Modifying behaviour to reduce over-speeding in work-related drivers: An objective approach

The goal of this study was to utilise an objective measurement tool, via an on-board Diagnostic tool (OBDII), to explore the effectiveness of a behaviour modification intervention designed to reduce over-speed violations in a group of work-related drivers. It was predicted that over-speed violations would be decreased following participation in a behaviour modification intervention where drivers received weekly feedback on their speeding performance and goal setting exercises. The final analysis included the on-road behaviour of 16 drivers, all of whom completed each stage of the intervention program. As predicted, over-speed violations significantly decreased from pre-test to post-test, after controlling for kilometres driven. These findings offer practical guidance for industry in developing interventions designed to improve work-related driving behaviour.

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BACKGROUND

More than 30% of registered motor vehicles in Australia are work-related vehicles with an estimated 33% of work-related fatalities occurring while driving (Driscoll et al., 2005). In New South Wales alone, fleet vehicles (defined as vehicles which have a business registration or vehicles with a private registration but where the registered operator is an organisation) (Haworth, Tingvall & Kowadlo, 2000) comprise up to 5.3 fatalities per 100,000 registered fleet vehicles (Stuckey, LaMontagne, Glass, & Sim, 2010) and there is evidence suggesting an over-representation of work-related drivers in road traffic injury compared with non-work-related driver (Downs, Keigan, Maycock, & Grayson, 1999; Lynn & Lockwood, 1998; Murray, Newnam, Watson, Schonfeld, & Davey, 2003; Newnam, Watson, & Murray, 2002).This emerging public health problem is not solely occurring in Australia, with work-related road traffic deaths estimated to account for 22% of work fatalities in the United States and 16% in New Zealand (Driscoll et al., 2005).

These statistics suggest the need for intervention to improve the safety behaviour of work-related drivers. In this study, we discuss an intervention approach designed to reduce speeding in a group of work-related drivers. This intervention utilised the principles of behaviour management (Luthans & Kreitner, 1985; Stajkovic & Luthans, 1997) to challenge drivers' key salient beliefs in regards to speeding. The following literature will discuss the development of this intervention.

Intervention development

Work-related driving interventions have traditionally been focused at the individual or driver level (Newnam & Watson, 2011). These interventions have tended to reflect micro-level initiatives, such as driver training (e.g., Christie, 2001; Dorn & Barker, 2005; Groeger &

Banks, 2007) and behaviour modification (e.g., Geller, 1987; Ludwig & Geller, 1991; Newnam, Lewis, & Watson, 2012; Newnam & Watson, 2009; Salminen, 2008). In regards to the latter, these interventions have utilised the A-B-C framework of behaviour modification (Luthans & Kreitner, 1985; Stajkovic & Luthans, 1997) to improve the safety of work-related driving behaviour. Based on the principles of operant conditioning (Skinner, 1974), the behavioural approach to work motivation examines the relationship between environmental cues (e.g., reinforcers) and a desired behaviour (Stajkovic & Luthans, 2003). That is, behaviours that positively affect performance must be contingently reinforced (Stajkovic & Luthans, 2001).

The principle of this theory states that a reinforcer that produces a desired consequence within the environment in which the behaviour occurs increases the frequency of the desired behaviour (Stajkovic & Luthans, 2003). In other words, behavioural management is dependent on contingently reinforcing those behaviours that improve performance. In the work-related driving intervention literature, contingencies of reinforcement used to modify safe driving practices have included incentives (e.g., (Marchetti, Hall, Hunter, & Stewart, 1992; Mortimer, Goldstein, Armstrong, & Macrina, 1990), group consensus (Geller, 1987; Newnam & Watson, 2009; Salminen, 2008), feedback and goal setting (Ludwig & Geller, 2000; Newnam, Lewis, & Watson, 2012). In the current study, we utilised feedback and goal setting components within an intervention designed to improve safety outcomes for work-related drivers and, in particular, reducing over-speed violations.

Speeding is believed to be the most prevalent work-related risky driving behaviour and the leading contributing factor to death and injury on the road. Anecdotal research suggests that speeding is one of the leading contributing factors to road crashes, and in particular, work-related driving crashes (Haworth et al., 2000). Drivers of employer owned cars and those driving a car for work-related purposes are presumed to be among the groups who are more

likely to engage in speeding (Stradling, 2000). Work-related drivers have been found to report higher involvement in passive crashes and thrill seeking, higher average and preferred driving speeds, and receive more speeding offences, compared to individuals who drive for personal purposes (Stradling, Meadows, & Beatty, 1999). This literature supports the implementation of solutions to reduce speeding in the work-related driving context.

