

HOW INTELLIGENT SPEED ADAPTATION AFFECTS COMPANY DRIVERS' ATTITUDES TO TRAFFIC RELATED ISSUES

Niels Agerholm^{1*}, Nerius Tradisauskas², Harry Lahrmann²

1. Fibigerstraede 11, 9220 Aalborg Oest - DK, Traffic Research Group, Aalborg University, Denmark,
+45 28959147, agerholm@plan.aau.dk

2. Traffic Research Group, Department of Development and Planning, Aalborg University, Denmark

ABSTRACT

A Danish Intelligent Speed Adaptation trial with company cars was concluded in November 2008. It included 26 cars and 51 non-voluntary drivers. Results presented here are regarding attitudes to behaviour in traffic and to Intelligent Speed Adaptation. In general the trial has increased the drivers' awareness of speed limits but hardly changed the drivers' attitude to what constitutes dangerous behaviour in traffic. Further, ISA was assessed as more positive for company cars than for private cars. Moreover, respondents from this trial were more aware of risk in traffic than were young drivers in another Danish Intelligent Speed Adaptation trial.

KEYWORDS

Intelligent Speed Adaptation, Driving speed, Attitudes, Traffic, Road Safety, Attitudes, Traffic Safety, White van driving

BACKGROUND

Road safety is one of the world's main causes of loss of years of life. In 2004 it was estimated that more than 1.2 million people died because of poor road safety [1]. The European Commission has set an ambitious goal to mitigate this problem. The goal is a reduction of road fatalities by 50% in 2010 compared to the situation in 2001. Nevertheless, in 2005 only a reduction of 17% was reached and it became clear that new tools must be introduced to reach the goal. In this context, Intelligent Transport Systems (ITS) and especially Intelligent Speed Adaptation (ISA) could be key tools in reaching the goal [2]. ISA means equipment in a car which compares the current speed with the current speed limit and gives feedback to the driver if speeding. Various forms of response can be given if speeding occurs: There may be a visual and/or auditory response in case of violations, and/or a display may show the speed limit. Additionally, violations can be logged on an on-board computer. Finally, the accelerator pedal may give resistance (heavy accelerator pedal) or even make it impossible to violate speed limits (hard accelerator pedal). These different types of ISA systems can be categorized as informative, advisory, recording, or intervening systems [2].

Commercial drivers have a poor reputation among other road users due to their behaviour, and are notably over-represented in traffic accidents. A new Danish study has e.g. concluded that commercial drivers are approx. 125% more exposed to road fatalities or severe injuries than are drivers in private cars [3]. Moreover, many companies have recently formulated policies regarding safety, environment, etc. Consequently, ISA could be a suitable solution for the companies to fulfil their stated goals.

In a number of countries, ISA trials with company cars have been carried out in the last decade with significant results. The Australian *TAC Safecar* project, which was carried out from 2003 to 2005, included 15 company cars and 23 voluntary participating drivers. This involved an advisory and intervening ISA system which consisted of a display showing the speed limit if speeding and a heavy accelerator pedal if speeding continued. The main results were a reduction by up to 2.7 km/h for the 85 percentile speed, and driving time with speeding by more than 5 km/h was reduced by up to 57% [4]. Also, in Stockholm, Sweden an ISA project with 20 public cars and a total of 130 drivers was carried out from 2003 to 2005. The highest effect here was found for rural roads with a speed reduction of up to 2 km/h. On motorways the effect was smaller. This trial involved an intervening ISA system with a heavy accelerator pedal [5]. Further a Belgian ISA trial with both private and commercial vehicles was carried out in the City of Ghent. 14 company cars were involved in this study. No separate results were given for company cars. However, a reduction of up to 2.5 km/h was found for the 85% percentile speed for all cars. The ISA system used in the trial was similar to the one used in Sweden [6]. So far ISA in company cars has shown significant results.

An ISA trial with incentives for company drivers

In the Danish ISA trial *ISA Commercial* (ISA C), ISA was tested with non-voluntary company drivers. In addition to an informative and advisory function, the ISA system had an incentive function based on recording ISA, which consisted of penalty points if a driver violated the speed limit. In this paper the non-voluntary professional drivers' attitude to ISA and road safety topics in general are studied.

