Intentions, efficacy, and norms: The impact of different self-regulatory cues on reducing engine idling at long wait stops.

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Abstract

Idling engines contribute significantly to air pollution and health problems. In a field study at a busy railway crossing we used the Theory of Planned Behavior to design persuasive messages to convince car drivers ($N = 442$) to turn off their engines during long wait stops. We compared the effects of three different messages (focusing on outcome efficacy, normative reputation, or reflection on one's intentions) against a baseline condition. With differing effectiveness, all three messages had a positive effect compared with the baseline. Drivers were most likely to turn off their engines when the message focused on outcome efficacy (49%) or reflection (43%), as compared to the baseline (29%). The increased compliance in the normative reputation condition (38%) was not significantly different from baseline. Thus, stimulating self-regulatory processes, particularly outcome efficacy, is demonstrated to have a positive effect on pro-environmental driving behavior. Theoretical and practical implications are discussed.

1. Introduction

Individuals' energy use greatly contributes to greenhouse gas emissions (e.g., Druckman & Jackson, 2016). The behavior of drivers (e.g., engine idling) has been identified as an important contributor to unnecessary emissions, and hence is a key target for intervention (Dietz, Gardner, Gilligan, Stern, & Vandenbergh, 2009). These emissions also pose a health threat. For example, in the Netherlands, car, bus, and bicycle passengers along high intensity traffic routes were all exposed to significantly more particulate air pollution than those on low intensity routes (Zuurbier et al., 2010). To address these environmental and health hazards we developed a field study to test the effectiveness of messages designed to persuade drivers to switch off their engines to reduce engine idling during long waits at a railway level crossing.

1.1. Using Theory of Planned Behavior to encourage pro-environmental behavior

Theory of Planned Behavior (TPB) asserts that attitudes, norms, and perceived behavioral control lead to intentions which proximally predict action (Ajzen, 1991, 2002). This TPB framework is useful for developing interventions aimed at pro-environmental behavior (PEB). Traffic-related behavior, despite being considered an important category of research for TPB, is only rarely investigated (Steinmetz, Knappstein, Ajzen, Schmidt, & Kabst, 2016). We focused here on *norms*, *perceived behavioral control* (via *outcome efficacy*), and *intentions* as the basis for messages aimed at encouraging a pro-environmental behavior (engine switch-off) at a long-wait stop. With respect to Abraham and Michie's taxonomy (2008), our intervention falls in between a "persuasion" and a "motivation" behavior change method, which were identified as quite effective methods when paired with TPB framework (see Steinmetz et al., 2016).

1.1.1 Norms and reputation

To invoke norms, we designed a persuasive message appealing to social reputation (Emler, 1990). Indeed, norms are often invoked by signaling the reputational relevance of behavior (Abrams & Hogg, 1990), which plays a key role in determining whether the behavior will be adopted by the individual. It has been suggested that people are more willing to act in a prosocial (including pro-environmental) manner when they can acquire a reputation for doing so (Roberts, 2012). For example, participants invested greater sums in a climate protection program when their investment was made public, i.e. when they gained social reputation (Milinski, Semmann, Krambeck, & Marotzke, 2006). In a similar vein, university students reduced their energy consumption on campus when a delegate provided them with, and commented on, their consumption feedback, but not when the feedback was provided electronically and privately (Emeakaroha, Ang, Yan, & Hopthrow, 2014). Finally, avoidance of publicly deviating from ingroup PEB norms can also increase PEB (Player et al., 2018; see also Goldstein, Cialdini, & Griskevicius, 2008). For the "normative reputation" condition, we therefore developed a sign that asked drivers*: "When barriers are down, turn off your engine to show others you care*". This designed to subtly induce a reputational motivation (to be caring) to engage in PEB.

1.1.2 Perceived control and outcome efficacy

Our second persuasive message relied on the attitude component of TPB, specifically, evaluation of behavioral outcomes. Attitude toward the behavior is driven by beliefs about the consequences of performing the behavior, such as whether their behavior will have a positive outcome (Hausenblas, Carron, & Mack, 1997; McEachan, Conner, Taylor, & Lawton, 2011). PEB can often be regarded as a 'drop in the ocean' (Kerr, 1996; Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007), whereby an individual may feel that their single contribution will not have any impact, and therefore there is no point in acting. In contrast, outcome expectancy highlights the importance of an individual behavior in leading to a

particular outcome (Doherty & Webler, 2016). Efficacy over the outcome can have direct, positive, and significant influences on public behavior about climate change (Doherty & Webler, 2016) and recycling behavior (Lindsay & Strathman, 1997). Assuming that all drivers are capable of turning off their engines, the relevant goal for perceived control is their belief that they can affect air quality (i.e., outcome efficacy), rather than the lower level ability to turn off their engine.

