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Rewarding safe and environmentally sustainable driving: a systematic review of trials

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ABSTRACT

The paper reviews trials designed to reward safe and environmentally sustainable driving. The most common type of trial offered monetary rewards to drivers for not speeding or for reducing mileage. Seven trials were identified. The most successful incentive schemes for reducing speeding were associated with a 60-80 percent reduction of speeding. Trials designed to reduce mileage were not as successful and resulted in mileage reductions of 0 to 10 percent. Small samples and high attrition rates (i.e. participants dropping out of the study before it was completed) characterized most trials. There is also likely to be self-selection bias, but the size of this bias is difficult to determine. Data for Sweden and Denmark suggest that it could be substantial. Hence, the effects found in the trials reported so far reflect what can be accomplished in groups of highly motivated drivers.

Key words: rewards, incentive systems, safe driving, environmentally sustainable driving

1 INTRODUCTION

Many years ago, Paul Hurst (*1*) wrote a paper entitled: Can anyone reward safe driving? At that time, technology that can monitor driver behavior hardly existed. Hurst was not too optimistic about the idea of effectively rewarding drivers for safe driving. He had noticed, however, that there were reports that drivers who continued driving after their license had been suspended tended to drive cautiously, so as not to attract the attention of the police or other drivers. In what he labeled a "Machiavellian" argument, he proposed that drivers could perhaps be motivated to safe driving by introducing a law many would be tempted to violate, but only by driving cautiously and inconspicuously, the way drivers with suspended licenses were driving.

Today, this line of reasoning is mainly of historical interest. There is technology which can monitor many aspects of driver behavior, notably speed, lane position, headway, use of turning indicators and kilometers driven. By installing such technology in cars, it is possible to reward safe and environmentally sustainable driving. The objectives of this paper are: (1) to systematically review trials rewarding safe and environmentally sustainable driving by means of pay-as-you-drive insurance schemes, (2) to synthesize the findings of these trials. As far as is known, this is the first paper summarizing trials rewarding driver behavior. The following main research problems will be discussed:

1. What types of rewards have been offered and how large are these rewards?
2. Do the rewards influence driver behavior?
3. Are the effects on driver behavior related to characteristics of the trials, in particular the size of the reward?
4. What are the principal methodological problems of studies that have evaluated the effects of pay-as-you-drive insurance schemes?
5. Can study findings be formally synthesized by means of meta-analysis?

Before presenting the studies that were retrieved, the concepts of safe and environmentally sustainable driving will be briefly defined. Safe driving denotes any changes in driving behavior that can be expected to reduce accident involvement. This includes, e.g. reducing speed, increasing following distance, abstaining from driving in high-risk conditions, such as at night, and reducing the distance driven. The concept of environmentally sustainable driving might strike some people as a contradiction-in-terms, since any use of a motor vehicle is associated with unwanted effects on the environment. This point of view is, however, not very helpful since it implies that the only way to avoid damaging the environment is by not driving a motor vehicle. In this paper, driver behavior will be regarded as environmentally sustainable if the amount of driving is reduced or if driver behavior reduces or minimizes fuel consumption and pollution emissions.

2 STUDY RETRIEVAL

Relevant studies were identified by searching ScienceDirect and TRIS using "pay-as-you-drive" as search term. Moreover, the ancestry approach was applied, i.e. studies were identified by examining the reference lists of papers identified in the literature

databases. Priority was given to papers reporting empirical research; in particular the effects on driver behavior of trials intended to motivate drivers to drive more safely or in a way that reduces impacts on the environment.

A total of seven trials reporting the effects of various types of pay-as-you-drive insurance schemes were found. This is a surprisingly small number, considering the fact that there seems to be great interest in developing insurance schemes that may improve safety. Moreover, the trials that were found differ in many important respects. It is therefore not easy to synthesize their findings. The next section reviews each of the trials.

