus, financial rewards may not be considered worthwhile when their size does not reciprocate the effort required.

In the social market, conversely, the amount of effort exerted depends mainly on altruistic motives. In other words, people consider behaviour to be worth the effort when it benefits the welfare of others and the environment, rather than themselves exclusively. When people are acting out of altruistic, rather than selfish, concerns, effort will be maintained despite the small benefits expected. For example, whether a volunteers' work improves the lives of 10 or 100 children does not alter the inherent satisfaction from volunteering: In both cases, people volunteer out of the desire to do "good" (Hsee and Rottenstreich 2004; Small et al. 2007). So, in a social market, the amount of benefits gained given the effort needed to engage in the actions is less relevant than that in a money market, and behaviours could be still considered worthwhile even though they yield modest benefits.

We argue that financial feedback, by appealing to drivers' monetary concern, may elicit a money market frame. Conversely, environmental feedback, by appealing to altruistic motives, may elicit a social market frame (cf. Heyman and Ariely 2004). Financial feedback on eco-driving stresses the monetary gains as a consequence of adopting an eco-driving style while environmental feedback stresses non-pecuniary benefits. Hence, we hypothesize that the fact that eco-driving behaviours result in small benefits will be particularly problematic for how worthwhile savings are perceived when communicating *financial* benefits, but less so when communicating *environmental* benefits.

Eliciting social market relations by using environmental feedback may thus bypass the drawback about the small savings of eco-driving behaviours because the amount of savings would be less relevant in this case. People may perceive that they are doing the right thing for the environment regardless of whether they are saving 1 g or 1 kg of CO₂ emissions; in both cases, their behaviour is a positive contribution to the environment, promoting willingness to invest effort. Thus, the amount of savings would be less important when communicating environmental benefits, and even small benefits may be perceived to be worthwhile.

The type of the information conveyed by feedback may also influence people's intentions to engage in a behaviour (Rothman et al. 2004). Given that eco-driving is typically associated with very modest savings, it is plausible to expect that environmental feedback may be a stronger motivator and yield stronger intentions to adopt behaviour than financial.

Current Study

The aim of the current research was to investigate the worthiness and effectiveness of financial and environmental feedback in promoting various types of eco-driving behaviours. We argued that financial feedback would evoke a money market decision frame, thereby reciprocity expectations. When motivated by reciprocity, people will evaluate whether the amount of financial benefits is worth the effort needed to adopt the behaviour. We expected that environmental feedback would evoke a social market decision frame, thereby altruistic motives. In this case, people will think it is worthwhile to adopt eco-driving practices even though the amount of environmental savings to be gained would be small.

Based on this, we first examined whether different types of feedback, focusing on either environmental or financial outcomes (experimental conditions), had a differential effect on how worthwhile eco-driving behaviours were perceived. We hypothesized that drivers would perceive eco-driving behaviours to be more worth the effort when feedback was provided on possible environmental gains rather than financial gains (hypothesis 1). Second, we examined whether presence and type of feedback was effective in influencing intentions to adopt eco-driving behaviours. We hypothesized that intention to adopt eco-driving behaviours would be higher when feedback was provided (experimental conditions) compared to when no feedback was provided (control condition) (hypothesis 2). Furthermore, we expected environmental feedback to evoke stronger intentions to adopt eco-driving behaviours than the financial feedback (hypothesis 3).

Method

Participants, Procedure, and Design

The study was carried out as part of an online questionnaire study. All participants owned a driver's license and were recruited by an online survey company who approached a representative sample of the Dutch population from their panel. Participants evaluated different eco-driving scenarios (described below) and completed demography questions. Three hundred-five respondents (155 females) participated in the study; one participant did not report his or her gender. The mean age of participants was 43.9 years ($SD=13.63$), and the average time since licensure was 23.2 years ($SD=13.63$). Respondents drove on average 17504 km in the year preceding the study ($SD=14331$); 21 participants did not report the mileage driven the year before the study. The average mileage is a bit higher than the Dutch average, which was 13 317 km for 2010 (Statistics Netherlands 2011).

We presented different eco-driving scenarios to respondents. In each scenario, we described a specific eco-driving behaviour. We selected six behaviours that typify an eco-driving style: avoiding idling while waiting for a level crossing, driving below the speed limit on a highway, avoiding overtaking, the use of an air conditioner, the use of a roof rack, and checking the tyre pressure regularly (see Eco-drive Netherlands 2011). A full description of the scenarios is provided in the [Appendix](#).