Although some research has addressed this issue, past research has relied on self-report measures of speeding (Newnam, Newton, & McGregor-Lowndes, 2009; Newnam, et al., 2002; Newnam, Watson., & Murray, 2004). Despite there being studies which have reported significant, moderately strong, positive correlations between self-report and more objective measures of speeding behaviour (e.g., Åberg & Warner, 2008; Hagland & Åberg, 2000); criticisms still remain as to the extent to which self-report measures are able to provide an accurate indication of actual speeding behaviour (Greaves & Ellison, 2011). The accurate, self-report assessment of speeding behaviour is made particularly problematic given the transient nature of speeding whereby from moment-to-moment in any given driving occasion, a driver may or may not be complying with the posted speed limit. As such, accuracy in the conclusions reported by studies based solely upon self-report measures, and the generalisability of such findings to the wider work-related driving population remains unclear.

In recent years, on-board driving monitors have been adopted to measure driving behaviour and improve driver safety in the fleet context. Examples of such systems include, DriveCam and SmartDrive technology. Both of these systems use video recording to monitor driver behaviour and have been identified as efficacious alternatives to self-report data collection approaches (see, Stanton & Salmon, 2009). Furthermore, DriveCam has been successfully used as a safety monitoring system in reducing unsafe driving events in an ambulance fleet (Myers et al., 2011). This research suggests that on-board monitoring tools are

both an effective tool for measuring driving behaviour and potentially improving safe driving behaviour.

In this study, we used an on-board Diagnostic tool (OBDII) to monitor drivers' speeding behaviour. .In particular, we utilised the data device tool to explore the effectiveness of a behaviour modification intervention focused on feedback and goal setting to reduce over-speed violations in a group of work-related drivers. It is hypothesised that pre-test over-speed violations will be significantly reduced after participating in the behaviour modification intervention.

METHODS

This research was conducted in collaboration with a non-profit religious organisation in a state of Australia. Following ethical approval obtained through the authors' university, a random sample of individuals who drove at last once per week for work-related purposes were invited by the fleet manager of the organisation to participate voluntarily in the intervention. The sample consisted of 16 full time remunerated drivers who drove company vehicles to care for individuals in the community. Of these drivers, 9 were male and 7 were female, with an average age of 45 years and average tenure in the organisation of 3.4 years (SD=3.4 years; Range 4 months -11.5 years). There drivers spent an average of 550 kilometres (SD=195; Range 150-900km/week) driving each week for work-related purposes. All participants drove in metropolitan areas. The average age, gender and average kilometres driven per week are comparable with the sample demographics in other work-related driving research (see Newnam et al., 2011; Newnam et al., 2008).

Procedure

The drivers were invited to participate in an initial one-hour seminar where they were given information on the (1) aims of the research, (2) implementation of the data devices in the vehicles, (3) data collection procedure, (4) procedure of the behaviour modification

intervention, and (5) ethical conduct of the research, including the safeguards to ensure privacy and confidentiality and the emphasis upon voluntary participation. Following this discussion, drivers were invited to participate in the program of research and were asked to sign a consent form. Once consent was provided, the data devices were installed in each of the vehicles. The vehicles implemented with the data devices were only driven by those individuals who gave their consent to participate in the program of research.

The research was conducted over a five week period and involved three phases. Figure one presents a diagram of the stages of data collection. The first phase involved monitoring driving speeds over a 5 day period. Data was used as a baseline to compare with the over-speed data post-test (i.e., phase three). At this initial phase, drivers also completed a brief demographic (e.g., age, gender) and driving exposure (ie., kilometres driven per week) questionnaire.

[Insert Figure 1 here]

The second phase of the study involved the implementation of the behaviour modification intervention. The behaviour modification techniques consisted of feedback and goal setting exercises, which are described, below.