Using outcome efficacy as the foundation, we therefore developed a message that asked: *"Please switch off your engine when barriers are down. You will improve air quality in this area"* (hereinafter labelled 'outcome efficacy'). This message aimed at showing the positive consequence of a simple action that was within the drivers' control.

1.1.3 Intention to act and self-reflection

The third persuasive message addressed intention to act. TPB asserts that intention is the closest predictor to behavior, with attitudes, norms, and perceived behavioral control as antecedents. However, an intention-behavior gap persists (see Sheeran & Webb, 2016), in part because people often forget to perform the behavior (Sheeran & Orbell, 1999). In cognitively demanding situations that involve multiple goals (such as driving), depleted cognitive resources can disrupt the link between an intention and its behavioral implementation, meaning that despite pro-environmental attitudes (and intention), the behavior is not actioned (Steg, Bolderdijk, Keizer, & Perlaviciute, 2014). Reminding people to consider their intentions could foster the enactment of consistent behavior. Indeed, studies found that simply questioning people about their behavioral intentions increased subsequent adoption of the behavior (mere measurement effect; see Godin et al., 2010; Todd & Mullan, 2011). Using a question to focus driver attention on their own behavioral intention about a salient action (switch off engine) should increase action. For this "reflection on intention"

condition, the message therefore asked drivers: *"When barriers are down do you intend to turn off your engine?"*.

2. Method

The study complied with ethical standards of the British Psychological Society and American Psychological Association, and was approved by the School of Psychology Ethical Review Board (# 20122491). We collected data on engine switch-off rates at a busy long-wait stop at the time of displaying one of three intervention signs (compared to baseline). We hypothesized that all messages would improve behavior relative to baseline and additionally explored differences in effectiveness between messages.

2.1 Sample

Data collection took place on 14 different days spread on a 6-month period (October 2012 to March 2013). Collection lasted for one hour at the time, between 8am and 6pm, Mondays to Saturdays. We randomly varied time of collection in order to reduce the chances that the same driver would be sampled repeatedly (e.g., while commuting to work), and so that intervention conditions would not be confounded with time of testing. Overall, 565 vehicles were sampled, a large majority of which were cars (n = 442).[1]

2.2 Materials and Procedure

2.2.1 Location and setting

Engine idling was observed at a busy level crossing in a medium-size city in the UK. The local council had erected a permanent sign asking people to switch off their engines that was visible before, and throughout the duration of the study (see supplementary material). The intervention messages were printed on a placard (420 × 594 mm; font type = Franklin Gothic medium, font size = 100 pt.), two meters above ground level. To ensure that that all vehicles would pass the sign on their approach to the level crossing, the placards, held by

[1] Other vehicles were excluded from analyses: see supplementary materials for N and justification.

stationary research assistants on the sidewalk, were positioned facing traffic on each side of the crossing, 75 meters before the barrier and approximately five meters from the existing council signs (futher detail on the methodology can be found in supplementary materials).

While the barrier was down and the vehicles were stationary, another research assistant walked along the sidewalk from the barrier toward the queuing traffic as far as the sign, discreetly recording whether each vehicle's engine was on (coded 0) or off (coded 1). This was assessed by viewing exhaust activity and listening for engine noise emitted from each vehicle (see supplementary materials for interrater reliability).

2.2.2 Intervention messages

We used three intervention messages: Normative reputation, Outcome efficacy, and Reflection on intentions, which were compared to a Baseline condition where no message was present (see Table 1).