The study consisted of two experimental groups, namely an environmental feedback and a financial feedback group, as well as a control group. Respondents were randomly assigned to one of the three conditions,² and all participants evaluated the six eco-driving scenarios. Depending on the experimental group, participants either read how much money or how much CO₂ emissions could be saved when the indicated fuel-efficient behaviour was adopted. Savings were calculated based on the information provided on the websites concerning eco-driving (e.g., The Daily Green 2011). Financial savings were calculated based on the price of a litre of oil in the Netherlands at the time the study was conducted. Environmental savings were calculated based on the amount of CO₂ emissions produced for a litre of oil (i.e., 2.3 kg/l; U.S. Environmental Protection Agency 2005). So, the amount of savings was essentially the same in both conditions and linearly related to fuel consumption. In the control condition, conversely, the same scenarios as in the experimental conditions were presented, but now, the eco-driving behaviour was presented as a suggestion (e.g., “As you approach a level crossing in your car, you hear the bell signalling that a train is approaching. The level crossing will be closed for a minute. You could turn off the engine of the car while waiting”; see [Appendix](#)).

Dependent Variables: Worthiness of Savings and Intention to Adopt Eco-driving Behaviours

For each scenario, participants in the two experimental groups first indicated whether they considered the amount of saving achieved by performing the fuel-efficient behaviour to be worth the effort (e.g., The amount of CO₂ emissions (euros) saved by turning the engine off while waiting is...) on a 6-point scale (1=not at all worth the effort, 6=totally worth the effort). Higher scores indicated higher perceived worthiness of the saving. Note that participants in the control condition did not answer the worthiness item, as they did not receive any information on the savings that could be realized by adopting the eco-driving behaviours.

Second, participants in all three conditions indicated their intention to adopt each of the six eco-driving behaviours (e.g., I would turn the engine off while waiting) on a 6-point scale (1=totally disagree, 6=totally agree). Higher scores indicated a higher intention to adopt the relevant eco-driving behaviour.

Results

Effect of Feedback Type on the Worth of Savings

In order to test our first hypothesis about the effect of feedback type on how worthwhile the savings were perceived, we conducted a multivariate analysis of variance (MANOVA) with feedback type as a fixed factor and the worthiness of the saving for each scenario as the dependent variable (see the left side of Table 1). A clear overall pattern emerged: Savings were perceived to be more worth the effort when feedback was provided in terms of environmental (CO₂ emissions) rather than financial units (euros) (Hotelling's $F(6, 181)=12.48, p<.001$, partial $\eta^2=.29$). Specific analyses revealed that participants rated CO₂ emissions to be more

² A second between-subjects independent variable in the current study was time span of savings. We did not observe differences between framing savings in the short and long terms. We therefore collapsed the data across these groups.

Table 1 Means and standard deviations (in brackets) for worthiness of savings and intention to adopt eco-driving behaviours in the environmental feedback, financial feedback, and control condition

	Worthiness		Intention		
	Environmental feedback	Financial feedback	Environmental feedback	Financial feedback	No feedback
Idling	4.12a (1.39)	3.38b (1.35)	4.35a (1.66)	4.13a (1.53)	3.37b (1.82)
Overtaking	3.98a (1.37)	3.02b (1.37)	2.93a (1.72)	2.74a (1.60)	2.12b (1.55)
Speed reduction	3.81a (1.45)	3.17b (1.42)	2.79a (1.62)	2.45a (1.50)	2.04b (1.49)
Air conditioning	3.65a (1.35)	2.43b (1.26)	2.81a (1.56)	2.48a (1.51)	2.61a (1.76)
Roof rack	4.49a (1.45)	3.13b (1.47)	4.78a (1.79)	4.38a (1.69)	4.63a (1.73)
Tyre pressure	4.48a (1.26)	3.01b (1.29)	4.15a (1.71)	3.94a (1.36)	4.04a (1.50)

Means with different letters for experimental conditions differ at $p < .05$

worth the effort than equivalent financial benefits for all the individual eco-driving behaviours, including avoiding idling ($F(1, 186) = 13.04, p < .001$, partial $\eta^2 = .07$), keeping the air conditioner off ($F(1, 186) = 42.44, p < .001$, partial $\eta^2 = .19$), reducing speed ($F(1, 186) = 9.80, p = .002$, partial $\eta^2 = .05$), removing the roof rack ($F(1, 186) = 39.01, p < .001$, partial $\eta^2 = .17$), checking the tyre pressure regularly ($F(1, 186) = 60.76, p < .001$, partial $\eta^2 = .25$), and avoiding overtaking ($F(1, 186) = 25.32, p < .001$, partial $\eta^2 = .12$).