Feedback: Over a three week period, drivers were given feedback in the form of a written report on (1) the percentage of time they spent within the speed limit and exceeding the speed limit, (2) the percentage of time exceeding the speed limit compared with other drivers participating in the intervention and (3) their 'safety' rank compared to other drivers in the intervention (the driver ranked first had the least over-speed violations). The primary aim of this feedback was to challenge drivers' key salient beliefs in regards to their speeding behaviour in the work vehicle. A member of the research team (AW) conducted these weekly feedback sessions. An example report is presented in figure 2.

[Insert Figure 2 here]

Also of note, the driver report presented in Figure 2 was presented within a booklet in which the cover page featured an intervention slogan. This slogan was, "*Caring for others extends to when you are behind the wheel too. So when driving BE the example that others should follow. Keep watch on your speed and always stick to the limit"*. The slogan was designed by a member of the research team (IL) for use on intervention materials for the duration of the intervention. It was designed to: (i) emphasise an important motivation for individuals within this driving fleet in terms of the value they place on caring for others. Specifically, a key belief that the slogan highlighted was that as an individual working within a caring profession, then that caring should also include others with whom they drive on the road; (ii) underpin the ranking aspect within the report in which each driver's performance was ranked in accordance with other members of the group. This slogan identified that a key aim, or goal, that each driver should aspire to was to be the driver that all others regarded as a good driver and one whom they should emulate; and (iii) finally, consistent with theoretical and empirical evidence supporting the importance of providing information/strategies within road safety messages (see Lewis, Watson, & White, 2013; Lewis, Watson, & White, 2010; Witte, 1992) the slogan ended with concrete strategies that individuals could enact to ensure that they reduce their engagement in speeding (i.e., keeping watch on speed and sticking to the limit).

Goal setting: In the weekly discussions, goal setting exercises were introduced. The aim of these exercises was to encourage drivers to reduce their overall number of over-speed violations for the next reporting period (i.e., the following week). The generation of the safety goals was conducted via a collaborative process between members of the research team (AW and SN) and the drivers themselves following a discussion about when and why they violated the speed limits on particular days. The goals initiated by members of the research team (AW and SN) were generated from previous intervention studies found to be effective in reducing speeding (Newnam & Watson, 2009). Some goals generated through this process included

“ring ahead if you are going to be late” and “use cruise control to ensure you keep within the speed limits”. Other goals generated through discussion between the researcher and the drivers themselves included “subvocalising the speed limit to increase attention and adherence” and “awareness of velocitization (particularly after highway driving)”.

The final phase of the intervention involved post-monitoring of over-speed violations to assess an overall change in over-speed violations following completion of the behaviour modification intervention.

Materials

Data devices were utilised to monitor driving speed. These devices used a Global Positioning System (GPS) and wireless cellular data network (GPRS) technology to monitor, record and transmit vehicle data in real-time. The devices were plugged into each vehicle’s diagnostic port (OBD-II) and were used to measure location and movement data at second-by-second intervals. Data obtained from the devices were matched to a local speed limit reporting system, so that we could monitor each driver’s over-speed violations. The devices contained a modem and were able to automatically transmit data via the GPRS network to a secure data server. At the end of each week of the intervention, all trip data was automatically recorded and displayed into an online mapping application.

Over-speed violations were monitored each day over the five weeks of the research (data collected over the weekends was not included in the final analysis). Drivers’ average number of over-speed violations was calculated at the end of each week of the intervention, including pre and post intervention.

Control variable

In this study, we controlled for average kilometres driven per week. Past research has found that occupational drivers, on average, accumulate higher mileage in comparison with the average private motorist (Downs et al., 1999) which may impact on the attention given to safe

driving in the vehicle. We obtained this information via the questionnaire from the drivers at pre-intervention stage.

RESULTS

A Wilcoxon Signed Ranks Test was used to test the difference in over-speed violations from pre-test to post-test[1]. An over-speed rate was calculated for each driver pre and post intervention by dividing their over-speed scores by the average number of kilometres driven per week. The average pre-intervention over-speed rate was .031 [95% CI .029 to .066] violations/km; the average post-intervention over-speed rate was .027 [95% CI .024 to .029] violations/km. As predicted, the results showed a statistically significant decrease in over-speed violations from pre-test to post-test (z = -2.27, p = .021, CI=.018 - .023). The data show that 75% (n=12) of the drivers who participated in the study reported a rate reduction in over-speed violations from pre to post intervention. Figure 3 (and Table 1) illustrates the variations in the rate reductions of over-speed violations for each driver over the course of the intervention.

