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Would those who need ISA, use it?

Investigating the relationship between drivers' speed choice

and their use of a voluntary ISA system

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Abstract

Intelligent Speed Adaptation (ISA) is one of the most promising new technologies for reducing the prevalence and severity of speed-related accidents. Such a system could be implemented in a number of ways, representing various "levels of control" over the driver. An ISA system could be purely advisory or could actually control the maximum speed of a vehicle. A compromise would be to introduce a system that allows a driver to choose when to engage ISA, thus creating a "voluntary" system. Whilst these voluntary systems are considered more acceptable by drivers, they will not offer safety benefits if they are not used by the driver. Two studies were carried out that examined the relationship between drivers' reported and actual speeding behaviour, their propensity to engage a voluntary ISA system and their attitudes towards such a system. These studies were carried out in a driving simulator and in an instrumented vehicle. In both the studies, drivers' propensity to exceed the speed limit was lowered when ISA was available but this effect was confined to the lower speed limits. In general, drivers engaged ISA for approximately half of their driving time, depending on the speed limit of the road and indeed, on the nature of the road and the surrounding traffic. This was particularly true in the field study where drivers were more inclined to "keep up with" the surrounding traffic. The results from the on-road study indicated that those drivers who considered ISA to be both a useful and pleasant system, were overall more likely to engage it. However, those drivers who confessed to enjoying exceeding the speed limit were less likely to use ISA. This is an important finding when considering the mechanisms for implementing ISA: those drivers who would benefit most would be less likely to use a voluntary system.

Keywords: intelligent speed adaptation, driver support systems, acceptability, driver behaviour, traffic safety

1 INTRODUCTION

The well documented relationship between speed and accidents (Finch, Kompfner, Lockwood & Maycock, 1994; Taylor, Lynam and Baruya, 2000) has led to the development of numerous interventions that attempt to reduce driver speed. These interventions have traditionally employed the "three Es" of Education, Enforcement and Engineering. Such interventions have demonstrated varying amounts of success, although it is often limited in time and space (Comte, Várhelyi and Santos, 1997). For example, whilst speed humps reduce speed locally, drivers are then free to increase their speed (Pau and Angius, 2001); this effect has also been observed with speed cameras (Keenan, 2004).

Intelligent Speed Adaptation (ISA) refers to an assortment of systems that provide drivers with support in their task of speed control. This support can be achieved via a number of technical solutions, including modifications to the engine control unit (Comte, 2000) or by modifying the accelerator pedal (Hjälmdahl and Várhelyi, 2004). A further variant in the design of an ISA system is the amount of control it exerts over the driver. ISA could be implemented as an *advisory* device which simply reminds drivers of the prevailing speed limit and exerts no control over the vehicle. Such a system may have potential advantages for drivers who are unaware of the speed limit (De Waard, Jessurun, Steyvers, Raggatt and Brookhuis, 1995). Cameron (1980) found that in urban areas, 26% of drivers were unaware of the speed limit and that these drivers were observed to be driving faster than others. An advisory system has been welcomed by those who argue that it allows drivers to remain "in-the-loop". However, such a system relies on drivers' willingness to comply with the speed limit displayed. The next level in control is known as *voluntary* ISA, which limits the vehicle to the speed limit, providing the driver engages the system. The

highest level of control can be termed *mandatory*, and exerts full speed control (usually with an emergency opt-out function).

Evaluations of these various types of ISA systems have used a combination of both objective and subjective measures in order to gauge likely safety benefits and acceptability by the driver. Objective measures of mean speed and speed variance have generally shown safety benefits of using ISA, with theoretical accident savings of approximately 30% (Várhelyi, 1996; Tate, 1998). These estimations are, however, based on mandatory systems, where drivers are not given the option of rejecting the speed control.

Several studies, using hypothetical situations, have shown that acceptance of voluntary ISA is fairly high (Dahlstedt, 1994; Carstensen and Christiansen, 1993). Whilst these results are encouraging, it should be noted that both these studies were questionnaire-based and the respondents had no practical experience of an ISA system. An evaluation of a system such as ISA should involve actual users interacting with the actual system, in order to glean an accurate representation of acceptability. For example, Várhelyi and Mäkinen (2001) and Comte (2001) found that drivers were more accepting once they had practical experience of ISA and that they generally preferred systems that allowed them to override the speed control function. Measuring system use is the most reliable indicator of acceptability.

This leaves policy-makers with a somewhat tough decision: if ISA is to be part of a traffic safety plan, should it be implemented as mandatory and risk alienating the driving population through non-acceptance, or should it be introduced as a voluntary system which carries the risk of low-use? This question will remain unanswered until we discover the propensity of drivers to use a voluntary system and discover in which

situations they decide not to use it. The use of voluntary safety systems has received little research attention although some studies have investigated seat-belt usage rates (Ashton et al., 1985) and cycle helmet use (Scuffham and Langley, 1997). Such studies generally cite increased usage only after mandatory legislation has been passed.