Effects of Feedback Type on Intention to Adopt Eco-driving Behaviours

To test our second and third hypotheses on the effect of presence and type of feedback on the intention to adopt fuel-efficient behaviour, we conducted a MANOVA with feedback type as the fixed factor and intention for each scenario as dependent variable (see the right side of Table 1). The overall effect of feedback condition (including environmental, financial, and no feedback) on the intentions to adopt eco-driving behaviours was significant (Wilk's lambda $F(12, 592) = 3.11, p < .001$, partial $\eta^2 = .06$). Specific analyses revealed a significant main effect of feedback type on the intention to adopt three of the six eco-driving behaviours, i.e., intention to avoid idling ($F(2, 301) = 9.84, p < .001$, partial $\eta^2 = .06$), intention to avoid overtaking ($F(2, 301) = 7.19, p = .001$, partial $\eta^2 = .05$), and intention to reduce speed on a highway ($F(2, 301) = 6.05, p = .003$, partial $\eta^2 = .04$; see Fig. 1). In order to clarify the differences between both experimental groups and the control group, we tested the planned contrasts: (1) comparing both experimental groups to the control group (hypothesis 2) and (2) comparing the environmental and financial groups to each other (hypothesis 3). Contrast analyses revealed that environmental and financial feedback resulted in higher intention to avoid idling, $F(1, 302) = 18.94, p < .001$, avoid overtaking, $F(1, 302) = 13.79, p < .001$, and reduce speed than no feedback (control condition), $F(1, 302) = 9.70, p < .001, p = .002$. However, we did not find significant differences between the environmental and financial feedback

Fig. 1 Differences between mean scores of environmental and financial feedback groups compared to the control group on intention to adopt specific eco-driving behaviours for each scenario

conditions for any of the three behaviours, $F(1, 189) = .84$, $p = .361$, $F(1, 189) = .58$, $p = .446$, and $F(1, 189) = 2.28$, $p = .133$, respectively, for avoiding idling, avoiding overtaking, and reducing speed. Hence, for these behaviours, the presence of feedback prompted higher intentions to adopt eco-driving behaviours, while the content of feedback did not matter much. More specifically, environmental feedback did not appear to result in significantly stronger intentions than financial feedback for any of these behaviours.

Effects of feedback on intentions to adopt the other three eco-driving behaviours, i.e., the intention to keep the air conditioner off ($F(2, 301) = 1.01$, $p = .364$), the intention to remove the roof rack ($F(2, 301) = 1.12$, $p = .329$), and the intention to check tyre pressure regularly ($F(2, 301) = 0.42$, $p = .655$), were not statistically significant.

Figure 1 shows the scores on intentions of the environmental and financial feedback groups relative to the control group. For this purpose, we used the control group as the reference group and subtracted the mean scores of the control group from the scores of the environmental feedback and financial feedback groups. The results presented in Fig. 1 reveal an interesting trend: For three of the eco-driving behaviours, we found that financial feedback resulted in slightly higher intentions than no feedback at all (see the left side of Fig. 1), while for the remaining three behaviours, financial feedback resulted in somewhat *lower* intentions than no feedback (see the right side of Fig. 1). However, the contrasts were not statistically significant.³

Discussion

How can drivers be motivated to adopt eco-driving behaviours, given that energy savings from eco-driving are typically rather modest? In the current study, we investigated whether feedback content had a differential effect on how worthwhile drivers perceived eco-driving behaviours to be and on whether feedback content

³ We could not establish whether feedback type influenced intention via worthiness as our data do not support an important precondition to establish mediation: the relationship between feedback type (environmental vs. financial) and intention was not significant for all behaviours.

would affect drivers' intentions to adopt these behaviours. We argued that environmental feedback on eco-driving would elicit a social market decision frame, with decisions being guided by altruism and being less sensitive to the size of the reward to be gained. Financial feedback, on the other hand, was expected to elicit a money market decision frame. Therefore, decisions would be guided by reciprocity and should be sensitive to the size of the reward to be gained given the effort needed.