Table 1

Intervention messages and sample size per condition

Type of Message	Text Displayed on Sign	*N*
Normative reputation	When barriers are down, turn off your engine to show others you care	113
Outcome efficacy	Please switch off your engine when barriers are down. You will improve air quality in this area.	117
Reflection on intention	When barriers are down do you intend to turn off your engine?	130
Baseline[2]	-- *no intervention sign* --	82

2.2.3 Control variables

It is possible that drivers' behavior is influenced by the weather (e.g., less likely to turn off the engine on a hot day where the car AC is on). To account for this, we coded for

[2] Previous research has confirmed that a person holding a sign containing no message at a long wait stop has no effect on driver behavior (Meleady et al., 2017).

each observation period the weather (rainy = -1, sunny or cloudy but dry = 1) and the visibility (dark or foggy = -1, visible = 1). Since a person's behavior can be impacted by the presence of others, we additionally recorded the number of people in the vehicle (M = 1.55, SD = .76). Most drivers were alone (58%) or accompanied by one passenger (32%), and the remaining vehicles had three or more people aboard.

3. Results

We conducted a hierarchical logistic regression to analyse the impact of the intervention messages on drivers' idling behavior. In a first step we included only the type of intervention as a predictor. To test more accurately the effect of the three interventions against the baseline, we computed the following contrast (hereinafter C1): Baseline = -3, Outcome efficacy = 1, Reflection = 1, Reputation = 1. We also entered the orthogonal contrasts in order to better estimate residuals (C2: Baseline = 0, Outcome efficacy = -2, Reflection = 1, Reputation = 1; C3 = Baseline = 0, Outcome efficacy = 0, Reflection = -1, Reputation = 1). In a second step, we additionally entered the three covariates: weather, visibility, and number of people in the car.

The analyses revealed a significant effect of the intervention messages. Relative to the baseline, drivers turned off their engine significantly more after exposure to any of the three messages. This effect held in the absence and presence of the covariates, which did not impact engine idling (see Table 2). Percentages of drivers that turned off their engine per experimental condition are illustrated in Figure 1.[3]

[3] The omnibus effect of the intervention messages was also significant, Wald's $\chi^2(3) = 8.06$, $p = .045$, Cox and Snell's $R^2 = .019$, Nagelkerke's $R^2 = .025$.

Table 2

Results of the hierarchical logistic regression testing the effect of intervention messages, weather, visibility, and number of people in cars, on drivers' idling behavior.

Step 1				
	OR	95% CI	Wald's χ^2	*p*-value
Constant	0.65	-	17.5	< .001
Intervention messages (Contrast 1)	1.18	[1.03, 1.34]	5.73	.017
Contrast 2	0.90	[0.78, 1.04]	1.96	.16
Contrast 3	0.90	[0.70, 1.17]	0.62	.43
Cox and Snell's R^2 = .020, Nagelkerke's R^2 = .026				
Step 2				
Constant	0.55	-	1.61	.21
Intervention messages (Contrast 1)	1.15	[1.00, 1.33]	4.07	.044
Contrast 2	0.97	[0.79, 1.12]	0.08	.78
Contrast 3	0.94	[0.72, 1.24]	0.18	.68
Weather	1.32	[0.77, 2.28]	1.01	.31
Visibility	0.86	[0.49, 1.49]	0.30	.58
Number of people in car	1.00	[0.77, 1.29]	0.00	.97
Cox and Snell's R^2 = .022, Nagelkerke's R^2 = .030				

Note: Contrast 1: Baseline = -3, Outcome efficacy = 1, Reflection = 1, Reputation = 1. Orthogonal Contrast 2: Baseline = 0, Outcome efficacy = -2, Reflection = 1, Reputation = 1; Orthogonal Contral 3: Baseline = 0, Outcome efficacy = 0, Reflection = -1, Reputation = 1.