Another consideration is that the benefits of a voluntary ISA system could be compromised if those who choose to use it are relatively safe drivers in the first place. Such “selective recruitment” was termed by Evans (1985) in his analysis of seat belt and non-seatbelt wearing fatalities. Using U.S. crash statistics he was able to demonstrate that the probability that a driver was wearing a seat belt at the time of the crash declined as crash severity increased. In other words, drivers who would benefit most are those least likely to wear a seat-belt (Evans, 1996). Other studies that have evaluated voluntary seat belt use among US drivers found that use was highest amongst female and older drivers (Williams et al. 1983; Lund, 1986). It is therefore of great interest to discover the types of drivers who would actually choose to use a voluntary ISA system.

The propensity for drivers to use a voluntary ISA system is likely to be mediated by how acceptable or likeable they find it. As noted above, it is best to measure usage rates to gauge acceptability, however subjective opinions can also be gleaned via questionnaires. Van der Laan, Heino and De Waard, (1997), developed a questionnaire to allow drivers to rate the acceptability of various driver support systems. It allows drivers to express their opinion in terms of “usefulness” and “satisfaction” using nine items. The concept of *usefulness* refers to how effective or supportive a system is, whilst *satisfaction* refers to how pleasant it is to use. The authors predict that acceptability lies along a continuum according to the complexity

of the system and the amount of control it exerts over driver behaviour. According to this model, one would expect the acceptability ratings for an advisory ISA system to be located at the lower end of the scale, whilst a mandatory one would be located towards the top end.

To summarise, whilst ISA is a promising tool for road safety, the way in which it will be implemented will be the subject of great debate. This debate will be driven by the need to balance safety benefits with the provision of a system that is acceptable to drivers.

The studies reported here aimed to examine the propensity of drivers to use a voluntary “opt-in” ISA system. When drivers encountered a change in speed limit, they were required to accept or reject it. By accepting the speed limit they opted into voluntary ISA, if they rejected it the vehicle reverted to its normal operation without ISA.

A number of factors, thought to be of relevance to the amount of system use, were included. First, acceptability was scored using the Van der Laan et al. (1997) scale. It was hypothesised that drivers who found the system acceptable, would engage it more. Second, prior to the experiment, drivers completed the Driving Style Questionnaire (DSQ). The DSQ (West, Elander and French, 1992) contains 15 items based on behaviours that are associated with risky driving behaviour. It was hypothesised that those who engage in riskier driving are more likely to exhibit low system use. Finally, actual speed choice (without ISA) was measured to determine whether it is those drivers who consistently exceed the speed limit who are less likely to use a voluntary system.

2 METHOD

Two studies were carried out, one in a driving simulator, the other using an instrumented vehicle. The purpose of the studies was not to make a comparison between behaviour observed in the two environments. Instead, the studies were designed to be complimentary, with the simulator providing a controlled, repeatable environment and the on-road trials a fully immersive, real-life experience.

2.1 Participants

A total of 18 participants took part, balanced for age and gender. In the simulator study, ten drivers were recruited between the ages of 19 and 55 [Mean= 27 years] with a reported annual mileage of between 5,000 and 22,000 miles [Mean= 10,000]. All participants possessed a full, clean driving licence. In the on-road study, eight drivers took part, again balanced for gender. They were between the ages of 21 and 57 [Mean= 29 years] with a reported annual mileage of between 6,000 and 20,000 miles [Mean= 10,500].

2.2 Driving simulator

The Leeds Advanced Driving Simulator is fixed-base, and presented a 120° forward view and 50° rear view. The ISA systems were implemented by making alterations to the simulator's vehicle dynamics model. Using a logical road network, each individual section of road can be given a speed limit that the car will, if required, adhere to. If the participant is driving the simulator at or below the speed limit the ISA system is inactive. If the ISA system is engaged and the participant attempts to accelerate above the speed limit, the vehicle dynamics model automatically prevents any further increase in speed by closing the throttle and applying a small brake pressure to the hydraulic system. Therefore even if the driver depresses the accelerator to its full extent there results no increase in speed.

2.3 Instrumented vehicle

In order for the ISA system to function in the real world, an instrumented vehicle was modified to receive information pertaining to the posted speed limit of the road on which it was travelling. The geographical position and value of each speed limit along a predefined test route was stored in a laptop computer as a “virtual beacon”. This virtual beacon could be moved and its radius altered according to where the ISA system should operate. ISA software was developed to calculate the appropriate speed limit (as described above) and compare this with the car’s actual speed, determined from the ABS wheel speed sensors. If the car was travelling below the speed limit, it behaved as a normal car. However, if the ISA system was engaged, and the participant attempted to exceed the speed limit, a signal was sent to a pair of auxiliary Engine Control Units. These first reduced engine power by retarding the ignition for up to 30 seconds. In order to provide a longer and/or greater reduction in power, the amount of fuel injected into the engine was progressively cut. If the retardation and the fuel cut-off were insufficient, because the car was going down hill for example, the brakes were gently applied to decelerate the car to the speed limit. A laptop PC, installed in the boot of the car, not only ran the ISA software but also recorded the required data.