ISA C was carried out in cooperation between Vejle Municipality and Aalborg University and included 26 company cars and 51 drivers in total. The cars belonged in six companies with 1-5 vehicles in each company. In most companies, the participation was decided after discussions among the drivers, who were mainly positive towards the trial beforehand. In one company, the decision was taken without involvement of the drivers, who were of course less positive towards the trial. The trial was finalized in November 2008. It was generally based on the same technology as in the *Pay As You Speed* ISA trial (PAYS) [7]. However, there were some differences, and a brief description of the ISA system follows here.

In each car an "On Board Unit" (OBU) was installed. It consisted of:

- A GPS/GPRS unit with a memory card on which the digital speed map was stored,
- a display with a loudspeaker. The display showed the speed limit and any penalty points. The loudspeaker was used for verbal warnings in case of speeding, and
- a 'key reader' which could read the drivers' unique key ID and hence distinguish between several drivers' behaviour in the same car.

Based on a GPS signal the position was matched onto the speed limit map. This limit was shown in the display and compared with the car's speed. If the speed limit was exceeded by

more than 5 km/h, the driver received a verbal warning in a female voice such as e.g.; ‘50 – you are driving too fast’. The warnings were repeated every sixth second until the speed was reduced to under the speed limit + 5 km/h. The third and subsequent warnings were associated with penalty points. The number of penalty points per warning depended progressively on the level of speeding. Moreover, each driver had access to a web page which showed all received penalty points.

During the first 1.5 months, the ISA equipment was inactive albeit collecting ‘normal’ behaviour among the drivers - a ‘baseline period’. After this, ISA was activated. The number of received penalty points per driver was summarized and compared with the driven distance once a month. The driver with the fewest penalty points per driven distance was announced as the driver of the month and received a small present worth app. 40 € After approx. 12 months with ISA activated, the trial stopped and the 10 drivers with virtually no penalty points received a GPS navigator for their private car as a reward. Data collected during the trial consisted of a recording of the driving for each driver based on GPS data. Also, the drivers’ attitudes to traffic related issues were collected by two web-based questionnaires.

Recorded driving data from the full trial period have not yet been analysed completely. However, preliminary results based on the behaviour in the ‘baseline period’ compared with the behaviour in the first 1.5 months with ISA activated have shown remarkable results (see table 1) [8].

Table 1. The proportion of the driven distance at more than 5 km/h above the speed limit

	Speed limit (km/h)				
	50	70	80	110	130
Baseline period	18.7%	15.2%	18.9%	25.5%	5.0%
ISA activated	7.4%	5.1%	4.7%	6.6%	1.3%
Reduction	11.3%	10.1%	14.2%	18.9%	3.7%
p-value	0.000	0.000	0.000	0.016	0.290

Based on these data, speeding was reduced significantly on all analysed road types except on motorways with a 130 km/h speed limit where almost no speeding occurred anyway.

The effect from ISA was significant, but how did the drivers review their experiences with the system, and what were their attitudes to behaviour in traffic generally? Moreover, how has ISA affected these attitudes? The large-scale Swedish trials in which private car owners participated concluded that a substantial part of the drivers would like to keep the ISA equipment after the end of the trial and that they became more positive towards ISA in general [9]. In the TAC Safecar trial, increased discontent with the system was indicated [10].

METHODS

Research design data and statistical analyses

Data were extracted from two web-based questionnaires. One questionnaire was filled in during the ‘baseline period’, while the other was filled in when the drivers had driven with ISA activated for approx. one year. These are subsequently mentioned as ‘baseline’ and

‘ISA’, respectively. Although the drivers were forced to participate in the trial because ISA was installed in their company car, the questionnaires were filled in voluntarily. The two questionnaires were almost identical, so any effect from ISA would be measurable. In total, 51 drivers were equipped with a key ID, and 40 of them filled in the first questionnaire (baseline). The number of respondents in the second questionnaire was too low after the first deadline, and a small reward was subsequently offered to all respondents to increase the number. However, the second questionnaire was only filled in by 23 drivers (ISA). Of these 23, two were ‘new’ and had not filled in the first one. Consequently, the analyses made here consist of feedback from 21 drivers. Four of them were women. These drivers are subsequently denoted as ‘respondents’.