3 REVIEW OF PAY-AS-YOU-DRIVE INSURANCE TRIALS

3.1 The Borlänge trial

The first trial that was found took place in September and October 2002 in the city of Borlänge, Sweden (*2-4*). A total of 95 drivers volunteered to join the trial, which was an extension of the trial with Intelligent Speed Adaptation (ISA) that took place in several cities in Sweden around 2000. Drivers were assigned to six groups:

1. A group offered a bonus of 500 SEK (1 SEK = 0.10 US Dollars in 2002) per month, with no incentive to change behavior.
2. A group offered a bonus of 250 SEK per month, with no incentive to change behavior.
3. A group offered a bonus of 500 SEK per month, from which 0.1-1.0 SEK was subtracted for each minute spent speeding. The amount subtracted depended of the level of speeding (up to 10 percent above speed limit, 11-20 percent above, more than 20 percent above)
4. A group offered a bonus of 250 SEK per month, from which 0.1-1.0 SEK was subtracted for each minute spent speeding, depending on the level of speeding.
5. A group offered a bonus of 500 SEK per month, from which 0.2-2.0 SEK was subtracted per minute spent speeding, depending on the level of speeding.
6. A group offered a bonus of 250 SEK per month, from which 0.2-2.0 SEK was subtracted per minute spent speeding, depending on the level of speeding.

The trial was small. Each group consisted of 16 drivers, except for group 6 which consisted of 15 drivers. A seventh group consisted of 19 drivers who refused to take part in the trial, but whose speed continued to be monitored by the ISA-device. The trial lasted two months. The stakes were highest for group 5. This group could earn 1,000 SEK during the trial, but lose up to 2 SEK per minute of speeding. If, as an example, a driver drives 20 minutes per day (60 days in two months), total driving time is 1,200 minutes. Spending 10 percent of the time speeding at the highest level would then carry a penalty of 2 x 120 = 240 SEK.

Effects were evaluated by comparing speeding in September 2002 (during) to September 2001 (before) and October 2002 (during) to October 2001 (before). Overall, the rate of speeding was reduced by about 35 percent from September 2001

to September 2002. The corresponding reduction from October 2001 to October 2002 was 43 percent.

3.2 The Belonitor trial

The Dutch Belonitor trial took place on the main roads of the country (*5*). Taking part in the trial offered reward points that could be used to take part in more than 100 activities as well as winning a monthly first prize worth 500 Euros (only one driver won this prize each month). The report does not state when the trial took place, but in 2002 500 Euros corresponded to about 470 US Dollars. The trial lasted about 16 weeks and rewarded drivers for keeping the speed limit and keeping a safe distance to the car in front of them. 62 drivers took part in the trial.

The maximum number of reward points earned was about 360. Each reward point was worth 0.04 Euros in the first two weeks of the trial, 0.02 Euros in the next two weeks and 0.01 Euros after five weeks.

Large reductions were found in both speeding and short following distances. Exact figures are not stated, but speeding was reduced by about 50 percent and short following distances were reduced by almost 60 percent immediately after the start of the trial. However, the effect on following distances gradually eroded during the trial and was down to about 30 percent when the trial ended.

3.3 The Minnesota pay-as-you-drive trial

The Minnesota pay-as-you-drive trial involved 130 households (*6*). 50 households were offered a mileage-based price selected randomly between 0.05 and 0.25 US Dollars per mile driven. Another 50 households continued to drive without the charge. The final 30 households formed a control group. The trial lasted three months.

Kilometers driven were reduced by 4.4 percent for those subject to the mileage-based charging system compared to those who did not pay per mile driven. There was a larger reduction in mileage among households who were assigned to the highest price per mile.

3.4 The North Texas pay-as-you-drive insurance trial

This trial took place in nine counties in North Central Texas (*7*). The trial was initiated by local government, but administered by Progressive Insurance. Car owners who had insured their cars at Progressive were offered to participate in a trial with pay-as-you-drive insurance. A total of 3,014 car owner volunteered to participate. The trial did not have a control group.

Participants were paid 50 US Dollars for uploading mileage data to Progressive after six months and again after twelve months. Participants could also earn 25 dollars for every five percent they reduced their mileage during a period of six months. They

could earn up to 175 dollars per six months or 350 dollars in total for the duration of the study.