2.4 Road characteristics

The simulator road network was approximately 35km in length and comprised of urban, rural and motorway environments, providing a full range of speed limits between 48 and 112 km/h. The presence of other cars in the scene provided the opportunity of simulating overtaking scenarios, gap acceptance tasks and car-following situations. The road environment also featured traffic lights and pedestrian crossings. Sub-standard curves were included in both the urban and rural sections. The other vehicles simulated on the route travelled at or below the speed limit in

order to orchestrate certain scenarios such as car-following and overtaking opportunities.

The field trial route was selected to include roads of varying speed limits and classes, and was approximately 70km in length. Speed limits varied from 48 to 112 km/h and included urban roads with mixed traffic and large numbers of pedestrians, rural roads and a motorway section. The route was mostly free-flowing and there were opportunities for drivers to exceed the speed limit.

2.5 *ISA System features*

The voluntary ISA system could be engaged and disengaged by drivers using on/off buttons located on the steering wheel. In both the simulator and the on-road trials, an LCD was mounted on the dashboard. The display for both trials was identical in order to increase comparability. The display indicated the speed limit of the road and the status of the ISA system (engaged or not).

2.6 *Data collection*

2.6.1 *Speed and system use*

Both the studies allowed the opportunity of collecting a wide range of driving variables, however, the variables of interest here were speed and the percentage of time the system was engaged. The raw speed data were manipulated into various derivatives including mean speed and speed variation. These were thought to be insufficient to capture the extremes of behaviour and therefore measures of the proportion of time drivers spent travelling over the speed limit were also calculated. The proportion of time that drivers engaged ISA was also recorded, and as with speed, subdivided by speed limit. These data were collected continuously throughout both studies.

2.6.2 Driving Style

Participants completed the DSQ before the experiments commenced. The DSQ contains 15 items based on behaviours that are associated with risky driving behaviour. The items relate to speed, traffic signal violation, headway, seatbelt use and gap acceptance. Self-reported speed as measured by the DSQ has been shown to correlate well with observed driving speed on a test route comprising motorway, rural and urban roads (West et al., 1992). The DSQ has been found to load onto six components namely: speed, calmness, social resistance, focus, planning and deviance. Whilst the DSQ only concentrates on breaking the speed limits (and thus does not address “appropriate speed”), there is evidence that violators of the speed limit exhibit increased accident risk (Parker, Reason, Manstead and Stradling 1995). Only the items relating to speed were of interest in these studies thus the scores relating to the three items concerning speed were totalled. These three items refer to drivers’ propensity to exceed the speed limit in built-up areas, on motorways and “in general”. It was hypothesised that DSQ scores would correlate with system acceptability, such that those drivers who ordinarily choose to drive fast would exhibit lower scores on the acceptability questionnaire. In addition it was hypothesised that the fast drivers would be more inclined to disengage the voluntary ISA system.

2.6.3 Acceptability

In order to measure acceptability, prior to drivers experiencing ISA, an acceptability questionnaire (Van der Laan et al., 1997) was administered. The two scales of “usefulness” and “satisfaction” were combined to provide an overall score of acceptability. This questionnaire was also administered after subsequent drives, thus providing an indication of if and how acceptability changed after exposure to ISA.

2.7 Experimental design and analysis

Two types of analyses were undertaken. The first analysis investigated whether drivers increased or decreased system use as familiarity with the system increased. This was achieved by asking drivers to return on a number of occasions. All drivers first completed a baseline drive, where ISA was not available to them. Those taking part in the simulator study returned on three further occasions to drive with ISA available, whilst those participating in the on-road study returned twice more. A number of within subject comparisons were undertaken for each of the two experiments.

The first comparison (System availability) used an orthogonal Helmert contrast to test the combined effect of the drives where ISA was available against the baseline drive. A significant difference would indicate that, overall, there was an effect of having voluntary ISA available. The second comparison (Exposure) was undertaken to test whether there was an effect of increased familiarity with the system. A one-way ANOVA was performed on Drives 2-4 for the simulator study and a paired t-test between Drives 2 and 3 for the on-road study. Pairwise comparisons (using the Bonferroni correction to control the familywise error) were carried out where appropriate, to test for the presence of novelty effects, or whether changes in behaviour were only exhibited after repeated exposure. Post-hoc analyses were then carried out to establish whether the percentage of time ISA was engaged varied across different speed limits.

The second analysis used results from the DSQ and acceptability scales. These were correlated with the objective measurements of speed choice and system use. Speed choice was calculated as the average proportion of time spent exceeding the speed limit by 10% or more. System use was defined as the proportion of time

drivers engaged voluntary ISA (averaged over the appropriate number of drives). It was hypothesised that there would be a negative correlation between the acceptability measures and the speed measures. On the other hand, it was expected that positive correlations would exist within the measures of acceptability and also within the speed measures, Figure 1.