The questions used in this trial were very similar to the ones used in the PAYS trial. Therefore, it is possible to compare results from ISA C with the ones from PAYS where suitable. Results from PAYS are only shown in figures if they differ markedly from the ISA C results. In addition, it is notable that the groups of questions used are similar to the ones used in most new ISA trials [11]. The first questionnaire included a number of background questions such as age, gender, education and car use. Also, questions related to driving style, attitudes to driving style, safe driving, driving speed, speed limits, and risky traffic behaviour were included. Further, any differences between driving behaviour in private and in company cars were expounded. Moreover, the drivers were asked about their attitudes to a number of ISA systems, including the one they tried in ISA C. The questionnaires were sent to the respondents by e-mail. Each questionnaire took 15 to 20 minutes to fill in and consisted of some 90 to 125 questions, depending on some answers which resulted in additional questions. To keep the results from the trial short and clear and to deal with the limited space available, only selected results are presented here. Moreover, regarding a number of topics, the respondents were asked about their behaviour in both private and company cars. In many cases, the results were almost similar for the two types of vehicles. Therefore, results regarding driving in private cars are only included in a few cases. Using the advantages of web-based questionnaires, the respondents were provided with a continuous scale without visible values for indication of their attitudes to most of the questions. These scales have a hidden scale and were made as two types: one ranging from -200 to +200 in bipolar questions in terms of how much respondents agreed or disagreed with a statement, and one ranging from 0 to 400 depending on e.g. how often they speed (see Figure 1).

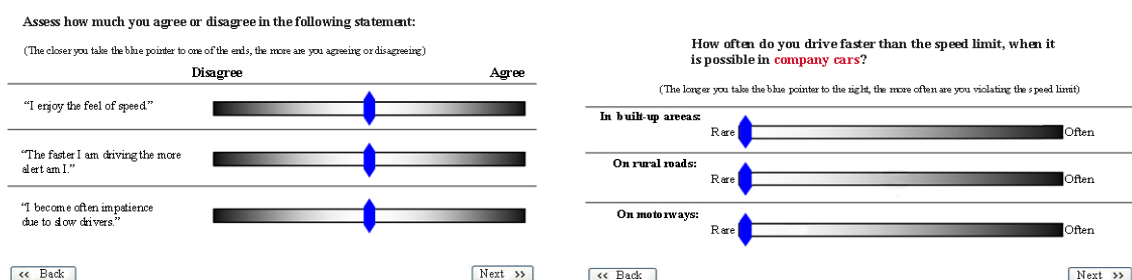


Figure 1. Examples of the two types of questions

A paired t-test was used to study differences between the baseline and ISA for various variables. Regarding e.g. the respondents’ attitudes to speeding in built-up areas, the differences for each respondent in the ‘baseline’ and ‘ISA’ were calculated. This resulted in up to 21 observed differences, and then a standard t-test was applied to test whether the

theoretical mean of these differences was significantly different from zero. P-values below 0.05 are assessed to be of statistical significance, while p-values between 0.05 and 0.10 are assessed as likely to be of statistical significance.

RESULTS

Personal data

The participating respondents were between 24 and 61 years old when the trial started. The mean age was 44. 76% had one or several children. All had obtained their driving licence before they were 21, so most of them were experienced drivers. Their assessed driving in company cars differs widely, from 600 km to 34,800 km per year, and some 75% of the drivers answered that they drove between 10,000 and 15,000 km per year.

Attitude to and occurrence of speeding

The drivers’ attitudes to risk in traffic depending on the road types in ‘baseline’ and ‘ISA’ are shown in Figure 2. Results marked with an oval indicate that the change is of statistical/likely to be of statistical significance.