Overall mileage was reduced by 4.7 percent. The largest reduction was found during low-volume daytime hours, the smallest reduction at night. There was a high rate of sample attrition, as only 1,173 cars of the 3,014 that were recruited completed all phases of the study. The report does neither state the mean age of study participants, nor their distribution by gender.

3.5 The Dutch pay-as-you-drive young driver trial

This trial was targeted at young drivers and offered a monthly discount on the insurance premium of up to 50 Euros (*8*) (about 73 US Dollars in 2008). 30 Euros could be earned by not speeding, 15 Euros by reducing mileage and 5 Euros by not driving during weekend nighttime hours. 100 drivers took part in the trial, 41 drivers served as a control group. The trial lasted four months. Data on driver behavior were collected before, during and after the trial.

The rate of speeding among drivers who took part in the trial was reduced by slightly more than 5 percent. In the control group, the rate of speeding increased during the same period. No effects were found for mileage and nighttime driving.

The effect on speeding in this trial was very small compared to the other trials discussed so far. The differences in effects found in the various trials will be discussed later in the paper.

3.6 The Danish pay-as-you-speed trial

The Danish pay-as-you-speed trial was targeted at young drivers (*9-10*). As the trial got underway, it turned out to be difficult to recruit the desired number of young drivers. The trial was therefore extended to include drivers of all ages. Drivers were randomly assigned to the following experimental conditions:

1. One group that was given information from an ISA-system in the car when they violated the speed limit.
2. One group who was offered a 30 percent discount on their insurance premium. Penalty points were assigned for speeding and earning the full discount was only possible by not speeding.
3. One group who was offered both the discount (with penalty points for speeding) and information about speeding.
4. A control group. The control group was neither given information about speeding nor offered an economic incentive.

A total of 146 drivers took part in the experiment. The experiment lasted for three 45-day periods. There was no change in the rate of speeding in the control group. The information group reduced their rate of speeding by about 33 percent; there was a slight tendency for the effect to erode towards the end of the experiment. The incentive group reduced the rate of speeding by about 25 percent. Finally, the group

that was exposed both to information and incentive reduced the rate of speeding by about 75 percent.

3.7 The Australian risk-based charging trial

This trial took place in Sydney, Australia, and included 148 drivers (*11-12*). Driver behavior was logged during a before-period of five weeks. Following this baseline period a kilometer-based insurance scheme was introduced intended to give incentives to reduce driving, drive less at night and speed less. During the baseline period, drivers had earned a budget, from which money was withdrawn if drivers did not reduce kilometers driven, the amount of nighttime driving and the amount of speeding. The maximum incentive (reward to be paid) for a driver who reduced kilometers driven by 15 percent, nighttime driving by 20 percent and speeding by 45 percent was estimated to be AUD 119 (equal to US Dollars 94 in 2009).

The trial lasted for four weeks. Overall kilometers driven were reduced by nearly 10 percent. There was no change in the number of kilometers driven at night. Kilometers driven speeding were reduced by 42 percent.

4 COMPARING THE TRIALS

4.1 Similarities and differences

The trials that were presented in section 3 have both similarities and differences. All the trials, except the North Central Texas pay-as-you-drive trial, are based on comparatively small samples. These samples were in all cases obtained by recruiting volunteers; i.e. the samples are self-selected and not drawn at random from a sampling frame. Therefore, none of the samples can be regarded as representative of the general population of drivers. There is likely to be self-selection bias in all studies, in the sense that those who volunteered to participate are likely to be more motivated to test the rewarding systems than other drivers and more willing to accept the detailed monitoring of their behavior required for the rewarding systems to function as intended. Table 1 lists key information about each trial.

All studies, possibly with the exception of the Dutch Belonitor trial, experienced considerable attrition, i.e. participants who withdrew and did not complete the study. Attrition rates (for those studies where they are stated or can be estimated) vary between 17 percent and 61 percent. It is likely that such high attrition rates reinforce self-selection bias.