[Insert Figure 3 and Table 1, here]

CONCLUSION

The aim of this study was to utilise in-vehicle data devices to explore the effectiveness of a behaviour modification intervention designed to reduce over-speed violations in a group of work-related drivers. Support was found for the intervention approach as the majority of drivers were found to reduce their overall number of over-speed violations from pre to post intervention. However, it is important to note that the data also showed variation in the rate reductions of over-speed violations over the course of the intervention. Thus, although the data suggests that the behaviour modification intervention was effective in reducing over-speed violations from pre to post intervention, there was also an inconsistent

[1] The sample size of 16 provided 90% power to detect an effect size at a .05 confidence interval.

pattern of speeding behaviour throughout the implementation of the feedback and goal setting exercises.

A possible explanation for the inconsistent pattern shown in over-speed reductions throughout the intervention may be due to the retrospective approach to implementing the feedback and goal setting exercises. At the end of each week of the intervention, goal setting strategies were designed to address the triggers for over-speed violations in the previous week (e.g., boredom on highway trips). However, the triggers for violating the posted speed limit in the following week (e.g., time pressure) may not have aligned with the goal setting strategies generated for the triggers identified in the previous week. In other words, the goal setting strategies generated to reduce over-speed violations in the following week may not have been relevant in addressing the 'new' triggers experienced by drivers in the same week. Thus, although the results of this study show preliminary support for an effect whereby drivers implemented the goal setting strategies generated over the course of the intervention, the results also highlight that drivers potentially faced new driving situations that triggered speeding, which required the generation of further strategies in response to the triggers that had not yet been generated as a goal setting strategy. This explanation suggests that future interventions may benefit from a longer intervention period where the identification of triggers for speeding reaches a point of saturation so that we can isolate those triggers that are generalizable across work-related drivers.

Despite evidence highlighting the over-representation of work-related road traffic trauma and death, there is limited research on effective preventive strategies. Although some research has found support for behaviour modification approaches in improving safety outcomes, these studies have been limited by their focus on self-report data (Newnam & Watson, 2009; Salminen, 2008), which impacts on the validity of the findings. This research overcomes this issue by utilising data devices to evaluate on-road behaviour (changes) and,

thus, provide evidence of the effectiveness of an intervention approach designed to reduce a high-risk behaviour. Thus, the within group results notwithstanding, the results of this program of research may be considered as offering some important preliminary insights into the effects of driver modifications techniques which, in turn, may offer some insight into the development of future safety initiatives in the work-related driving context.

Practical applications

The findings of this study offer some practical interventions to improve safety outcomes for work-related drivers. First, these preliminary results suggest that feedback and goal-setting are effective contingent reinforcers for reducing over-speed violations. Industry could use the findings of this study to develop an intervention approach that not only utilises behaviour modification techniques to target compliance with safety procedures (e.g., speeding) but is integrated within the organisational context. For example, a leadership intervention could focus on providing feedback and establishing goal setting exercises to drivers based on their speeding performance. In support, previous research has identified that work-group supervisors play a critical role in providing performance feedback to drivers and improving safety outcomes in the work-related driving context (Newnam et al., 2012).

Second, this research suggests that incorporating feedback and goal setting exercises within the daily safety management of work-related drivers could be effective in improving other types of high risk driving behaviours relevant within the work-related driving context (Newnam, Greenslade, Newton, & Watson, 2011). For example, driving infractions (including mobile phone use) and (in)attentional behaviours could be targeted by utilising in-vehicle telemetry devices which involve distal measurement such as eye-tracking (e.g., Horrey et al., 2006; Nabatilan et al., 2011; Young, Mitsopoulos-Rubens, Rudin-Brown, & Lenne, 2012). The strength of using in-vehicle telemetry devices is that they can provide safety benefits through their feedback mechanisms. However, organisations should be aware of their potential negative

impact, particularly in relation to some drivers' concerns regarding privacy (e.g., Huang et al., 2005; Peng, Ghazizadehz, Boyle & Lee, 2012). Thus, implementation strategies should be directed at addressing the safety benefits and mitigating privacy concerns. One approach to successful implementation could be integration with existing workplace practices, such as feedback from leaders. In support, research has found that drivers prefer to receive feedback from supervisors or managers over feedback from technology alone (Huang et al., 2005).