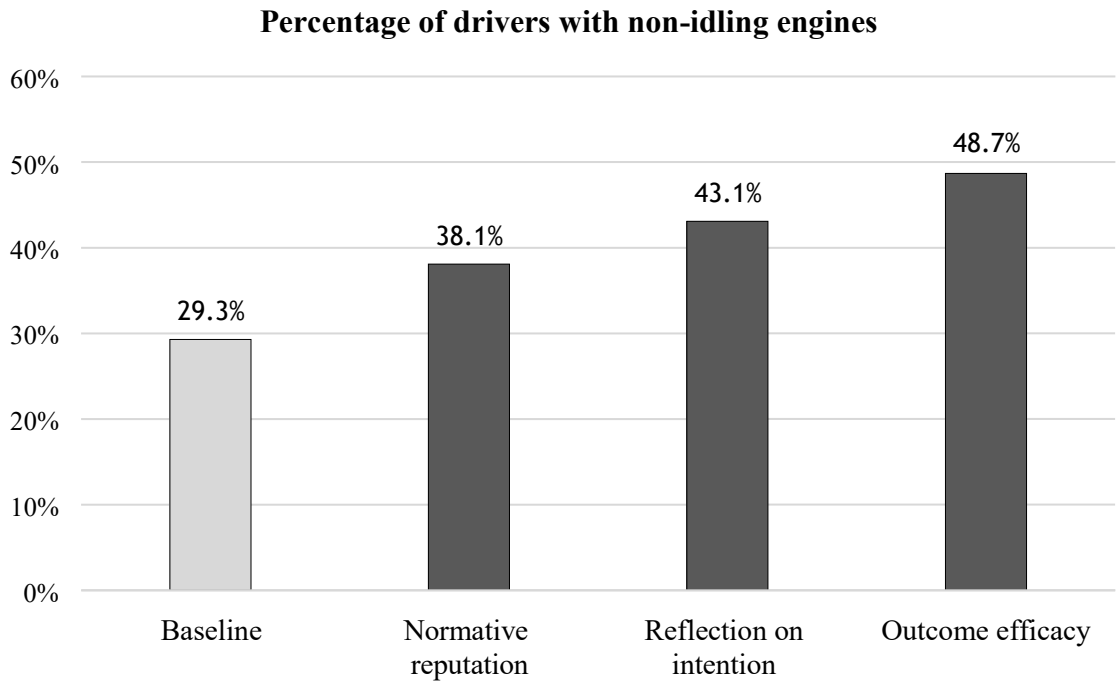

Figure 1. Percentage of cars with non-idling engines as a function of the intervention message. Baseline is a control condition with no message present.

To complement these results, we additionally tested the difference between each message and the baseline condition. The difference was significant for both Outcome efficacy, *OR* = 2.30, 95% CI [1.26, 4.18], Wald's $\chi^2 = 7.42$, $p = .006$, and Reflection on intention, *OR* = 1.83, 95% CI [1.02, 3.30], Wald's $\chi^2 = 4.04$, $p = .045$. It failed to reach significance for Normative reputation, *OR* = 1.49, 95% CI [0.81, 2.73], Wald's $\chi^2 = 1.62$, $p = .20$.

4. Discussion

4.1 The present results

In this experiment we tested the effectiveness of interventions aimed at encouraging PEB in a context where they are commonly rare. Drawing from TPB (see Steinmetz et al., 2016, for a recent meta-analysis), we hence tested the effectiveness of three messages (normative reputation: "…show others you care"; outcome efficacy: "…you will improve air

quality"; reflection on intention: "…do you intend to switch off?") to encourage drivers to turn off their engines at a long wait stop. Our aim was to test whether focusing on different aspects of behavioral regulation could be effective in triggering more environmentally positive behavior. Initial results showed that all messages led to higher compliance (higher rates of engine switch-off) than the baseline. However, analyses also revealed that not all messages had the same impact: despite descriptively increasing compliance (by 8.8 points), the reputation message did not significantly differ from baseline, whereas reflection and outcome efficacy did (by 13.8 and 19.4 points, respectively). Hence, the study shows that the mere presence of a person carrying a persuasive sign on the sidewalk is not enough to impact drivers' behavior: the content of the message is essential.

The normative reputation message aimed to motivate drivers based on opportunity to enhance their reputation by showing others they care (Steg et al., 2014). However, our results suggest that this was not enough to elicit behavior change. It is possible that drivers were not convinced that others would be able to detect their PEB, and hence that there was in fact little reputational gain to be achieved. Moreover, the message may have caused some dissonance for drivers with strong self-interest or hedonic values, and thus reduced the likelihood of action since the messaging opposed their existing belief system (Kollmus & Ageyman, 2002). This seems consistent with evidence that PEB messages can be effective when they target self-interest motives (Van de Vyver et al., 2018) or appeal to drivers with stronger hedonic or egoistic values (Steg et al., 2014).

The reflection on intention message aimed to target drivers with preexisting intentions to behave pro-environmentally who might not do so in certain settings because they are distracted or forget to enact their intentions. This message elicited significantly higher behavioral compliance than baseline, which is consistent with the mere measurement effect (Godin et al, 2010; Todd & Mullan, 2011). However, the nature of the message does restrict

its impact to receivers who already hold pro-environmental intentions. Drivers who are relatively unconcerned about the environment would be less likely to harbor intentions to turn their engines off, and therefore would not be influenced by the message. This might be especially important in the particular context of this study, since factors such as status and comfort have been found to influence behavioral choice (Gatersleben, Steg, & Vlek, 2002), so switching off the engine and losing other functions (such as heating/AC and radio) may outweigh the PEB.