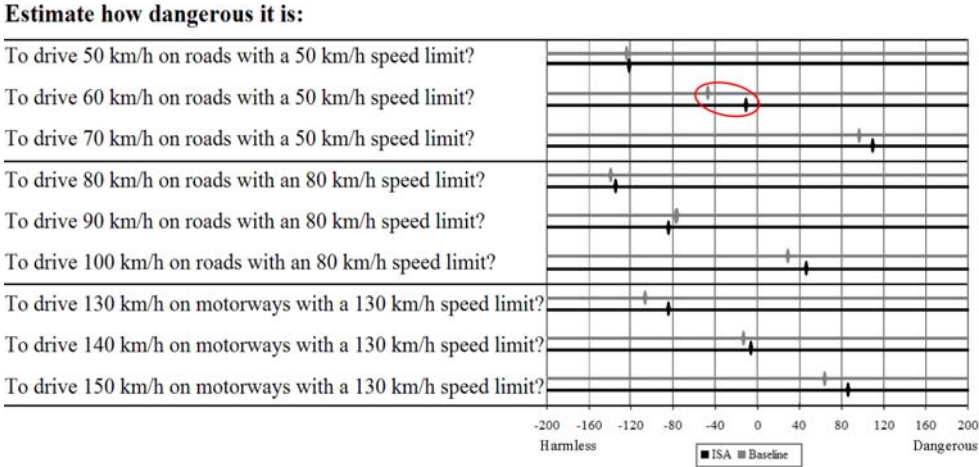


Figure 2. Respondents’ attitudes to speed and risk on different road types

The Danish speed limit in built-up areas is 50 km/h, in rural areas it is 80 km/h, and on motorways it is 130 km/h, unless other speed limits are stated locally. In general the respondents found that increased speed results in higher danger. However, regardless of road type, they found a 10 km/h violation of the speed limit harmless rather than dangerous. Serious speeding by 20 km/h was assessed as somewhat dangerous, most dangerous on roads in built-up areas, and least dangerous on roads in rural areas. The only significant change due to ISA was regarding moderate speeding (10 km/h) on roads in built-up areas (p=0.041). These attitudes corresponded well with the attitude among voluntary participants in other Danish ISA trials as well as with Danish drivers who had never participated in an ISA trial [11,12]. In the TAC Safecar trial speed violations by 10 km/h were assessed as dangerous while the ones by 20 km/h were assessed as very dangerous [10]. In general the Australian

participants found that speeding is more dangerous than did the Danish participants. The lowest acceptance of posted speed limits was for the rural roads. This result is alarming, because this is where the majority of severe road accidents occur in Denmark [13]. The respondents were also asked about their preferred speed limits on roads in built-up areas, roads in rural areas, and on motorways. Based on the mean results, these were approx. 50, 86, and 125 km/h for the three road types, respectively (not shown). So their feeling of danger corresponds well with the respondents' proposed speed limits. They assessed the limit in built-up areas as suitable, while it should be increased somewhat on rural roads and reduced to a similar extent on motorways. These results are somewhat identical with the ones found in the Belgian trial, where the respondents stated that they speeded the most on rural road and less in urban roads. Moreover, they felt that the speed limits in general were acceptable [14].

The respondents assessed that they speed quite rarely regardless of if they were driving in built-up areas, rural areas, or on motorways. In private cars the respondents stated that they speed least on roads in built-up areas, while they speed the least on motorways when driving company cars. No changes in attitudes due to the activation of ISA were significant. The discrepancy with the results in Figure 2 may be because small violations of a speed limit might not be perceived as 'real' speeding in the results in Figure 3.

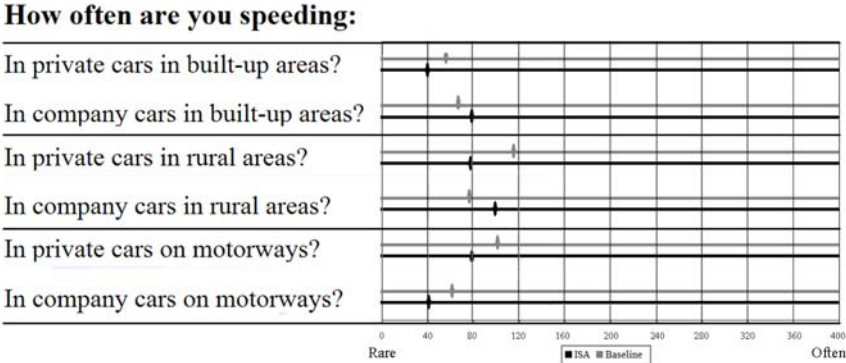


Figure 3. Respondents' assessment of how often they speed in company cars and private cars, respectively