Alternatively, feedback and goal setting exercises could be more proactively oriented towards avoiding unsafe driving scenarios. For example, scheduling regular safety meetings with drivers may provide the opportunity for drivers to identify potential hazards in the driving role and for management to offer feedback and encouragement to drivers on ways to avoid unsafe driving scenarios (Lewis & Newnam, 2011).

Limitations

Despite its theoretical development and practical applications, this study has a number of limitations. First, a limitation of this study was the small sample size. Although the sample was considered to be representative of work-related drivers, in regards to age and gender (Newnam et al., 2011; Newnam, Griffin, & Mason, 2008), the effect size was small and there was large inter-subject variability. Thus, caution should be taken in interpreting the results. It would be desirable to replicate this study with a larger random sample within a repeated measures (or similar) design.

A second limitation of this study was the design. A pretest-posttest design precluded confirmation that the behaviour modification intervention was responsible for the post-test change in over-speed violations (see, Spector, 1981). However, the possibility of confounding factors being able to explain our results was unlikely. We were able to control for maturation and historical effects by conducting the intervention over a short time period (i.e., 5 weeks). Thus, reducing the likelihood of external factors being responsibility for the decrease in over-

speed violations from pre-test to post-test. We were also able to control for the possibility of instrument reactivity and Hawthorne effects being explanations for our results by ensuring that knowledge was constant throughout the program of research. Prior to pre-test data collection, all drivers were made aware of the aims and data collection procedures.

Although the latter issue presents a limitation, adopting an alternative design (e.g., randomised control trial) is often difficult in the safety context. Research with industry partners often calls for practicality and ethical conduct; delivering potential safety benefits to some workplace employees and not others is not feasible within the scope of industry engagement. The methodology we employed in this study offered a pragmatic and scientifically valid approach to evaluating the effectiveness of a behaviour modification intervention within a high risk driving population.

Due to ethical constraints in collecting data on specific details of any single over-speed violation, a third limitation was that we were not able to analyse duration while exceeding the posted speed limit. An example would be a driver that exceeded the post speed limit for 20 minutes as opposed to another driver who exceeded the posted speed limited for only 5 seconds. Thus, we could not identify those drivers who may be considered more ‘high-risk’ drivers (whom may engage in speeding often and for longer periods) as opposed to those who may have had just a lapse in attention.

A fourth limitation relates to self-report data being utilised for average kilometres driven per week. It is possible that drivers may have over-estimated or under-estimated their average kilometres which may have biased the rates derived in this study. However, this possibility is less likely to be of concern in this study considering that the drivers in this sample regularly completed driving logs as part of their job role. Thus, it would seem reasonable to assume that, as a group, such drivers would be more readily aware of the details of their regular driving episodes.

Conclusion

This study was designed to explore the effectiveness of a behaviour modification intervention designed to reduce over-speeding in a group of work-related drivers. The strength of this study was in using an objective method to record over-speed violations (OBDII devices). The results found support for feedback and goal setting exercises in reducing over-speed violations. The findings of this study offer some practical guidance for organisations in designing an intervention approach that adopts behaviour modification techniques and extending on this approach by utilises existing workplace practices to bring about change in safe driving outcomes.