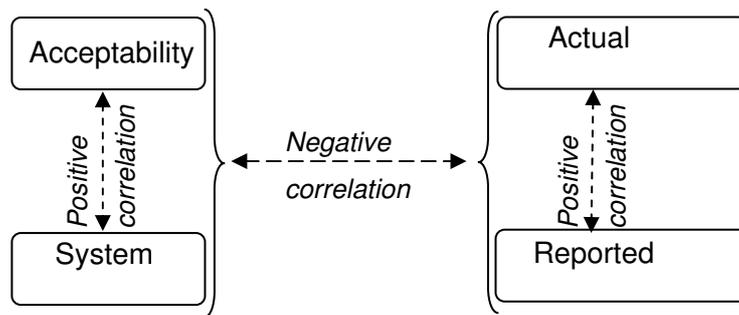


Fig 1. Hypothetical relationship between measured variables

2.8 Procedure

The procedure was, as far as feasible, identical in the two studies. A description of the study was presented to the participants and their consent obtained. They were asked to drive the simulator (or instrumented vehicle) for 15 minutes in order to familiarise themselves with both the interface and the ISA system. Following this, participants completed the experimental drives. The ISA system was always engaged at the beginning of the drive, thus requiring participants to actively choose to disengage it. They were instructed to engage ISA as much or as little as they wished and no incentives were given to encourage use of the system. The two experiments were carried out in close succession, with the on-road study taking place on fair-weather days in off-peak traffic conditions. For clarity, the results of the two studies will be described separately.

3 RESULTS

3.1 Driving simulator study

Each participant completed four drives using the same route. ISA remained disengaged for the first drive, thus supplying baseline data. Mean speeds were calculated for each of the individual road sections along with proportion of time spent above the speed limit. This latter measure was calculated using two thresholds of 10% and 20% above the speed limit. Whilst there was no main effect of System availability on mean speeds in any of the speed limits (i.e. speeds in Drives 2-4 were the same as in Drive 1), there was an effect on the amount of time drivers spent over the speed limit (Table 1). This effect varied depending on the speed limit of the road. There was no change in excessive speeding on roads with the higher speed limits (80 km/h and over). However, for the urban areas (48 and 64 km/h speed limits), where the overall amount of excessive speeding was higher, there was an effect of System availability: when voluntary ISA was available for drivers to use, excessive speeding fell by approximately 30% [$F(1,9)=$; $p<0.05$]. This effect was stable over Drives 2-4.

Table 1. Proportion of time spent 10% [and 20%] over the speed limit

Speed Limit (km/h)	Drive 1 (baseline)	Drive 2	Drive 3	Drive 4
48	40.99 [15.49]	30.29 [9.95]	24.92 [10.76]	28.24 [10.46]
64	30.46 [15.01]	22.30 [9.48]	22.83 [10.09]	23.15 [9.86]
80	7.35 [4.49]	6.86 [3.90]	7.31 [4.52]	7.65 [4.23]
96	7.30 [4.54]	6.78 [4.16]	7.30 [4.20]	7.45 [4.22]
112	6.85 [4.07]	6.19 [3.23]	6.80 [4.21]	7.21 [3.76]

These data demonstrate that drivers engaged in excessive speeding and that this reduced when voluntary ISA was available. Further analysis was undertaken to calculate the percentage of time ISA was engaged for the different speed limits. It

was found that the propensity to engage the system increased as the speed limit increased (see Figure 2). This effect was stable over time.

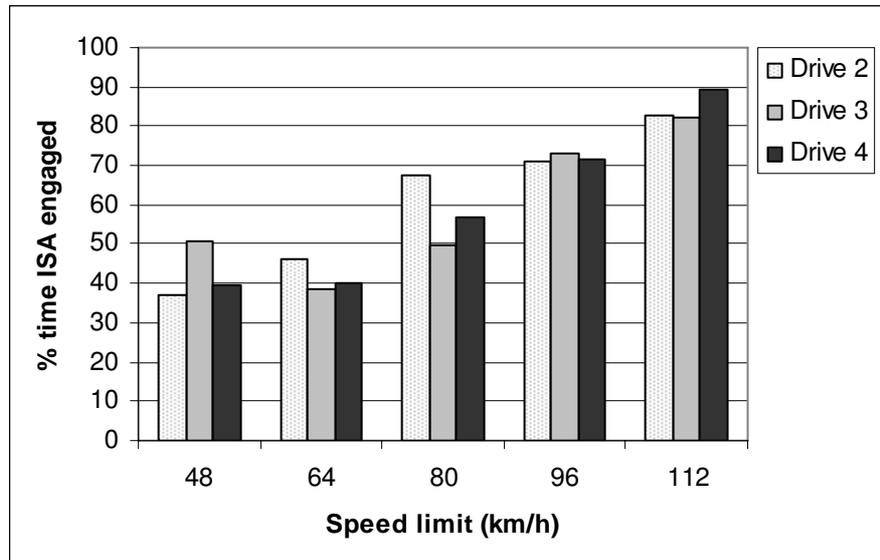


Fig 2. Use of the voluntary ISA system (simulator study)

