Stimulating the drive to drive green: A longitudinal experiment on socially comparative vs. individual digital eco-driving feedback

Pieter Vanpaemel
Vlerick Business School
Bert Weijters
Ghent University
Frank Goedertier
Vlerick Business School

Cite as:
Vanpaemel Pieter, Weijters Bert, Goedertier Frank (2019), Stimulating the drive to drive green: A longitudinal experiment on socially comparative vs. individual digital eco-driving feedback. *Proceedings of the European Marketing Academy*, 48th, (9314)

Paper presented at the 48th Annual EMAC Conference, Hamburg, May 24-27, 2019.

EMAC
EUROPEAN MARKETING ACADEMY

Stimulating the drive to drive green: A longitudinal experiment on socially comparative vs. individual digital eco-driving feedback

Abstract:

In the global fight against climate change, eco-driving could contribute to the reduction of CO_2 emissions. Recommendations on how to drive more ecologically abound, but drivers may fail to implement them as they experience difficulties monitoring their own behaviour. Digital feedback systems can help. In a longitudinal experiment, we communicate eco-driving recommendations to a sample of drivers (N = 412). Over a seven week time frame (in addition to a 13-week pre-experimental baseline measurement), we test whether digital feedback using an eco-score index further improves eco-driving. We experimentally evaluate whether adding a competitive component to the feedback further impacts eco-driving, testing different types of socially comparative feedback. Our results show that competitive feedback may help reduce speeding (but not other aspects of eco-driving), irrespective of the type of social comparison provided, suggesting that possibly the competitive mind-set as such (rather than the specific information conveyed) triggers the partial eco-driving improvement.

Keywords: Eco-driving, telematics, feedback, competition, social comparison

Track: Social Responsibility & Ethics

Introduction

Eco-driving can be defined as the implementation of ecologically beneficial driving techniques like keeping the speed down, efficient gear shifting, anticipatory, calm and steady driving, and efficient braking (Strömberg, Karlsson, & Rexfelt, 2015). Eco-driving has multiple beneficial effects in terms of reducing greenhouse gasses and improving safety and well-being, while at the same time reducing fuel costs (Barkenbus, 2010; Fors, Kircher, & Ahlström, 2015; Lauper, Moser, Fischer, Matthies, & Kaufmann-Hayoz, 2015). However, realizing all these benefits on a large scale will require education efforts and social norm reinforcement (Barkenbus 2010). Digital feedback systems may be helpful to reach this objective.

Digital feedback systems constitute a promising and effective solution in steering driving behaviour in general and eco-driving in particular (Brouwer et al., 2015; Fors, Kircher, & Ahlström, 2015; Tulusan et al., 2012). In the current study, we investigate whether enriching an eco-driving digital feedback system with socially comparative information can further leverage its impact. Normative messages can have a stronger impact on behaviour than mere non-social factual information (Goldstein, Cialdini, & Griskevicius, 2008). Literature has shown that a competitive (social comparison) framing impacts behaviour in different contexts, including stimulating energy saving, lowering water consumption or stimulating physical exercise (Ferraro & Price, 2013; Fischer, 2008; Garcia et al., 2013; Gerber, Wheeler, & Suls, 2018; Hamari & Koivisto, 2015; Rimal & Real, 2005; Rolim et al., 2016; Suls, Martin, & Wheeler, 2002). However, little research has focused on the impact of competitive social comparison on eco-driving behaviour. Exceptions include an exploratory simulation-based study by Brouwer et al. (2015) which suggests that performance related comparative feedback may be effective in stimulating eco-driving. Inspired by these studies, we aim to further contribute to the literature by comparing the impact on eco-driving of individual feedback vs. different social comparison feedback types in a longitudinal experiment.