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Figures

Figure 1: Stages of data collection

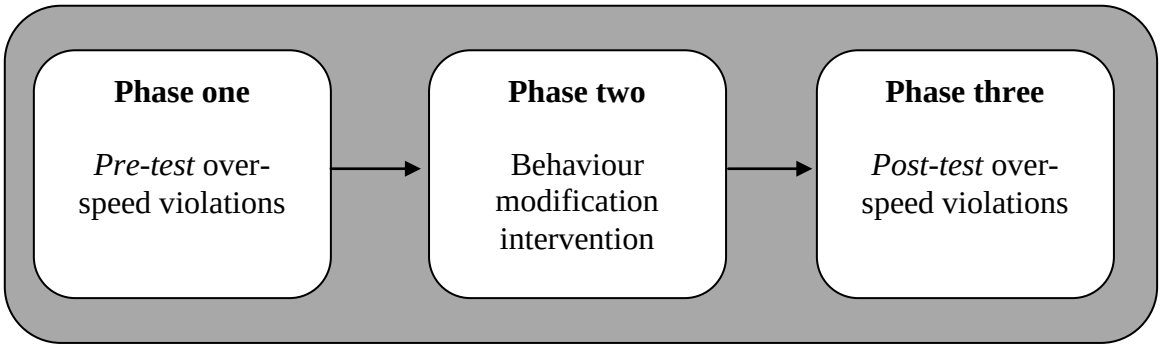


Figure 2: An example of a weekly feedback report of a driver's safety profile

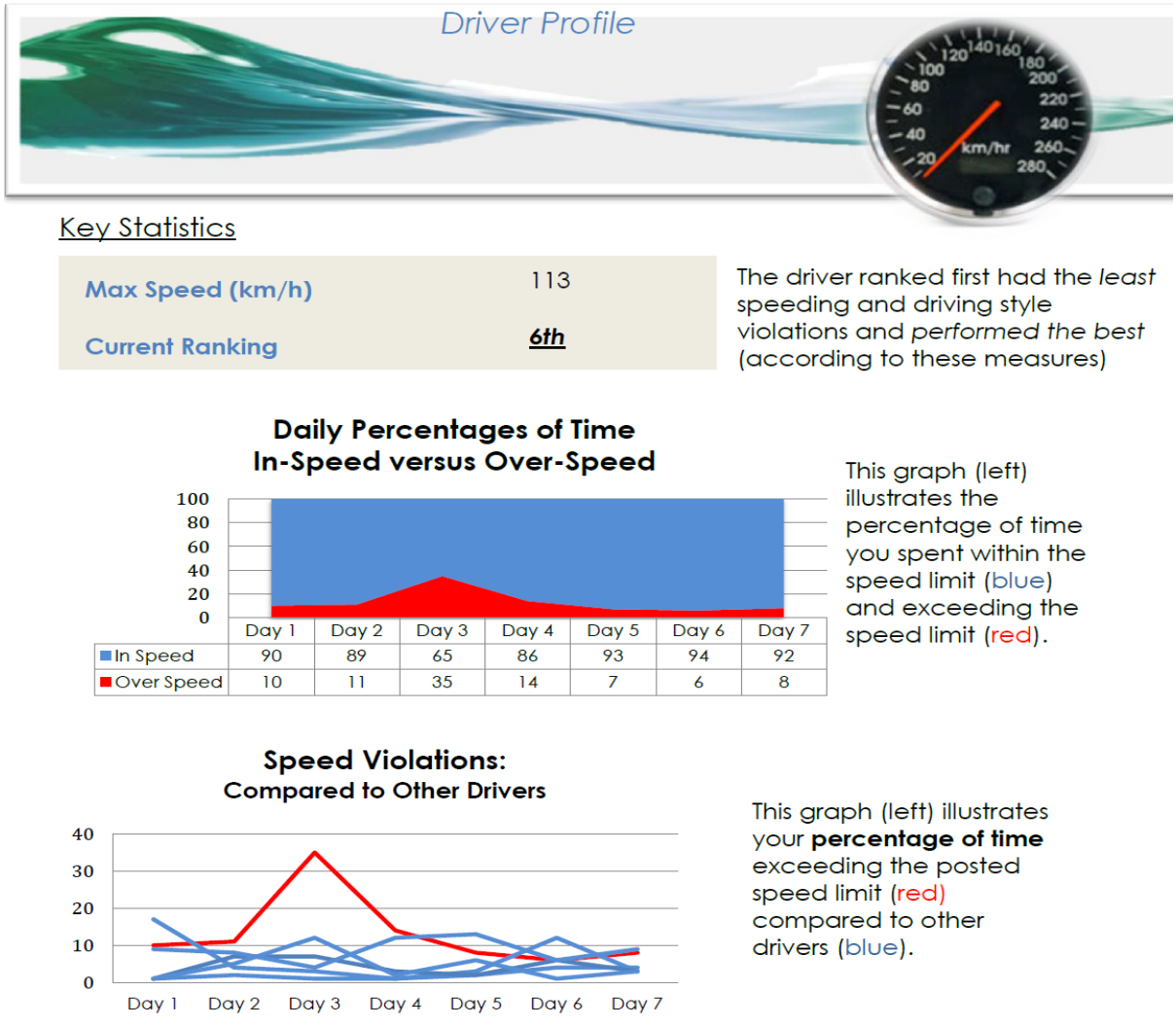
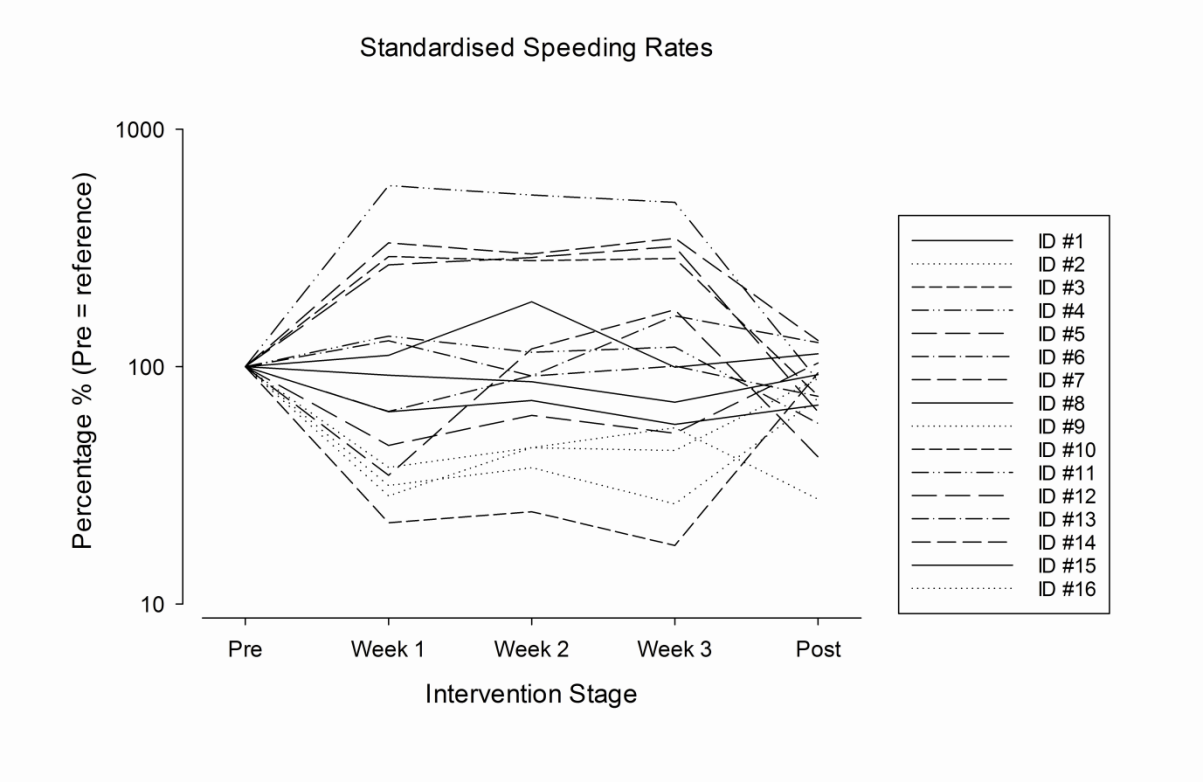