The final step in this analysis was to establish driver's speed choice when they chose to disengage ISA. This would indicate whether the disengagement was "intentional" in order to allow them to exceed the speed limit, or whether the drivers were simply travelling below the speed limit – in which case the ISA status was irrelevant. Figure 3 shows that drivers intentionally disengaged ISA in the lower speed limits in order to exceed the speed limit. In the 48 and 64 km/h zones, drivers exceeded the speed limit between 20-30% of the time (as already established in Table 1), however they also spent a comparable amount of time with ISA disengaged but not speeding. This can most likely be attributed to the fact that driving was more "interrupted" in the urban environments with drivers having to negotiate junctions etc. In these situations, drivers would not be affected by ISA and thus disengaging it was not beneficial. In the higher speed limits, drivers were more likely to have ISA activated, and displayed only a small tendency to disengage ISA in order to exceed the speed limit.

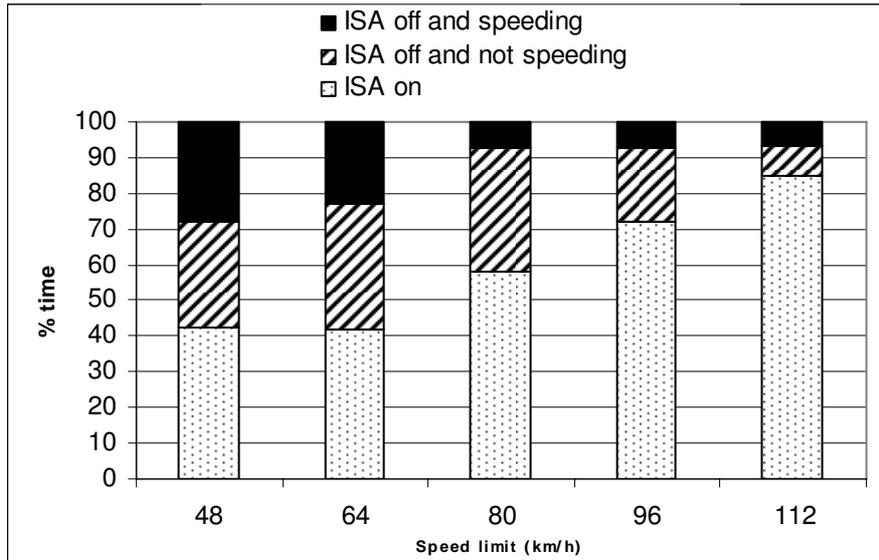


Fig 3. Use of the voluntary ISA system and speed choice (simulator study)

So who used the system? Did all drivers engage ISA or was there a subset that used it for a high proportion of time? Figure 4 shows that usage rates varied between 20-90% across all drivers, and that drivers were fairly inconsistent in their usage rates. Apart from Driver 1, usage rates varied, on average, by 40% between drives. The data suggest that there is not a subset of drivers who consistently use the voluntary system more than others.

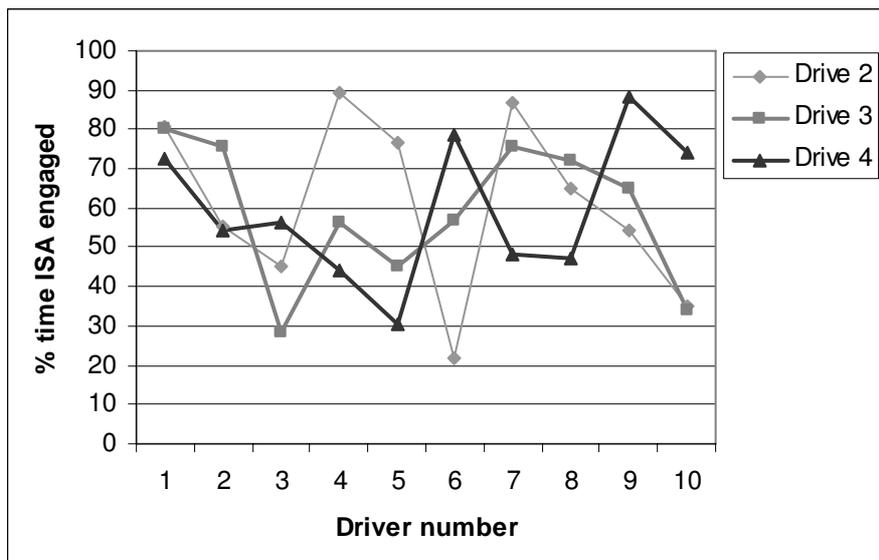


Fig 4. Use of the voluntary ISA system by individual drivers

This was confirmed using correlation analysis between the variables of system use, acceptability scores and DSQ scores; age was also included as a factor. Table 2 shows the matrix of non-parametric Spearman's correlations. Statistically significant correlations exist between the speed measures and acceptability. The negative correlation suggests that drivers who engage in higher speeds (as measured either by the DSQ or by observed speed), rate the acceptability of voluntary ISA as low. However, different driver types as defined by their acceptability towards ISA, their speed choice or their age, did not differ in terms of their propensity to use the voluntary ISA system. This confirms the lack of obvious trends or patterns in Figure 4.

