



The impact of immediate or delayed feedback on driving behaviour in a simulated Pay-As-You-Drive system



Chris Dijksterhuis*, Ben Lewis-Evans, Bart Jelijs, Dick de Waard, Karel Brookhuis, Oliver Tucha

Neuropsychology, University of Groningen, The Netherlands

ARTICLE INFO

Article history:

Received 12 September 2014

Received in revised form 29 October 2014

Accepted 20 November 2014

Available online 26 November 2014

Keywords:

Usage based insurance

Behavioural feedback

Distraction

Intelligent transport system

ABSTRACT

Pay-As-You-Drive (PAYD) insurance links an individual's driving behaviour to the insurance fee that they pay, making car insurance more actuarially accurate. The best known PAYD insurance format is purely mileage based and is estimated to reduce accidents by about 15% (Litman, 2011). However, these benefits could be further enhanced by incorporating a wider range of driving behaviours, such as lateral and longitudinal accelerations and speeding behaviour, thereby stimulating not only a safe but also an eco-friendly driving style. Currently, feedback on rewards and driver behaviour is mostly provided through a web-based interface, which is presented temporally separated from driving. However, providing immediate feedback within the vehicle itself could elicit more effect. To investigate this hypothesis, two groups of 20 participants drove with a behavioural based PAYD system in a driving simulator and were provided with either delayed feedback through a website, or immediate feedback through an in-car interface, allowing them to earn up to €6 extra. To be clear, every participant in the web group did actually view their feedback during the one week between sessions. Results indicate clear driving behaviour improvements for both PAYD groups as compared to baseline rides and an equal sized control group. After both PAYD groups had received feedback, the initial advantage of the in-car group was reduced substantially. Taken together with usability ratings and driving behaviours in specific situations these results show a moderate advantage of using immediate in-car feedback. However, the study also showed that under conditions of feedback certainty, the effectiveness of delayed feedback approaches that of immediate feedback as compared to a naïve control group.

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1. Introduction

Pay-As-You-Drive insurance (PAYD), where insurance customers are charged directly for when, where, and how they drive, is now possible thanks to modern information and communication technology. PAYD addresses many problems with traditional insurance in that it is more fair, and transparently charges users for their own driving behaviour, rather than the behaviours of an aggregate group, and lessens the financial impacts of insurance on lower socioeconomic groups in particular (Adkins, 2004; Litman, 2005, 2011; Bordoff and Noel, 2008). Indeed, some estimates of PAYD in the USA have suggested that if mileage based PAYD was

implemented, where you pay insurance based on the distance you drive, two thirds of households would benefit with savings of around \$270 USD per car per year (Bordoff and Noel, 2008; Litman, 2011).

The potential benefits of PAYD insurance are not only limited to individual insurance customers. Rather, it is estimated that PAYD would also have significant societal impacts, including possible reductions in mileage of up to 8–12% (Harvey and Deakin, 1998; Adkins, 2004; Balcombe et al., 2004; Litman, 2005, 2011; Bordoff and Noel, 2008). Such reductions in mileage could be associated with total accident reductions of 12–18% (Litman, 2011). Furthermore, it is estimated that even an 8% reduction in mileage would reduce carbon dioxide emissions by 2% and petrol consumption by 4%. This reduction in petrol consumption would be equivalent to the effect of a \$1 USD per gallon increase in the price of petrol (Bordoff and Noel, 2008).

The above estimates are mostly based on economic and transport models and therefore may or may not completely reflect reality. Assessing the real world impacts of PAYD insurance, however, is difficult as PAYD has not been widely adopted and data

* Corresponding author at: Grote Kruisstraat 1/2, 9712 TS Groningen, The Netherlands. Tel.: +31 50 363 6923; fax: +31 50 363 6304.

E-mail addresses: c.dijksterhuis@rug.nl (C. Dijksterhuis), b.lewis-evans@rug.nl (B. Lewis-Evans), d.de.waard@rug.nl (D. de Waard), k.a.brookhuis@rug.nl (K. Brookhuis), o.m.tucha@rug.nl (O. Tucha).

on its effectiveness are obviously commercially sensitive. A few research projects have been carried out and have tended to find significant positive impacts of PAYD on driving, yet these impacts have been somewhat more modest than those predicted by modellers. Reported effects have included reductions in speeding in the case of Pay-As-You-Speed additions to PAYD insurance (Mazureck and van Hattem, 2006; Bolderdijk et al., 2011; Greaves and Fifer, 2011), and reductions in mileage under both Pay-As-You-Speed (Greaves and Fifer, 2011) and mileage based PAYD conditions (Buxbaum, 2006).

As already hinted at above, there can be many types of PAYD insurance. Ranging from pre-paid options, where customers pre-purchase a certain number of miles and are then charged based on additional mileage driven, to full behaviour based telematics PAYD insurance, where drivers can be rewarded or penalised based on not only how much they drive, but also on where, when, and how they drive (Litman, 2005, 2011; Bordoff and Noel, 2008). This, later, behaviour based PAYD could be hypothesised to be more effective than simple mileage based PAYD due to its capability to provide richer feedback on driver behaviour that is currently sorely lacking in the road environment (Thorndike, 1911; Watson, 1917; Näätänen and Summala, 1974; Skinner, 1974; Fuller, 1984; Rothengatter, 1988, 2002). The potential impact of behaviour based PAYD is important, as the earlier provided estimates for the effectiveness of PAYD insurance are mostly based on a simple mileage based charge (Harvey and Deakin, 1998; Adkins, 2004; Balcombe et al., 2004; Litman, 2005, 2011; Bordoff and Noel, 2008) due to the well-established link between mileage and accident risk (Bordoff and Noel, 2008; Litman, 2011). Therefore, if more behavioural focused PAYD insurance was effective, in addition to a mileage based system, the positive impacts on society may be further enhanced.