Figure 3: Standardised speeding rates over the course of the intervention*



* The numbers in this figure represent individual standardised speeding rates (rate=speeding violations/ km driven) with pre-intervention as reference. The y-axis is logarithmic as rates were used.

Table 1: Individual summary of each driver's rate reduction in over-speed violations over the course of the intervention

Driver ID	Pre to Wk1	Wk1 to Wk2	Wk2 to Wk3	Wk3 to Post	Pre to Post*
ID#1	-.08	-.06	-.18	.31	-.07
ID#2	-.68	.19	-.30	1.79	-.26
ID#3	1.91	-.04	.02	-.74	-.25
ID#4	.35	-.15	.05	-.52	-.42
ID#5	-.53	.34	-.16	.98	.04
ID#6	.29	-.29	.10	-.26	-.25
ID#7	2.33	-.10	.16	-.63	.29
ID#8	.12	.68	-.47	.14	.13
ID#9	-.62	.21	-.03	1.01	-.11
ID#10	-.78	.11	-.28	4.35	-.06
ID#11	4.80	-.09	-.07	-.82	-.13
ID#12	1.69	.07	.11	-.80	-.35
ID#13	-.35	.42	.79	-.23	.26
ID#14	-.65	2.43	.46	-.76	-.58
ID#15	-.35	.11	-.21	.20	-.31
ID#16	-.71	.60	.21	-.50	-.72

* Highlighted figures indicate a decrease in over-speed violations from pre to post intervention