Attitudes to different types of and reasons for risk related behaviour

The two most important reasons for speeding appear in Table 2. Both in the baseline and ISA period it was lack of awareness of the speed and a desire to follow the flow of traffic. Pressure from others cars was in the baseline a minor reason for speeding, but with ISA the proportion increased as expected. Intention to speed is more rarely as reasons for speeding and did not change. The awareness of the speed limits decreased from baseline to ISA. One can wonder about this result, because the respondents in the ISA period got continuous information about the speed limit contrary to in the baseline period where they only had information from the speed limit signs placed on the road. Finally their urge to speed dropped from baseline to ISA. It was probably because in the ISA period they knew that that speeding was not possible without getting penalty points. However, none of these changes were of statistical significance. In the TAC Safecar trial, the respondent stated that the most important reasons for speeding were lack of awareness of the speed and unawareness regarding the speed limit. A desire about to follow the traffic was only rare the case [10].

Table 2. Respondents' two most important reasons for speeding

	Baseline	ISA
	Proportion	
I wish to follow the traffic.	62%	57%
I am not aware of my speed.	67%	52%
I feel pressure from other cars.	14%	29%
I intend to speed.	19%	19%
I am not aware of speed limit.	19%	38%
I feel an urge to speed.	19%	5%

The reasons for speeding were several, and so were the various risk-related activities. Figure 4 shows respondents' attitudes to risky behaviour.

Estimate how much you agree in this statement:

- I enjoy the feel of speed.
- The faster I go the more attentive am I.
- I often get impatient with slow drivers on the road.
- I try to reach my destination as fast as I can.
- I worry a lot about accident risk.
- It is more important to follow traffic than to comply with speed limits
- It is a duty of all drivers to comply with the speed limits.
- Speed limits are virtually unnecessary in traffic.
- If I am busy I may run a risk in traffic.
- If there was no enforcement I would drive faster than else.
- I sometimes feel a pressure in traffic to drive faster than enjoy.

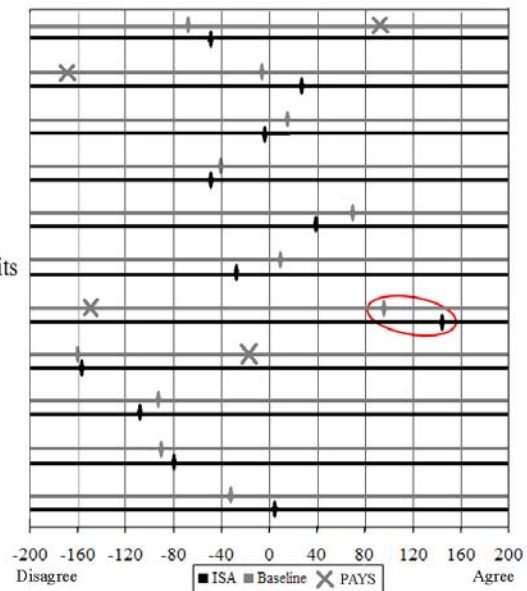


Figure 4. Respondents' attitudes to a various statements regarding risky behaviour

Respondents generally disagreed with the following statements:

- enjoying the feeling of speed,
- lack of enforcement would make them speed more,
- if busy they were prepared to take risks,
- they try to reach their destinations as soon as possible, and
- speed limits are unnecessary in traffic.

Respondents neither agreed nor disagreed on the following issues:

- feeling of pressure from the car behind,
- it is more important to follow the traffic than the speed limits,
- they would often become impatient due to slow drivers, and

- increased speed results in increased awareness.

Respondents agreed with these statements:

- they worried much about the risk of accidents, and
- it is a duty of all drivers to comply with speed limits.

When these results are compared with the ones found in other ISA trials, there are some noticeable differences. The respondents in ISA C stated that speed did not result in enjoyment. The drivers in the Belgian ISA trial were also disagreeing in this statement, while the drivers in PAYS stated the opposite [11,14]. On the other hand, the ISA C respondents were almost neutral regarding higher speeds resulting in higher awareness, while PAYS showed significant disagreement with this statement. Also differences were found regarding the necessity of speed limits and the duty to comply with them, which the ISA C drivers found much more important than, did the PAYS drivers. Furthermore, ISA C resulted in a significant increased agreement on this statement ($p=0.012$), so it seems that their safety awareness has increased somewhat. The reasons for these noticeable differences are probably that the PAYS drivers were younger, less experienced and somewhat blind to risks related to speeding. These characteristics are well known for young drivers and could explain some of their high over-representation in the accidents statistics.