Conceptual development

Competitive behaviour is often fuelled by social comparison, i.e., the tendency to self-evaluate by comparing ourselves to others (Garcia et al., 2013). As mentioned earlier, different studies have already used socially comparative feedback to stimulate behaviours resulting in reduced energy consumption, water consumption, etc. Furthermore, this type of feedback often had a stronger influence on behaviour compared to mere non-social factual messages (Ferraro & Price, 2013; Fischer, 2008; Midden, Kimura, Ham, Nakajima, & Kleppe, 2011). In line with the outcomes of these studies, we believe that social comparison

can have a similar impact on eco-driving behaviour. Thus, we hypothesize: (H1) drivers who receive socially comparative feedback will drive more ecologically as compared to drivers who do not receive feedback; and (H2) drivers who receive social comparison feedback will drive more ecologically compared to drivers who receive non-social factual feedback.
Social comparison research has identified two types of group related comparison: (1) people compare themselves within a group, i.e., to members of the same group, called the in-group. The more people are similar to or identify with other members of their group, the more likely it becomes that social comparison ("intragroup comparisons"), and thereby competitive behaviour, might take place (Correll & Park, 2005; Garcia et al., 2013; Midden et al., 2011; Suls et al., 2002). On the other hand, research also indicates that comparing between groups (i.e., intergroup comparisons) can increase competitive behaviour between groups because of the perceived difference or dissimilarity between one's own group and another group. As a result, intergroup competition can enhance group performance (Bornstein & Erev, 1994; Correll & Park, 2005; Jetten, Spears, & Manstead, n.d.; Turner, 1975). In other words, there is evidence that both intragroup comparisons and intergroup comparisons can create comparison concerns and thus competitiveness. In the current study we compare intra- vs. intergroup competition as a means to stimulate eco-driving.

While doing so we pay special attention to the element of group identification. Group identification is an important factor in creating distinctiveness between groups and similarity within groups, and can therefore be an important factor stimulating competitiveness within and between groups (Garcia et al., 2013; Jetten et al., n.d.; Rimal & Real, 2005). According to Correll & Park (2005, p.349) "*Identification with an ingroup reflects the group's self-relevance, or the connection between the self-concept and the group as an aspect of identity*". According to self-categorization theory, normative and comparative fit are two factors causing an individual to identify with a group. Normative fit reflects the socio-cultural relevance, whereas comparative fit reflects how relevant a certain classification is in a given situation. In the current study, we compare categorizations using brands (which provides normative fit) to categorizations using technical engine specifications (which provides comparative fit). As to the former, previous research has shown the potential of brands as meaningful source of identification (Algesheimer, Dholakia, & Herrmann, 2005; Stokburger-Sauer, 2010, 2010; Zhou, Zhang, Su, & Zhou, 2012). Although in the latter classification (technical engine specifications) normative fit might be lower, the classification is relevant considering the topic (eco-driving) and might therefore have a strong comparative fit.

To sum up, we want to identify whether socially comparative feedback enhances eco-driving. Furthermore, we will test whether drivers in the social comparison setting drive more ecologically compared to drivers in a non-social factual feedback setting. Finally, we distinguish four types of competition defined along two dimensions: intragroup vs. intergroup competition, and with groups based on car brand vs. based on technical engine specifications. For each of these we test the impact on the outcome variables of focus.

Method

Employees (N = 458) of a financial services company voluntarily installed a dongle (black box) in their car to take part in a telematics test project. Sixteen participants were removed from the experiment because of technical issues, twenty-four participants were allocated to a training session that precluded participation in the current experiment, two participants were removed for being aware of the experimental set-up, and four participants were left out because of missing data, leaving a usable sample of N = 412 participants. All participants drive a lease car (company car), mainly used for commuting. Demographics were not available because of GDPR reasons.