In support of this reasoning, our results suggest that eco-driving behaviours were indeed perceived to be more worth the effort when environmental (CO₂ emissions), rather than equivalent financial (fuel costs), consequences were presented (hypothesis 1). This implies that the type of motive elicited by the feedback affects the extent to which people think the behaviour is worth investing effort.

However, we did not find that environmental feedback resulted in significantly stronger intentions to adopt eco-driving than financial feedback. If anything, our results indicated that any feedback is more effective than no feedback at all, at least when promoting behaviours such as avoiding idling, avoiding overtaking, and reducing speed. This finding implies that people's intentions may not be strictly based on how worthwhile they perceive a behaviour to be.

However, a closer inspection of the intention data (see Fig. 1) points to another possibility: When motivating relatively "effortless" behaviours such as avoiding idling, avoiding overtaking, and reducing speed, both financial and environmental feedback seem to be more effective relative to no feedback. For more "effortful" behaviours such as tyre pressure checks, removing the roof rack, and avoiding the use of the air conditioner, however, the pattern is more in line with the worthwhile ratings: Environmental feedback seems more effective than no feedback, while financial feedback seems even less effective than offering no feedback (see Fig. 1). Although not anticipated, these patterns do resonate with prior literature: Any reason, no matter how valid, can be sufficient to prompt compliance as long as it concerns low-effort requests (Langer et al. 1978). People are, however, more wary of a high-effort request and will not comply unless a valid reason is provided (Diekmann and Preisendörfer 2003). This mechanism could explain why financial feedback may backfire for some, but not other, behaviours; the fact that financial gains are perceived less worthwhile is only relevant when it involves a high-effort behaviour.

Although appealing, we stress that our reasoning is speculative and that the abovementioned trend was not statistically significant. Future research should test the effect of different types of feedback on propensity to engage in high- and low-effort behaviours in more detail, for example by systematically varying the effort involved in behaviour. Ideally, such research (either in the driving simulator or via instrumented cars) includes some kind of behavioural measure, rather than merely gauging intentions.

Our findings have important practical implications. We found that the type of feedback affects the extent to which adoption of eco-driving practices is considered to be worthwhile: Environmental benefits of eco-driving were considered more worthwhile than commensurate monetary benefits. This finding challenges the consensus among policy makers and marketers that appealing to monetary gain is the most effective way to encourage sustainable actions (CIECA 2007). Moreover, these results provide guidelines to promote eco-driving. Specifically, rather than simply assuming that portraying monetary benefit will be the most effective means of motivating sustainable consumer behaviour, alternatives (such as explicating the CO₂ emissions associated with one's actions) should be considered.

Appendix

Avoiding idling

As you approach a level crossing in your car, you hear the bell signalling that a train is approaching. The level crossing will be closed for a minute. If you turn off the engine of your car while you are waiting, you would save *0.018 kg CO₂ emissions/€ 0.05*.

Speed reduction

You are driving on a motorway with a 120-km/h speed limit. You still have 100 km to reach your destination. If you drive 100 km/h instead of 120 km/h, you would save *2.40 kg CO₂ emissions/€ 1.70* for this trip.

Overtaking

You are driving on a motorway with a 120-km/h speed limit. You still have to travel 80 km to reach your destination. The cars in front of you drive between 100 and 110 km/h. There are opportunities to safely overtake. If you do not overtake the cars in front of you, you would save *1.92 kg CO₂ emissions/€ 1.35* for this trip.

Air conditioning

You are travelling by your car on a warm day. You still have 40 km to go. You consider turning on the air conditioner. If you keep the air conditioner off, you would save *0.56 kg of CO₂ emissions/€ 0.44* for this trip.

Roof rack

You have a roof rack installed on your car. You will need the roof rack again in a month. You consider keeping the roof rack on your car during this month. If you remove the roof rack now and re-install it when you need it, you would save *1.96 kg CO₂ emission/€ 1.20* during this month.

Tyre pressure

You have not checked your tyres for some time and notice your tyres are underinflated. If you check the tyre pressure of your vehicle regularly on a monthly basis from now on, you would save *1.47 kg of CO₂ emissions/€ 0.90* over a month.

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