Finally, the outcome efficacy message aimed to increase drivers' sense of efficacy and remove uncertainty regarding the effectiveness of their (non-idling) behavior. This message elicited significantly higher behavioral compliance than baseline and was, descriptively at least, the most effective message, increasing compliance by 66%. This remarkable effectiveness could be explained by the fact that the message went beyond the heightening of values and normative behavior by delivering a specific and positive message that the driver's personal contribution would make a difference to the environment (Doherty & Webler, 2016; Hine & Gifford, 1996; Meyerowitz & Chaiken, 1987; Morton, Rabinovich, Marshall, & Bretschneider, 2011; Webb & Eves, 2007).

4.2 Limitations, Future Research and Conclusions

This study has some limitations that must be acknowledged. First, observations were limited to one location. Future studies will need to ensure that the results can be replicated in different places. Moreover, the procedure relied on the presence of a research assistant to hold the placard. Even if past studies have ensured that the mere presence of a person on the sidewalk (holding a blank sign) did not significantly affect the rated of engine idling (Meleady et al., 2017), it may have somewhat altered the drivers' usual behavior. Future studies should therefore investigate the effect of messages attached to fixed poles. Finally, given the non-intrusive nature of the study, we assessed behavior but could not measure its

psychological antecedents. Hence, we cannot know of sure whether the messages impacted the targeted cognitions and/or others. It will be valuable to conduct additional experimental studies that test the impact of the messages on the relevant cognitions – but this goes beyond the scope of the present field study.

In sum, this study makes a substantial contribution by showing that behavior change towards PEB is sensitive to the way that persuasive messages tap into particular routes for self-regulation. It also raises interesting questions for future research about how different approaches might work in particular contexts and about how different aspects of self-regulation might feed into one another. The most effective message, outcome efficacy, led to a decrease of engine idling by 19.4% (corresponding to an increase in compliance by 66%). Relative to the usual traffic at the level crossing where the experiment took place, this impact would prevent the emission of 3,538 tons of CO_2 per year.[4] We believe that this can still be increased and the message made even more effective, notably by giving additional, specific details on the efficacy of the behavior (Steg & Vlek, 2009; Webb & Eves, 2007). For example, adding a specific outcome (e.g. engine switch off would improve air quality by X%) or by providing some sort of feedback to drivers (e.g. each car that switches off reduces pollution by X amount) could boost the effectiveness of the efficacy message still further.

[4] Calculation based on an average number of 13.8 cars queuing at the level crossing (*SD* = 5.41) in each direction of traffic and on average gas emissions by car when idling (https://www.nrcan.gc.ca/energy/efficiency/communities-infrastructure/transportation/cars-light-trucks/idling/4415).

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Supplementary Material:

Additional Considerations - Hypotheses and Baseline.

The rationale for the outcome efficacy condition is that drivers can generally be assumed to have complete control over whether or not their engine remains running. Therefore, the focus of the control is whether drivers' behavior can cause the intended outcome (outcome expectancy). Because the perceived control involves both a behavioral component and an outcome component we refer to this as outcome efficacy. We also note that the outcome in question ('improve air quality') might be interpreted as an evaluative element (i.e., closer to an attitude), but the distinction here is that there is no assumption that respondents should think that improving air quality (and objective effect) is good, necessary or desirable.

The rationale for the reflection on intention condition relies on (some) drivers having a generally pro-environmental intention when driving. Thus, although it seems reasonable that many drives might have such intentions, it is also conceivable that some actually hold anti-environmental behavior intentions, or simply no pro-environmental intentions. Therefore, in principle the effectiveness of the message might be limited because it only depends on a larger number of people being willing (but sometimes failing) to perform the behavior than those that prefer not to perform the behavior.

Prior research (Meleady et al., 2017) established there was no difference between baseline recordings when no placard was displayed versus when a blank placard was displayed (23% switched off engines,), and even when a simple instruction to 'turn off your engine when the barriers are down' is displayed. Moreover, the baseline rates in the present

study are similar to those in other studies using the same methodology in this context (Player et al., 2019; Van de Vyver et al., 2018). Across these studies the implication is that the simple presence of an RA holding a sign does not, in itself, reduce engine idling. Further, other persuasive messages were found to be ineffective in the past. For example, in Meleady et al. (2017), a pair of watching eyes did not change the percentage of compliance. Similarly, Player et al. (2018) found that a message based on outgroup prescriptive deviance was not effective. Hence, we are confident that not all messages work and it is their content that matters.