Table 2. Correlation analyses for simulator study

	DSQ score	Actual speed	System use	Age
Acceptability	-0.46*	-0.56*	0.23	0.21
DSQ score		0.68*	0.30	0.13
Actual speed			-0.05	0.21
System use				0.13

Note: * $p < .05$

It was thought unwise to draw firm conclusions from these results without investigating the possibility that simulated driving with ISA is very different to driving in real traffic. For example, the driving simulator that was used was fixed-base, and thus no motional cues with regards to deceleration were available to the drivers. In addition, the acceptability scores may have been affected by the fact that other vehicles in the scene were travelling at or below the speed limit. The on-road study provided the ideal environment for further investigation.

3.2 On-road study

The experimental design matched the simulator study. However, due to time constraints, each participant only completed three drives using the same route. As before, voluntary ISA was not available for the first drive, thus supplying baseline data. The participants for the study were drawn from an existing database and there was no overlap with the simulator study. The sample was balanced for age and gender and participants were selected on the basis that they were regular drivers on all the road types incorporated in the test route.

Mean speeds and the amount of time spent above the speed limit were calculated. As in the simulator trial, there was no main effect of System availability on mean speeds in any of the speed limits. In some of the lower speed limits (48 km/h urban and 64 km/h) there was an effect, however, on excessive speeds, (see Table 3). Drivers spent less time above the speed limit when ISA was available, [$F(1,7)=$; $p<0.05$].

Table 3. Proportion of time spent 10% [and 20%] over the speed limit

Speed Limit (km/h)	Drive 1 (baseline)	Drive 2	Drive 3
48 (urban)	18.46 [15.59]	13.16 [10.90]	12.83[10.76]
48 (rural)	38.17 [22.36]	38.56[21.45]	37.58[25.36]
64	18.39 [15.21]	12.67 [10.28]	12.41 [9.89]
96	7.15 [4.17]	6.61 [4.41]	6.18 [3.71]
112	6.66 [3.77]	6.11 [3.41]	5.72 [3.57]

The propensity to engage the system can be seen in Figure 5. Drivers were willing to engage the ISA system for approximately 60% of the time spent driving. This was consistent across the speed limits, apart from in the 48 km/h rural zone, where system use was generally much lower (30% on average). Across all speed limits,

decreases in system use were observed between Drives 2 and 3, being statistically significant in both the 48 km/h zones ($p < .01$).

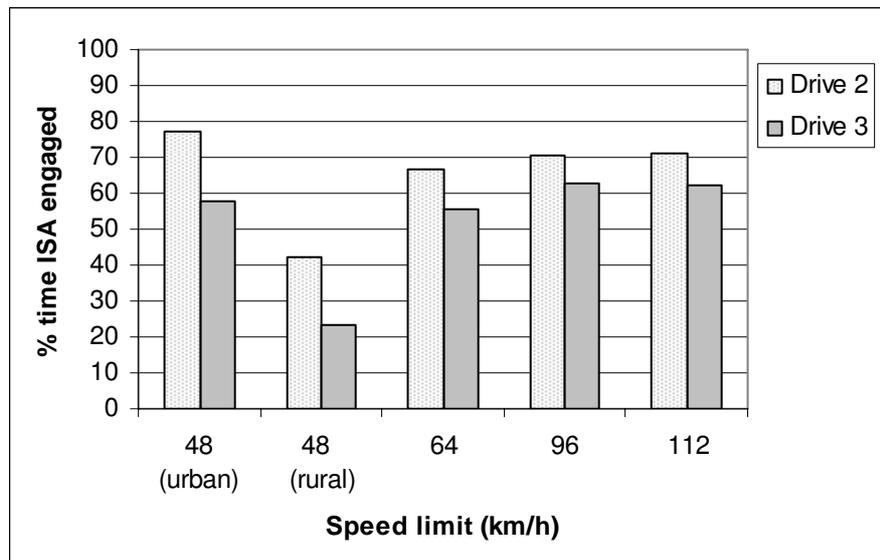


Fig 5. Use of the voluntary ISA system (on-road study)

Figure 6 shows that whilst drivers only engaged ISA for approximately 60% of their driving, when they chose to disengage it, they only exceeded the speed limit for a further 10% of the driving time. The remainder of the time was spent travelling with ISA disengaged, but below the speed limit. The only exception to this was in the rural 48 km/h road, where drivers appear to be disengaging ISA to intentionally speed. This 48 km/h zone was located directly after 96 km/h speed limit zone and drivers commented that they felt pressurised by traffic from behind, and felt uncomfortable travelling at the speed limit.