We set up an experiment with six conditions, as shown in Table 1, comparing four competitive conditions to two non-competitive conditions (which did not receive social comparison feedback). At the start of the experiment, all participants received an e-mail with general information (including project timing), as well as more condition-specific information (about the eco-score for conditions 2 to 6, and about their respective competitions for conditions 3 to 6). Over the subsequent seven weeks, participants received weekly e-mails with a variety of validated eco-driving tips and tricks, e.g., drive at a constant, moderate speed; turn off the engine when idle; avoid harsh braking,… (Zhao et al. 2015). In addition, participants in condition 2 received their weekly individual eco-scores, plotted over time (i.e., one data point was added each week). Participants in the competitive conditions (3 to 6) received their weekly eco-score enriched with social comparison info.

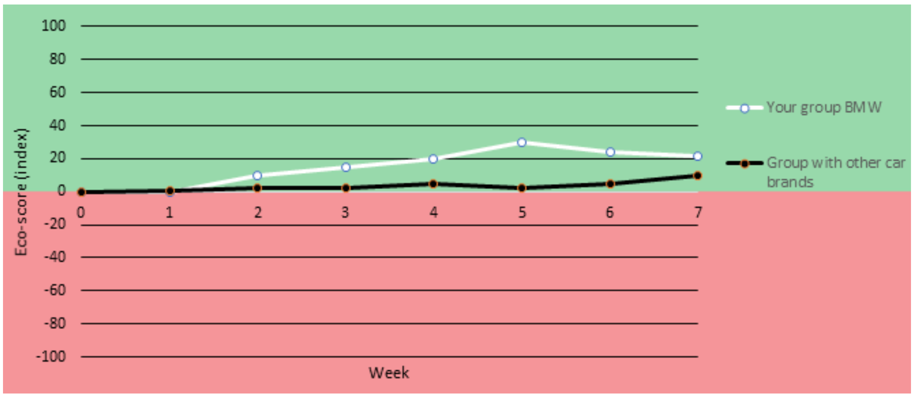
Table 1: experimental conditions

Condition			Competitive conditions			
	1 Control (no feedback)	2 Individual feedback	3 Inter-brand	4 Intra-brand	5 Inter-tech	6 Intra-tech
N	40	41	83	83	83	82
Tips	Yes	Yes	Yes	Yes	Yes	Yes
Grouping	None	None	Brand (k=12)	Brand (k=12)	Technical (k=12)	Technical (k=12)
Feedback	None	Individual eco-score	Between-group	Within-group	Between-group	Within-group

Note: experimental conditions were matched on car brand (13 brands), engine power (5 categories), and fuel type (3 types); k = number of groups.

Eco-scores are based on a weighted average of five sub-scores related to harsh braking, harsh acceleration, journey length (shorter journeys are less ecological), duration of driving at a speed above the optimally efficient speed, and duration of idling (the specific operationalization is owned and copyrighted by the digital feedback system provider). Eco-scores were communicated in the form of an index relative to a pre-experimental baseline (which was measured from the moment the dongle was installed till the start of the experiment). Thus, eco-score index = *Average eco-score week X – average eco-score pre-experiment baseline measurement.* The resulting index can range from -100 to 100 and the baseline score is zero by definition. In the competitive conditions, participants were performing better (worse) than their opponents when having improved more (less) compared to the baseline measurement than their opponents. This information was also presented in a graph (see Figure 1 for an example of a BMW driver in the inter-brand condition).

Figure 1. Personalized eco-score index plot in week 7, condition 3 (inter-brand)



All conditions received tips & tricks on how to drive more ecologically. In addition, condition 2 received individual feedback about its driving behaviour in the form of a weekly eco-score, but no social comparison feedback was provided. The four competitive conditions got socially comparative feedback that varied along two dimensions: group classification (based on brand vs. technical engine specifications, i.e., fuel type and power) and type of social comparison (within-group vs. between-group). For instance, condition 3 (inter-brand) compared the average of the drivers with the same car brand as the participant to the average of the other brands, whereas condition 4 compared a participant's individual score with the average of other same-brand drivers. A similar set-up was created for condition 5 and 6, but these within- and between-group comparisons were based on technical specifications.