Additional Methodological Information

Sample. The sample size was determined by our interest in discovering a meaningful effect size (small to medium, w >= .20). An *a priori* power analysis indicated that, for non-parametric analysis, n = 100 per condition would provide power = .95 (α = .05), or power = .80. (α = .01). Other vehicles sampled were vans (n = 42), buses (n = 41), taxis (n = 25), lorries (n = 7), service vehicles (n = 5), and motorcycles (n = 3). Given that the driver's behavior for vehicles of these latter categories can be dictated by other rules or contingencies than for cars, and because their number was too small to formally test for effects of conditions, we focused our analyses solely on car drivers.

Materials and procedure. Barrier drops lasted on average 2.50 minutes (SD = 0.86), barriers dropped between four and six times per hour during the day, and between one and 17 cars were sampled in each barrier drop.

The sign randomization was predetermined by the PI who did not directly collect any data themselves. In total, 19 RAs supported data collection. Owing to availability of RAs and the ratio of male:female RAs, only female RAs were sign holders. Messages/signs were randomly distributed between sessions, ensuring that the same sign was used on each side of

the barrier so that drivers received the same messaging. Without advanced knowledge, RAs were assigned signs at the start of the session based on the predetermined allocation to condition. Thus, although RAs were not blind to condition, they were not aware of which condition they would be collecting data in until arriving at the data collection site, preventing them from having any control over which messages to display. While it remains possible that RAs could have acted subtly differently, depending on the sign they were carrying it is unlikely that different RAs would have conveyed the same subtle signs as one another in the same conditions. A further possibility is that, despite our having assigned each RA to different messages across sessions through randomization, the appearance or demeanor of a given RA on a given day could have played a role in the drivers' attention to the sign. However, we have to assume that randomization procedures mitigated this possibility as far as was feasible.

One might consider that a useful control condition would be to present the Council's sign again as a hand held sign. However, this would mean that the same message was presented twice (once on the fixed sign and again on the hand held sign). In order to make the other conditions comparable we would then have had to ask the Council to replace its fixed sign with the alternative messages in each condition. This would have made the randomization impractical because each change of permanent sign would have required formal application and consent and involved a significant delay. Moreover, we would still not necessarily know whether effects were due to dual presentation or to the content of the signs.

One female RA remained stationary holding the sign approximately 75 meters before the barrier and approximately five meters from the existing council signs. The sign holder was instructed to stand still, and not interact verbally or non-verbally with the other RAs or any road users so as to avoid drawing attention to their role. Starting at the barrier and

walking along the line of vehicles, the second RA recorded engine idling vs. switch off and other details for each vehicle. They did this by looking for exhaust activity and listening for engine noise from each vehicle.

Interrater reliability of this method had been established in a baseline (no placard) sample prior to the start of the main programme of research (reported by Meleady et al, 2017). These data confirm that there was high consistency (85% inter-rater agreement, *Cohen's kappa* = .62, $p < .001$) in the on/off codes of independent judges of the same vehicles. Discrepancies were inspected and instructions to observers were modified to eliminate ambiguities in the coding instructions for subsequent experiments.

A note was also made of number of passengers in each vehicle, as well as the time, duration of barrier drops, and weather during the barrier drop period. No interrater reliability was deemed necessary for these measures. Though it might have been optimal to measure temperature, it was not practicable to record a stable measure of temperature owing to the multi-location aspect of the research. It was also considered more useful to record the overall weather conditions that might affect driver's decisions to keep their engine running (e.g. rain) as these were more likely to vary in meaningful ways between barrier drops. Randomization also meant that there was no discernible relationship between weather conditions and engine idling, so we have little reason to expect temperature to be related to idling either in the present context.

Figure 1. The pre-existing council sign, present in all conditions.

Figure 2. Street scene with queuing traffic

Figure 3. Wording on the signs for the experimental conditions.

Please switch off your engine when barriers are down. You will improve air quality in this area

When barriers are down do you intend to turn off your engine?

When barriers are down turn off your engine to show others you care