Estimate how dangerous you think it is to do the following activities:

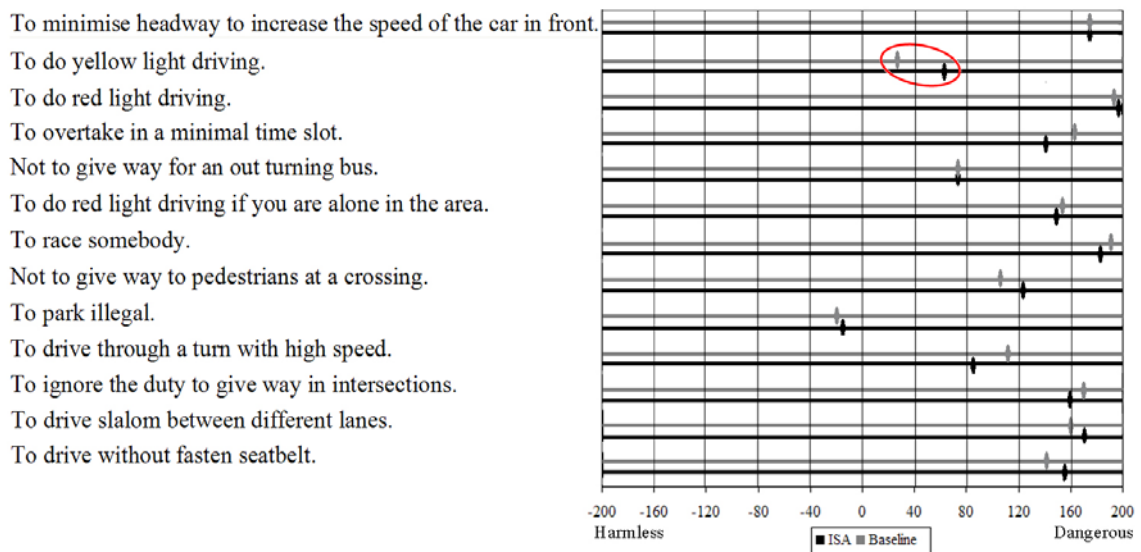


Figure 5. Respondents’ estimated level of danger in connection with activities in traffic

Moreover, the respondents have answered questions about how dangerous a number of risk-related activities in road traffic are (see Figure 5). A hypothesis could be that ISA would have increased respondents’ risk awareness. However, this is not supported by the feedback from respondents. In general, respondents’ assessed danger of risk-related activities only changed minimally after the introduction of ISA. Only yellow-light driving tended to change significantly towards a more dangerous assessment ($p=0.0849$). Therefore, it can be concluded that ISA C did not change respondents’ view of what constitutes dangerous behaviour in traffic.

Describe your driving style:

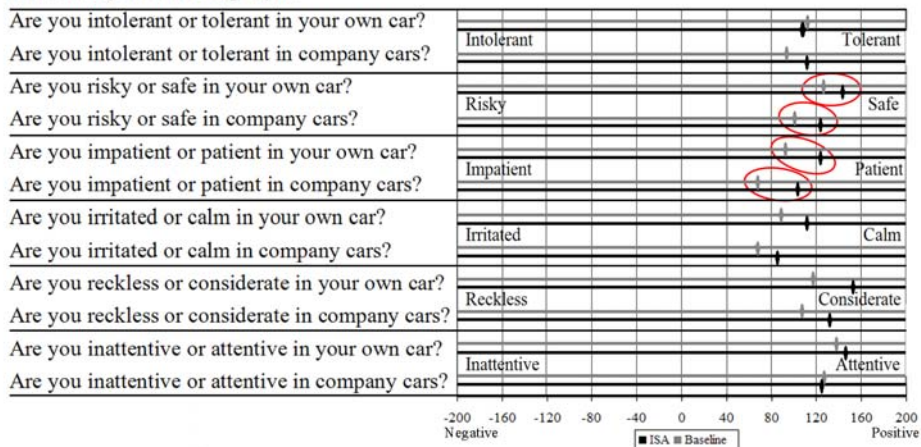


Figure 6. Respondents’ assessment of their behaviour in company and private cars, respectively