Results

The data from the experiment have a multilevel structure, with weekly repeated observations nested within individuals, nested within groups (for conditions 1 and 2, all participants are treated as belonging to the same group). We use multilevel modelling to test the effects of the experimental manipulations on the individual trajectories of eco-score variables over time. More specifically, we use the THREELEVEL procedure in Mplus 7.0 with Bayesian estimation, using 10000 iterations and thinning to every fifth iteration. Although eco-scores were communicated as an aggregate score to participants, we will analyse not only the aggregate eco-score (which did not show significant effects, as discussed below) but also the five component scores separately in order to better understand the specific behaviours that were or were not affected. The five component scores consist of a score from 0 to 100 for braking, acceleration, idling, distance and speed, where a higher score indicates more ecological driving. Data is available for 13 weeks prior to the experiment (which was summarized into a single baseline score in the feedback to the respondent, but which is included as disaggregated data in the current analyses), and seven weeks in the experimental phase. At the within-individual level, for each dependent variable y, we estimate a latent curve by estimating an intercept term, a linear slope and a quadratic slope as follows. First, the intercept term is estimated by regressing y on a dummy variable that equals zero before and one during the experiment. Thus, the intercept represents the extent to which the average eco-score during the experimental phase is different from the eco-score in the 13 weeks preceding the experiment. In addition, we estimate a linear slope, for which the weeks during the experimental phase are coded 0, 1, 2,…,6, and a quadratic slope, for which experimental weeks are coded 0, 1, 4, 9, etc., representing the extent to which eco-scores increase over the course of the 7 weeks of the experiment. The latent curve parameters capturing the intercept, linear slope and quadratic slope are modelled as random coefficients that can freely vary across individuals and groups. At the between-group level, the latent curve parameters are regressed on dummy variables that represent the experimental conditions (see Table 1). Due to space constraints, we report detailed results only for the dependent variables for which statistically significant results were obtained.

In a first series of analyses, we compare the combined competitive conditions against condition 2 (individual feedback) and condition 1 (control group). Here, we find that no statistically significant experimental effects occur for the latent curve parameters of the aggregate eco-driving score. That is, the average intercept, linear slope, quadratic slope are not significantly different from zero and are not significantly affected by the experimental variables, with all $p > .10$. In sum, neither individual nor socially comparative feedback led to a significant improvement in eco-driving scores. However, in the analyses on the separate component scores (for braking, acceleration, idling, distance and speed), statistically significant effects are found for the eco-score components eco-speed and eco-distance. As for eco-speed, the average intercept, linear slope and quadratic slope are not significantly different from zero (all $p > .10$) and no significant effect on the eco-speed intercept was found of feedback ($B = 2.265$, $p > .10$) nor of socially comparative feedback ($B = -1.231$, $p > .10$). No significant effect of feedback (compared to the control condition) was found on the latent curve parameters (all $p > .10$). However, the competitive conditions (with socially comparative feedback, i.e., conditions 3 to 6) show a linear slope that is significantly more positive ($B = 1.749$, $p = .046$), but also a quadratic slope that is significantly more negative ($B = -.308$, $p = .032$), indicating that eco-speed improves at a decreasing rate relative to conditions 1 and 2. Contrary to expectations, for eco-distance the results indicate that socially comparative feedback has a negative effect on eco-distance slope ($B = -3.152$, $p = .004$) and a positive effect on eco-distance quadratic slope ($B = .374$, $p = .040$), suggesting that the decreasing trend levels off over time, even though it is not clear why the decrease initially occurs. In a second series of analyses, we test whether the four competitive conditions show significant differences with regards to the latent curve parameters. Here, also contrary to expectations, no significant effects are found.