There are also a number of differences between the studies. First, the targets for intervention differ. The most common target is speeding, but driving distance is also common. Night-time driving was targeted in two studies and following distance in one study.

Most of the trials included drivers of all ages, but two trials were targeted specifically at young drivers. Only the Dutch PAYD trial (*8*) succeeded in recruiting a sufficient number of young drivers to complete the trial. The Danish trial (*9-10*) did not succeed in recruiting enough young drivers and had to be extended to drivers of all

ages. The size of the reward offered also varied between trials. The maximum reward was highest in the Swedish and Danish trials (*2-4, 9-10*).

As for the effects of the trials, it is in most cases possible to extract several estimates of effect from each study. To give an example, an early presentation of the Swedish pay-as-you-speed trial (*2*) contains a total of 204 estimates of effect (24 in Table 1; 36 in Figure 4; 24 in Table 2; 48 in Table 3; 24 in Table 4; 36 in Figure 5; 12 in Figure 6). This obviously gives a very detailed picture of the results of the trial. It also allows for examining whether there is a dose-response pattern in the results. On the other hand, it makes it more difficult to extract the best summary estimate of effect from the study. It is also clear that many of the estimates of effect are highly uncertain and based on very small sample sizes – in some cases down to 10 drivers.

The problem of extracting a single best summary estimate of effect from studies presenting multiple estimates of effect is compounded by the fact that, in many studies, there are many ways of estimating effects. The Dutch pay-as-you-drive trial involving young drivers is a case in point (*8*). Data on speeding were recorded four times for both the incentive group and the control group:

1. Before the start of the trial
2. During the first phase of the trial
3. During the last phase of the trial
4. After the end of the trial

The percentage of distance driven while speeding in these four periods in the incentive group was, respectively, 18.6 %, 17.7 %, 17.6 % and 20.5 %. The corresponding percentages in the control group were: 17.9 %, 19.0 %, 19.7 % and 19.7 %. When commenting on these changes, the authors of the study only make within-group comparisons, e.g. they test the differences in the incentive group between 18.6 % and 17.6 % statistically. This, however, is only one way of estimating effects. Some examples of the many ways effects in this trial can be estimated are:

Within-group speeding rate-ratio (incentive): 17.6/18.6 = 0.946 = 5.4 percent reduction in speeding.

Between group speeding rate-ratio (odds ratio): (17.6/18.6)/(19.7/17.9) =0.860 = 14.0 percent reduction in speeding.

Difference in differences: (17.6 – 18.6) – (19.7 – 17.9) = –1.0 – (+1.8) = –2.8 percentage points reduction in speeding.

Which of these estimators of effect is the best? None of them are wrong, but they do not convey the same information. Estimators that utilize as much of the information contained in the study as possible would often be regarded as best, but these estimators may be associated with a larger variance than simpler estimators. If, in the Dutch study which is used here as an example, one thinks that the control group provides information about how speeding would have developed in the absence of the trial, then an estimator of effect that relies on data for both the incentive group and the control group should be preferred to an estimator of effect that ignores information about the control group.

4.2 The possibility of synthesizing study findings by means of meta-analysis

Can the findings of the studies discussed above be formally synthesized by means of meta-analysis? Meta-analysis is feasible whenever there are:

1. Multiple statistically independent estimates of the effect of the same or similar treatments.
2. The statistical precision of each estimate of effect is known or can be calculated.

It is clear that both requirements are problematic with respect to the studies presented above. As noted, many of these studies present multiple estimates of effect. These estimates cannot be regarded as statistically independent, since many of them are based partly on the same data, for example comparing different treatment groups to the same control group. Data for the control group will then be identical for all treatment groups, which will make the estimates of effect correlated. To make sure estimates are statistically independent, it would therefore seem necessary to extract a single estimate of effect from each study. A drawback of doing so would be that important information is lost, for example information showing that different treatments are associated with different effects.

Most studies present statistics intended to show uncertainty in estimates of effect. These statistics differ from study to study and it is not entirely clear how to convert the different statistics to a common metric. Besides, not all studies state uncertainty in the results. The statistical precision of estimates of effect is therefore not known for all studies. An alternative might be to base a synthesis on the sample size for each estimate of effect.