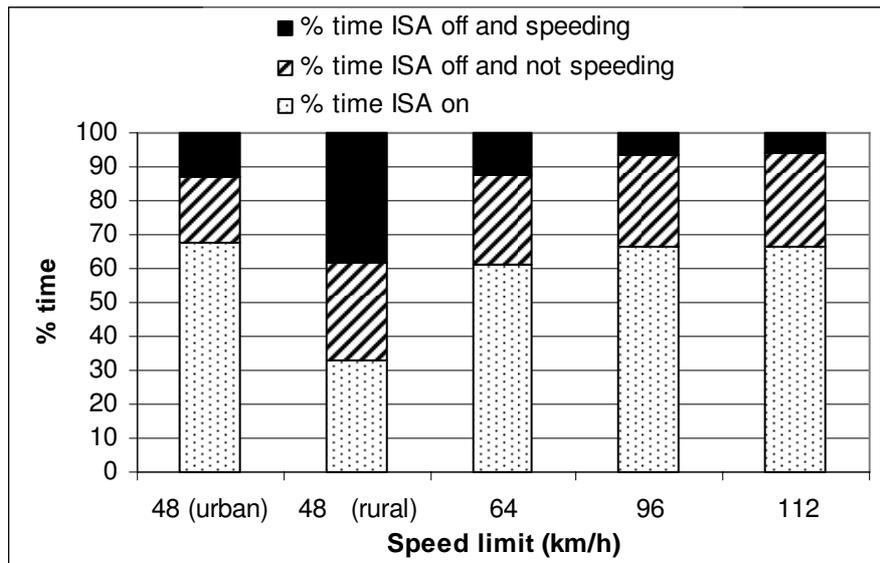


Fig 6. Use of the voluntary ISA system and speed choice (on-road study)

Compared to the driving simulator study, a much clearer pattern of use for individual drivers emerged, Figure 7. Drivers were more consistent in their use of the voluntary system, with there being an average drop for almost all drivers of 10% over time.

Drivers 1-4 were male and it can be seen that in general their usage rates were lower than that of the female drivers.

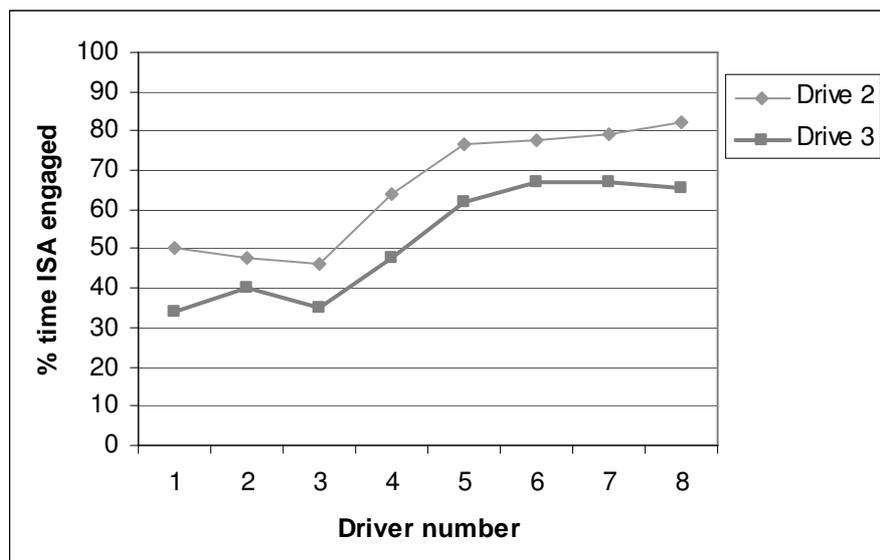


Fig 7. Use of the voluntary ISA system by individual drivers (on-road study)

A similar correlation analysis, as described above, was undertaken (Table 4). Again, positive correlations were found between acceptability and speed. In addition, in contrast to the simulator study, there were statistically significant negative correlations between the actual speed measures, acceptability and system use. This indicates that those drivers who were more likely to speed rated voluntary ISA as less acceptable and subsequently engaged it less.

Table 4. Correlation analyses for on-road study

	DSQ score	Actual speed	System use	Age
Acceptability	-0.30	-0.44*	0.52*	0.22
DSQ score		0.46*	-0.20	0.10
Actual speed			-0.43*	0.18
System use				0.09

Note: * p<.05

3.3 Summary

The results from the two trials are summarised in Table 5.