Discussion

Surprisingly, neither feedback as such, nor socially comparative feedback had a positive impact on the aggregate eco-driving score. No differences were found between the four different social comparison conditions. Some possible explanations for the unexpectedly weak impact of the experimental manipulations include the following: (a) perhaps some previous results are limited to settings where drivers are focused on eco-driving without the day-to-day distractions drivers typically face in a longitudinal field experiment; (b) participants in the current experiment may have had limited degrees of freedom in terms of their driving behaviour, as all cars were leased company cars mostly used for commuting to work, typically during rush hours on heavily congested roads; (c) the specific format we used for providing feedback may be insufficiently engaging, as we wanted to have a clean manipulation without confounding factors (e.g., we did not include gamification approaches like leader boards). Also contrary to our expectations, social comparison had a negative impact on eco-distance scores over time during the experiment. This indicates that participants did more short trips during the experiment, which is currently hard to explain. One (not so plausible) possibility is that some people decided to ‘practice’ eco-driving techniques, overlooking the detrimental effect of short trips on their eco-score. Currently, we are running follow-up analyses to gain a deeper understanding of the data; these analyses also include a follow-up survey among participants that is sure to bring up additional insights that could feed the discussion at the conference (conditional on acceptance, of course).

On the positive side, and in line with previous literature on speeding behaviour, we found a significant positive impact of socially comparative feedback on the eco-speed score increase over time during the experiment (though the increase levelled off over the course of the experiment), suggesting that this aspect of eco-driving did show some improvement in response to competition. The finding that this effect did not vary across the different types of competition (i.e., intra- vs. intergroup, with groups defined by brand or technical characteristics of the engine) may suggest that it is not the substance of the socially comparative info that matters most, but the competitive mind-set that it engenders. This possibility needs further validation in future research.

References.

Algesheimer, R., Dholakia, U. M., & Herrmann, A. (2005). The Social Influence of Brand Community: Evidence from European Car Clubs. *Journal of Marketing*, *69*(3), 19–34.

Barkenbus, J. N. (2010). Eco-driving: An overlooked climate change initiative. *Energy Policy*, *38*(2), 762–769. https://doi.org/10.1016/j.enpol.2009.10.021

Bornstein, G., & Erev, I. (1994). The enhancing effect of intergroup competition on group performance. *International Journal of Conflict Management*, *5*(3), 271–283. https://doi.org/10.1108/eb022747

Brouwer, R. F. T., Stuiver, A., Hof, T., Kroon, L., Pauwelussen, J., & Holleman, B. (2015). Personalised feedback and eco-driving: An explorative study. *Technologies to Support Green Driving*, *58*, 760–771. https://doi.org/10.1016/j.trc.2015.04.027

Correll, J., & Park, B. (2005). A Model of the Ingroup as a Social Resource. *Personality and Social Psychology Review*, *9*(4), 341–359. https://doi.org/10.1207/s15327957pspr0904_4

Ferraro, P. J., & Price, M. K. (2013). Using Nonpecuniary Strategies to Influence Behavior: Evidence from a Large-Scale Field Experiment. *The Review of Economics and Statistics*, *95*(1), 64–73. https://doi.org/10.1162/REST_a_00344

Fischer, C. (2008). Feedback on household electricity consumption: a tool for saving energy? *Energy Efficiency*, *1*(1), 79–104. https://doi.org/10.1007/s12053-008-9009-7

Fors, C., Kircher, K., & Ahlström, C. (2015). Interface design of eco-driving support systems – Truck drivers' preferences and behavioural compliance. *Technologies to Support Green Driving*, *58*, 706–720. https://doi.org/10.1016/j.trc.2015.03.035

Garcia, S. M., Tor, A., & Schiff, T. M. (2013). The Psychology of Competition: A Social Comparison Perspective. *Perspectives on Psychological Science*, *8*(6), 634–650. https://doi.org/10.1177/1745691613504114

Gerber, J. P., Wheeler, L., & Suls, J. (2018). A social comparison theory meta-analysis 60+ years on. *Psychological Bulletin*, *144*(2), 177–197. https://doi.org/10.1037/bul0000127