Despite these difficulties, an attempt has nevertheless been made to compare the findings of the studies discussed in section 3. This comparison is not a meta-analysis; it is more akin to a structured interpretation of study findings. The comparison consists of the following steps:

1. Identify studies with identical targets (e.g. all studies targeting speeding).
2. For studies presenting data for a control group, estimates of effect were stated as odds ratios, i.e.: (after in treated group/before in treated group)/(after in control group/before in control group).
3. For studies containing more than one group or treatment, the most and least effective treatments were identified.
4. For studies containing only a single treatment whose effects were measured at several points in time, the largest and smallest effects were identified.
5. Compare the effects of the most and least effective treatments between studies.

Table 2 reports the results of this comparison for studies targeted at speeding. There is a high level of consistency in study findings for all studies, except the Dutch study that was targeted at young drivers. The effects found in that study were considerably smaller than in the other studies. The most effective incentive systems reduce the rate of speeding by 60-80 percent. The least effective incentive systems are apparently also associated with a reduction in speeding, although much smaller than the most effective incentive systems. Note that in two of the studies, the Dutch

young driver trial (*8*) and the Australian risk-based charging trial (*11-12*), all participants were subject to the same incentive system. The comparison in these two studies is therefore either between different phases of the trial (the Dutch trial) or between drivers who were influenced by the incentives and drivers who were not (the Australian trial).

The trials offered drivers very different maximum rewards. The largest reward was offered in the Danish trial, 700 Euros (about 1020 US dollars in 2008). To earn the entire reward, a driver had to avoid any speeding. In one of the experimental groups, drivers reduced speeding by close to 80 percent. If the assumption is made that the amount paid to drivers is proportional to the reduction of speeding, drivers reducing their speeding by close to 80 percent would be rewarded by about 553 Euros. Similar estimates of the effective reward paid to drivers were made for the other trials quoted above. The results are presented in Figure 1.

There is a very clear dose-response pattern, which makes sense according to economic theory. A logarithmic function fits the data very well. The most effective incentive systems are very effective and go a long way towards eliminating speeding. The results of these trials show that it is indeed possible to effectively reward safe driving. How about trying to reward drivers for reducing their driving? Only four trials targeting mileage have been found, and their percentage effects are much smaller than the effects found in the trials targeting speeding. In the Minnesota pay-as-you drive trial (*6*), overall mileage was reduced by only 4.4 percent. The largest reduction was found for weekend travel (8.1 percent), the smallest for weekday off-peak travel (3.3 percent). The trial in North Texas resulted in an only slightly greater overall reduction of mileage, at 4.7 percent (*7*). The reduction ranged from 5.7 percent in daytime to 3.6 percent at night. The Dutch young driver trial (*8*) did not find any effect on driving distance. The Australian trial (*11-12*) found an overall reduction of kilometers driven of 9.8 percent. Recreational travel was reduced by 17.6 percent, whereas shopping and personal business travel increased by 1 percent.

5 DISCUSSION

The possibility of promoting safer and more environmentally sustainable driving by means of rewards has been discussed for a long time. It is, however, only during the last 10-15 years that technology for monitoring driver behavior has become sufficiently reliable to implement field trials designed to reward drivers for driving less, complying with speed limits, curtailing night-time driving or keeping a safe distance to vehicles in front of them. Rewarding people for doing the right thing is generally regarded as more desirable and more effective than punishing them for doing the wrong thing. Still, there have been few trials designed to reward drivers. These few trials differ greatly among themselves, but a common problem is difficulties in recruiting drivers, high attrition rates and small sample sizes. Moreover, the drivers who volunteer for the trials are unlikely to be representative of drivers in general. In particular, drivers who sign up for pay-as-you-speed trials may be less likely to speed than other drivers and therefore more likely to earn the reward offered.

It is difficult to determine precisely how large the self-selection bias is. In the Swedish trial (*2-4*), drivers were speeding 13-17 percent of their driving time before the trial. At the time of the trial, about 55 percent of traffic in Sweden was speeding (*13*). The rate of speeding was therefore, as one might suspect, considerably lower among drivers joining the trial than among drivers in general.