When examining the possibilities of behaviour based PAYD insurance there is one promising behavioural candidate that could be used with modern technology; acceleration behaviour. Acceleration behaviour can be taken as an indication of both risky and environmentally unfriendly driving and is relatively easily monitored by modern telematics (AfWählberg, 2008; Barkenbus, 2010; Dorn, 2014). In addition to acceleration, given that telematics PAYD already tends to involve GPS tracking, there is also an opportunity to add advisory intelligent speed adaptation (ISA) to telematics based PAYD insurance. Simply put, advisory ISA provides warnings to drivers when they exceed the speed limit and has been shown to enhance the impacts of PAYD insurance (Lahrmann et al., 2012), as well as having significant speed reducing qualities by itself (e.g., Brookhuis and de Waard, 1999; Sundberg, 1999; Päätao et al., 2002; Lahrmann et al., 2012).

When considering PAYD insurance, behaviour based or otherwise, one way to look at PAYD is effectively a delivery system for incentives, i.e. for rewards and penalties. Therefore, it is important that the incentives are structured and presented correctly within any PAYD insurance product to maximise their effectiveness. Both rewards and penalties are effective when behaviour is relatively certain to be rewarded or penalised and when the reward or penalty follows swiftly after the target behaviour (Skinner, 1974; Abrahamse et al., 2005; Lehman et al., 2014). However, when it comes to rewards vs. penalties the advice from psychology is clear. Rewards are preferred and penalties, while they can still be effective under some circumstances, should generally be avoided or used sparingly (Thorndike, 1911; Watson, 1917; Skinner, 1953, 1974; Renner, 1964; Cameron and Pierce, 1994; Lattal, 2010; Gneezy et al., 2011). Rewards are favoured as they communicate information on what should be done in the future, rather than just saying that someone has done something wrong. Rewards also have the potential to create positive associations between receiving the reward and otherwise somewhat dull tasks, such

as driving safely (Bandura, 1986). Importantly for PAYD, where savings on a moment to moment or even month to month basis are expected to be somewhat small, the size of a reward has also been shown to be less important than the speed and certainty with which the reward is received (Skinner, 1974; Bjørnskau and Elvik, 1992; Zaal, 1994). Indeed, in terms of reward size, there is evidence to suggest that instead of directly giving feedback on monetary savings, credit points or some other medium could be used. It turns out that individuals are not particularly sensitive to the trade-offs between this medium and the eventual reward (Hsee et al., 2003; Bagchi and Li, 2011). This means that points could be varied more freely or in larger amounts but trade off to relatively small financial savings while still having a significant impact on driver behaviour.

That is not to say that rewards have not been criticised and there is indeed considerable debate about the potentially negative impacts of providing external rewards on individual's intrinsic motivation to perform behaviours (Cameron and Pierce, 1994; Deci et al., 1999, 2001; Cameron et al., 2001). The debate about the negative effects of rewards is focused on the controlling aspects of giving rewards and has primarily only been examined in tasks that are interesting and in themselves intrinsically motivating (Deci, 1971; Deci et al., 1999, 2001; Kohn, 1999). Therefore, while the possible demotivating effects of rewards are important to be aware of, they may not apply strongly to PAYD insurance that essentially aims to reward relatively dull safety related behaviours. Furthermore, many of the reported negative effects only hold once a reward is removed (Cameron and Pierce, 1994; Cameron et al., 2001). PAYD insurance, however, is a repeated reward that would essentially always be present unless a customer changed to a non-PAYD insurance plan. Still, care should be taken to further minimise any potential negative impacts of providing external rewards and positive feedback by making sure that rewards are provided in a non-judgemental and non-controlling fashion (Brehm, 1966; Skinner, 1972; Deci et al., 1999, 2001).

In terms of the feedback provided by PAYD telematics systems, behaviour based or otherwise, a popular option used by many PAYD systems is to provide feedback via a dedicated website (e.g., Progressive's Snapshot (<http://www.progressive.com/auto/snapshot/>), Esurance's DriveSense (<http://www.esurance.com/discounts/drivesense-discount>), Coverbox (<https://www.coverbox.co.uk/>)). Under these web based systems data on the customers' driving is collected and can be viewed at the customer's discretion via an online web portal. The use of web based feedback is convenient in that it allows for rich data to be presented to customers in a flexible, and perhaps even customer tailored, fashion. However, web based feedback suffers from two major problems. The first is that web based feedback is delayed, in that it is not available until the driver takes the time to check the website. This means that feedback on driving style and current insurance charges is removed from the driving task itself and comes sometime after the behaviour that is intended to be rewarded or penalised has occurred. The second is that customers may very rarely, or even never, take the time to check in on web based feedback. For example in the study of Bolderdijk et al. (2011) it was reported that, despite the effectiveness of the Pay-As-You-Speed system that was examined, the majority of their participants never logged into the provided feedback website. This is particularly significant as in the Bolderdijk et al. (2011) study the participants could earn up to €50 based on their driving, a sum far larger than most PAYD products would realistically offer in the same timeframe, yet even with this large amount of reward on offer participants did not seem motivated to access relatively readily available feedback on their progress towards this reward.

An alternative to web based feedback is in-car feedback where feedback on the driver's behaviour and on the rewards and penalties they have received could be delivered to them in real

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