Goldstein, N. J., Cialdini, R. B., & Griskevicius, V. (2008). A Room with a Viewpoint: Using Social Norms to Motivate Environmental Conservation in Hotels. *Journal of Consumer Research*, *35*(3), 472–482. https://doi.org/10.1086/586910

Hamari, J., & Koivisto, J. (2015). "Working out for likes": An empirical study on social influence in exercise gamification. *Computers in Human Behavior*, *50*, 333–347. https://doi.org/10.1016/j.chb.2015.04.018

Jetten, J., Spears, R., & Manstead, A. S. R. (n.d.). Similarity as a source of differentiation: the role of group identification. *European Journal of Social Psychology*, *31*(6), 621–640. https://doi.org/10.1002/ejsp.72

Lauper, E., Moser, S., Fischer, M., Matthies, E., & Kaufmann-Hayoz, R. (2015). Psychological

predictors of eco-driving: A longitudinal study. *Transportation Research Part F: Traffic Psychology and Behaviour*, *33*, 27–37. https://doi.org/10.1016/j.trf.2015.06.005
Midden, C., Kimura, H., Ham, J., Nakajima, T., & Kleppe, M. (2011). Persuasive Power in Groups: The Influence of Group Feedback and Individual Comparison Feedback on Energy Consumption Behavior. In *Proceedings of the 6th International Conference on Persuasive Technology: Persuasive Technology and Design: Enhancing Sustainability and Health* (p. 1:1–1:8). New York, NY, USA: ACM. https://doi.org/10.1145/2467803.2467804
Rimal, R. N., & Real, K. (2005). How Behaviors are Influenced by Perceived Norms: A Test of the Theory of Normative Social Behavior. *Communication Research*, *32*(3), 389–414. https://doi.org/10.1177/0093650205275385
Rolim, C., Baptista, P., Duarte, G., Farias, T., & Pereira, J. (2016). Impacts of delayed feedback on eco-driving behavior and resulting environmental performance changes. *Transportation Research Part F: Traffic Psychology and Behaviour*, *43*, 366–378. https://doi.org/10.1016/j.trf.2016.09.003
Stokburger-Sauer, N. (2010). Brand community: Drivers and outcomes. *Psychology & Marketing*, *27*(4), 347–368. https://doi.org/10.1002/mar.20335
Strömberg, H., Karlsson, M., & Rexfelt, O. (2015). *Eco-driving: Drivers' Understanding of the Concept and Implications for Future Interventions* (Vol. 39). https://doi.org/10.1016/j.tranpol.2015.02.001
Suls, J., Martin, R., & Wheeler, L. (2002). Social Comparison: Why, With Whom, and With What Effect? *Current Directions in Psychological Science*, *11*(5), 159–163. https://doi.org/10.1111/1467-8721.00191
Tulusan, J., Staake, T., & Fleisch, E. (2012). Providing Eco-driving Feedback to Corporate Car Drivers: What Impact Does a Smartphone Application Have on Their Fuel Efficiency? In *Proceedings of the 2012 ACM Conference on Ubiquitous Computing* (pp. 212–215). New York, NY, USA: ACM. https://doi.org/10.1145/2370216.2370250
Turner, J. C. (1975). Social comparison and social identity: Some prospects for intergroup behaviour. *European Journal of Social Psychology*, *5*(1), 1–34. https://doi.org/10.1002/ejsp.2420050102
Zhao, X., Wu, Y., Rong, J., & Zhang, Y. (2015). Development of a driving simulator based eco-driving support system. *Technologies to Support Green Driving*, 58, 631–641. https://doi.org/10.1016/j.trc.2015.03.030
Zhou, Z., Zhang, Q., Su, C., & Zhou, N. (2012). How do brand communities generate brand relationships? Intermediate mechanisms. *Journal of Business Research*, *65*(7), 890–895. https://doi.org/10.1016/j.jbusres.2011.06.034