The rate of speeding among the Danish drivers who took part in the ISA-reward trial was 10-17 percent before the start of the trial. The mean speed of these drivers on roads with a speed limit of 80 km/h was 5-10 km lower than the mean speed of traffic on these roads. On roads with a speed limit of 50 km/h, trial drivers drove 3-5 km/h slower than the mean speed of traffic (*10*).

These comparisons suggest that drivers taking part in the pay-as-you-speed trials were less likely to speed than other drivers. Complying even better with speed limits was therefore comparatively easy for these drivers and did not add much to their travel time. The cost of complying with speed limits, both in terms of longer travel time and in terms of driving at a lower speed than the most preferred, would be greater for drivers speeding more often. An incentive system might be less effective for these drivers.

Unfortunately, most trials do not report whether effects were related to how frequently drivers were speeding before the trial. The only trial to report this kind of information is the Australian risk-based charging trial (*12*). The trial found a positive correlation between the rate of speeding before the trial and the rate of speeding after the trial. The data had a correlation of 0.54 with a line of proportionality showing no effect. These data do not lend strong support to the hypotheses that drivers who commonly speed will reduce their speeding more than drivers who rarely speed when monetary incentives are given for not speeding.

A related point is that drivers taking part in the trials knew that their behavior was being monitored even before the rewarding systems took effect. This may have influenced behavior. In some trials, drivers earned a budget based on their baseline behavior. This may have given drivers an incentive to adapt behavior so as to earn the largest possible budget. When rewarding started, some drivers may have felt that they could afford to spend a fair amount the budget they had earned, in particular if they would still earn a net reward.

It is therefore doubtful if the results of the trials designed to reward drivers for complying with speed limits can be generalized to drivers in general. There is a risk that the effects found in the trials presented in this paper are larger than those that would be found among drivers who speed more frequently.

An interesting question is whether it is possible to overcome self-selection bias and design systems that would be attractive even to high-risk drivers. Unfortunately, the studies that have been reported so far do not give much reason for optimism in this respect. A study of the use drivers made of a voluntary ISA (Intelligent Speed Adaptation) system (*14*) found that drivers who enjoyed speeding used the system less often than drivers who were more inclined to comply with speed limits. The Danish ISA-trial (*9*) experienced greater difficulties in recruiting young drivers, a high-risk group, than in recruiting middle-aged drivers. A study of incentives to

tempt drivers to buy cars with Intelligent Speed Adaptation (ISA) (*15*) found that very strong incentives must be offered to persuade drivers who dislike ISA to buy a car having such a system. Many years ago, Leonard Evans (*16, 17*) found that drivers wearing seat belts were less often involved in accidents than drivers not wearing seat belts. Self-selection bias with respect to voluntary use of safety measures thus appears to be a common phenomenon, which is perhaps not easy to counteract.

There is little doubt that the effects found in the trials reviewed in this paper are real, not methodological artifacts. The observed reductions in speeding are, for example, not likely to be the result of regression-to-the-mean, chance variation, faulty speed data or a sudden increase in congestion leading to reduced speed. The trials therefore show that it is possible by means of rewards to motivate people to drive less and comply better with speed limits. These effects were, however, observed in samples who volunteered for the trials and who were probably more motivated to change behavior than drivers in general. Moreover, effects on the number of accidents or on pollution were not evaluated in any of the trials.

6 CONCLUSIONS

The main conclusion of the study presented in this paper can be summarized as follows:

1. Modern technology offers the possibility of monitoring driver behavior in great detail. This creates a possibility for rewarding safe behavior.
2. A limited number of trials have been reported in which drivers were rewarded for reducing their driving, complying with speed limits, not driving at night and keeping a safe distance to cars ahead of them.
3. All these trials have been successful in promoting the behavior that was rewarded. The largest effects were found in trials rewarding compliance with speed limits. Rewarding drivers for driving less has had smaller effects.
4. In all trials, drivers volunteered to participate in the trial. This is likely to generate self-selection bias. The effects found represent the effects of the incentive systems among drivers who were more highly motivated to test such systems than drivers in general.
5. In planning future trials, it may be relevant to use as preliminary guidelines that: (1) Speeding is the most promising target for incentives among those tested so far; (2) The larger the incentives, the greater the effects; (3) There is a risk that incentives become less effective over time; continuous monitoring of behavior is therefore needed.