Table 5. Summary of results

	Simulator	On-road
Reduction in mean speed	None	None
Reduction in excessive speeding	In lower speed limits	In lower speed limits
% time ISA engaged	Increased as speed limit increased	More consistent across speed limits, with exception of low use in urban area
Disengage ISA in order to speed	In lower speed limits	Not much evidence except in rural village
Usage rates between drives	Inconsistent	Consistent, with a significant decrease between drives
Characteristics of speeders	Low ISA acceptability No relationship with usage rates	Low ISA acceptability Low ISA use

4 CONCLUSIONS

The two studies described above were carried out to investigate the potential benefits of a voluntary ISA system. The focus of the experiments was to discover first the propensity of drivers to use such a system, and secondly whether there were particular drivers who were more likely to use it. It was hypothesised that drivers who were more speed-limit abiding would be more likely to engage the system, creating concern for policy makers who would hope that this type of intervention could potentially be safety beneficial.

Mean speeds did not change when ISA was available for drivers to use, in either of the two studies. However, the measure of mean speed is “contaminated” especially on congested roads by large variances in speed. Alternative measures of speed were used to capture the more specific behaviour of exceeding the speed limit by various proportions. In both the studies, drivers’ propensity to exceed the speed limit was lowered when ISA was available. This effect was confined to the lower speed limits.

Further analysis was undertaken to discover whether these decreases were due to use of the voluntary ISA. The studies showed that, in general, drivers engaged ISA for approximately half of their driving time. This figure varied, however, depending on the speed limit of the road and indeed, on the nature of the road and the surrounding traffic. Previous research has found that drivers tend to influence one another’s speed (Åberg, Larsen, Glad and Beilinson, 1997) and that drivers choose their speed by comparing it to those of other drivers around them (Connolly and Åberg, 1993). In the simulator study, drivers were more inclined to engage ISA when the speed limit of the road was higher but neither mean speed or excessive speeding reduced in these situations. This was clarified by the analysis undertaken to discover how drivers

behaved when they disengaged ISA – there was little desire to travel at higher speeds in this situation.

This was contrasted by the results in the on-road study – in general there was no relationship between drivers' propensity to engage ISA and the speed limit. It appears that the surrounding traffic conditions contributed to this effect with congested urban roads making it unnecessary to disengage ISA. This was not so in a comparable speed limit where traffic was less heavy (and indeed pressurised our test drivers from behind). In this situation, drivers used the system for only 30% of the time, and when disabled, they took the opportunity to exceed the speed limit for a substantial amount of time. In summary, the test drivers appear to have driven at a speed they felt comfortable with given the road and traffic conditions. If this speed was higher than the posted speed limit, they were inclined to disengage ISA in order to maintain this speed.

Both the simulator study and the on-road trial indicated that drivers were less willing to engage the system in low speed limit areas, where other speed-constraining factors existed. In addition, in both higher speed limit areas, particularly where traffic density was low, and in speed transition areas, drivers' propensity to engage the system was considerably less. This introduces an "unknown" into the equation of system compliance in that drivers' decisions are based on extraneous and changeable variables.

So, we know that drivers are sensitive to the prevailing traffic conditions when deciding whether to use ISA, but what about individual driver characteristics? Does driver style influence the propensity to use such a safety system? The studies allowed some pertinent variables to be measured alongside actual system use to

investigate this idea. The results from the on-road study indicated that those drivers who considered ISA to be both a useful and pleasant system, were overall more likely to engage it. This is hardly surprising and it is only when the speed behaviour is analysed can we conclude something more concrete. It was hypothesised that those drivers who enjoy and engage in speeding, or exceeding the speed limit, were less likely to use a system that would inhibit this. This was not found to be so in the simulator study, but when immersed in real traffic it was indeed found to be true. This is an important finding when considering the mechanisms for implementing ISA: those drivers who would benefit most would be less likely to use a voluntary system.

Whilst these studies were unable to examine long-term behaviour, it was possible to gain insight into two separate snapshots of driving with ISA, separated by approximately one week. In the on-road study, when drivers returned for their second drive with ISA, they were then less inclined to engage ISA. This may have been due to the nature of the experiment in that test drivers were the only ones equipped with ISA. Some commented that they found the experience of driving at the speed limit somewhat worrisome, with other traffic attempting to intimidate them into going faster. Another limitation of the study was the sample size – this was compromised due to the experimental design. It would have been too costly to increase the number substantially whilst still retaining the design that allowed us to study behaviour at two time points.

These two studies represent the first specific investigations of driver's propensity to use a voluntary ISA system and provide insight into the situations in which they did so, along with some observations of the types of drivers that are more likely to use such a system. The relatively small number of participants employed in the study should be noted, but the experiments provided a very rich data source which partially

offsets this disadvantage. The contrasts between the simulator and field trial results indicate the importance of carrying out the latter when evaluating new technology as they provide the driver with an opportunity to interact with “live” traffic. This was found to be an influential factor in the calculation of usage rates for the voluntary ISA. With regards to the title of this paper, the results suggest that it is precisely those drivers who would benefit from using ISA, who choose not to. If voluntary ISA were to be implemented it is likely that its safety benefits would be limited.

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