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LIST OF TABLES AND FIGURES

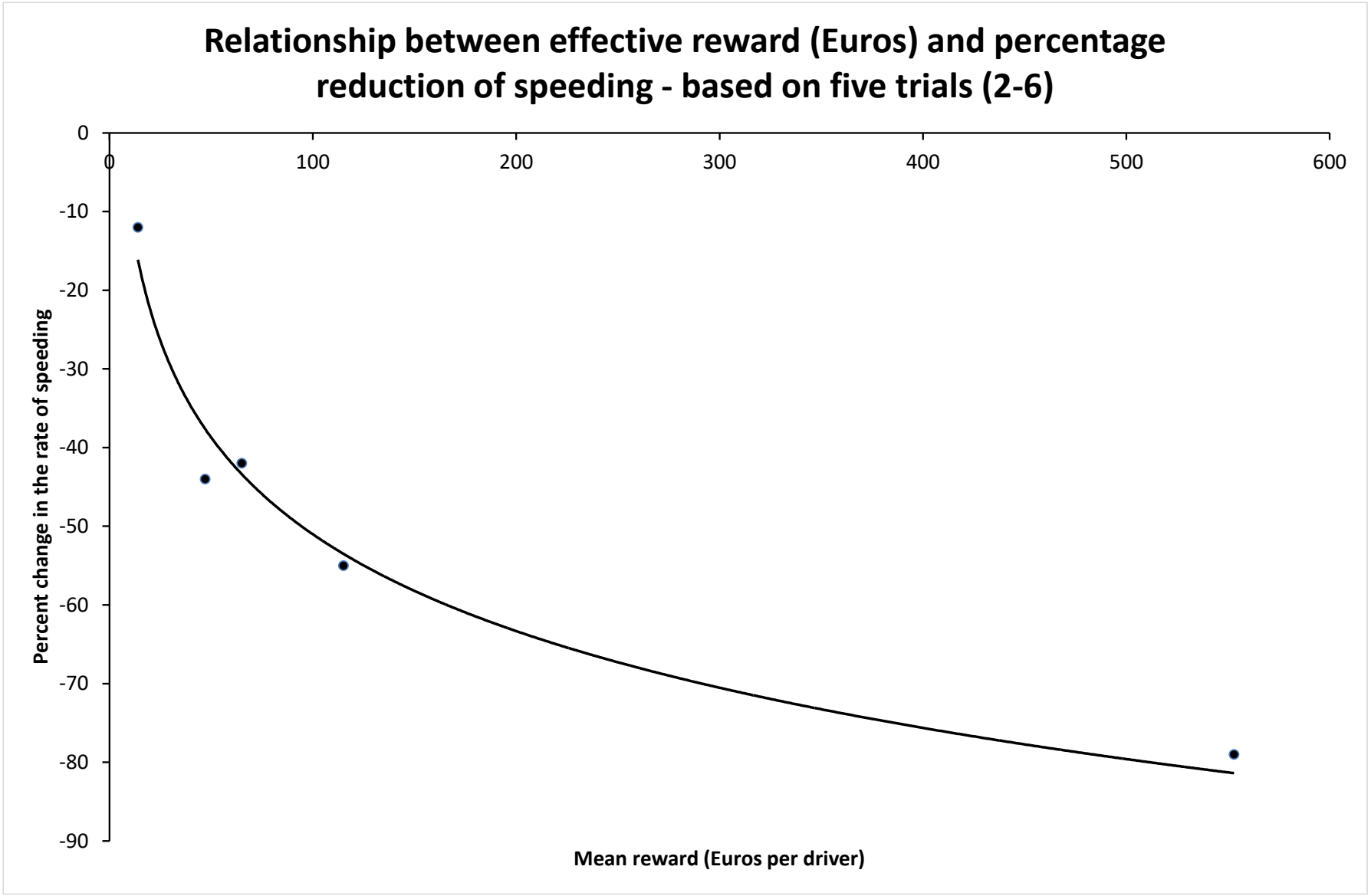
TABLE 1:

	Trials in chronological order (PAYS = Pay-as-you-speed; PAYD = pay-as-you-drive)						
Characteristics of trial	**Borlänge PAYS**	**Dutch Belonitor**	**Minnesota PAYD**	**Dutch PAYD**	**Danish PAYS**	**Texas PAYD**	**Australian PAYD**
Total sample size	114	212	130	228	146	3,014	148
Treatment conditions	6 conditions	1 condition	2 conditions	2 conditions	3 conditions	1 condition	2 conditions
Treatment group(s)	16-16-16-16-16-15	62	48-51	100 (at end of study)	36-36-36	3,014	26-80
Control group	19	150	31	41 (at end of study)	37	No control group	29
Mean age in sample (years)	57	47	Not stated	24	39	Not stated	41
Percent female	26	2	Not stated	40	36	Not stated	58
Treatment attrition rate	17 % (September); 51 % (October)	Not stated; could be zero (Table 1)	24 % (at end of study)	38 % (228 at start; 141 at end of study)	38 % (146 at start; 91 at end of study)	61 % (3,014 at start; 1,173 at end)	28 % (148 at start; 106 at end of study)
Targets for treatment	Speeding	Speeding; following distance	Distance driven	Distance driven; speeding; night-time driving	Speeding	Distance driven	Distance driven; speeding; night-time driving
Maximum reward	1000 SEK	500 Euro (lottery win)	Mileage budget based on before-period	50 Euro insurance discount per month	700 Euro	350 US Dollars	Mileage budget based on before-period
Penalty	0.1-1.0 or 0.2-2.0 SEK/minute speeding	No penalty was implemented	Entire budget spent if distance was the same; gain by reducing driving	The entire discount could be lost by not changing behavior	0.07 Euro per penalty point (points depended on level of speeding)	No penalty, but reward could only be earned by reducing mileage	0.15-1.20 or 0.20-2.40 AUD/km
Change in rate of speeding, following distance or night-time driving	–35 % (all treatment groups; September) +14 % (control group; September)	–50 % for speeding; –60 % for short following distance	Not relevant for study	–5 % (speeding; treatment group) +10 % (speeding; control group); no change in night-time driving	–33 % (information); –27 % (incentive); –80% (incentive and information); no change in control group	Not relevant for study	–42 % for speeding; +1 % for night-time driving
Change in kilometers driven	Not stated	Not stated	–4.4 %	No change	Not stated	–4.7 %	–9.8 %
Dose-response pattern	Yes, partly	Yes, effects tended to reduce as the reward was reduced	Yes, higher price associated with larger reduction in driving	The study did not test for a dose-response pattern	Yes, combined incentive and information most effective	The study did not test for a dose-response pattern	Yes, a large budget was associated with larger rewards

TABLE 2:

Trial	Largest percentage effect	Group in which observed	Smallest percentage effect	Group in which observed
Borlänge trial	–75	High bonus, high price	–33	Low bonus, low price
Dutch Belonitor trial	–69	Week 2 of trial (bonus 0.04 Euro)	–44	Week 11 of trial (bonus 0.01 Euro)
Dutch young driver PAYD trial	–14	Phase 2 of trial	–10	Phase 1 of trial
Danish PAYS trial	–79	Information and incentive	–31	Incentive only
Australian PAYD trial	–62	Those who made money	–2	Those who did not make money

FIGURE 1:


Relationship between effective reward (Euros) and percentage reduction of speeding - based on five trials (2-6)
0
0
100
200
300
400
500
600
-10
-20
-30
-40
-50
-60
-70
-80
-90
Percent change in the rate of speeding
Mean reward (Euros per driver)