As shown in Figure 6, respondents stated that their driving behaviour was positive rather than negative. Based on the summarised values for each respondent, ISA resulted in significantly better behaviour ($p=0.0142$), but also significant changes regarding other statements are found. Patience increased for private and for company cars ($p=0.0065$ and $p=0.0167$, respectively). Also, drivers’ behaviour became safer with ISA ($p=0.0203$ and $p=0.0395$, respectively). Further, consideration and calmness in private cars were likely to increase significantly ($p=0.0638$ and $p=0.0934$, respectively). In general, the results correspond well with the PAYS results. However, the respondents in ISA C stated that they were slightly more tolerant and calm than did the ones in PAYS - maybe due to the higher age group in ISA C. Another thing that appears from these data is that for all objectives, partly with the exception of ‘Tolerant’ vs. ‘Intolerant’, the respondent stated that their behaviour was more negative when driving in company car than in private car. This points towards the same problems regarding safety and company cars as stated in the first section.

Attitudes to ISA

What is your attitude to:

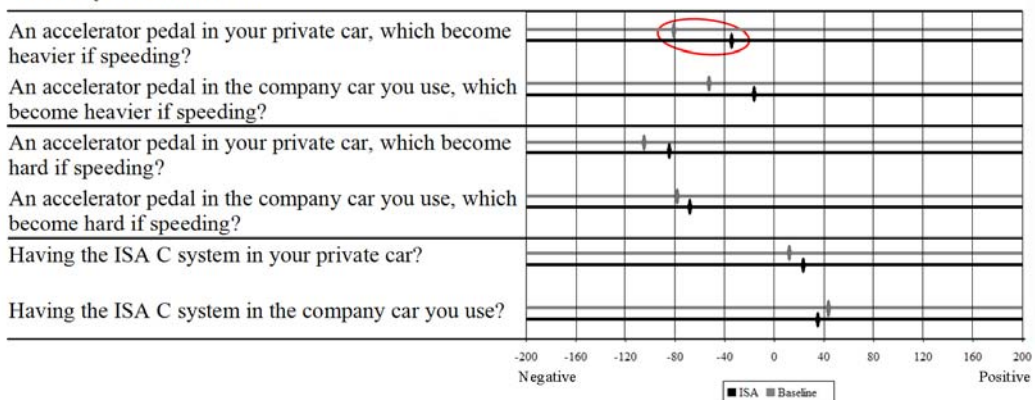


Figure 7. Respondents' attitude to different ISA systems in company cars and private cars, respectively

Respondents' attitudes to different ISA systems appear in Figure 7. When asked about their attitude to ISA equipment in general, and to the ISA C equipment in particular, they were cautiously positive towards driving with the ISA C equipment both in private and company cars. Respondents' attitudes to the heavy and hard accelerator pedal were, despite a decrease in negativity during the trial, generally rather negative. As regards a heavy accelerator pedal, the changes towards a more positive attitude tended to be significant for private cars, while it almost tended to be so for company cars ($p=0.0901$ and $p=0.1278$, respectively). These results correspond reasonably well to the results from PAYS. What is also noteworthy is that the respondents were in general slightly more positive towards ISA in company cars than in their private cars, irrespective of the type of ISA. It is also noteworthy that the respondents in general were slightly more positive towards ISA in company cars than in private cars, irrespective of the type of ISA. It also corresponds well to the respondents' assessment that their attitudes when driving in company cars were slightly more negative than when driving in private cars. These results show both a bigger need and a bigger acceptance of ISA in company cars than they do in private cars. In Belgium, it was found that commercial drivers were slightly negative to ISA (heavy accelerator pedal) while the private drivers were clear positive [14]. In ISA C the drivers were also mainly negative, but they were less negative regarding ISA in commercial vehicles. Moreover in the Australian trial, the respondent stated that they were positive to a heavy accelerator pedal while they were negative to a hard one [10].

How do you think:

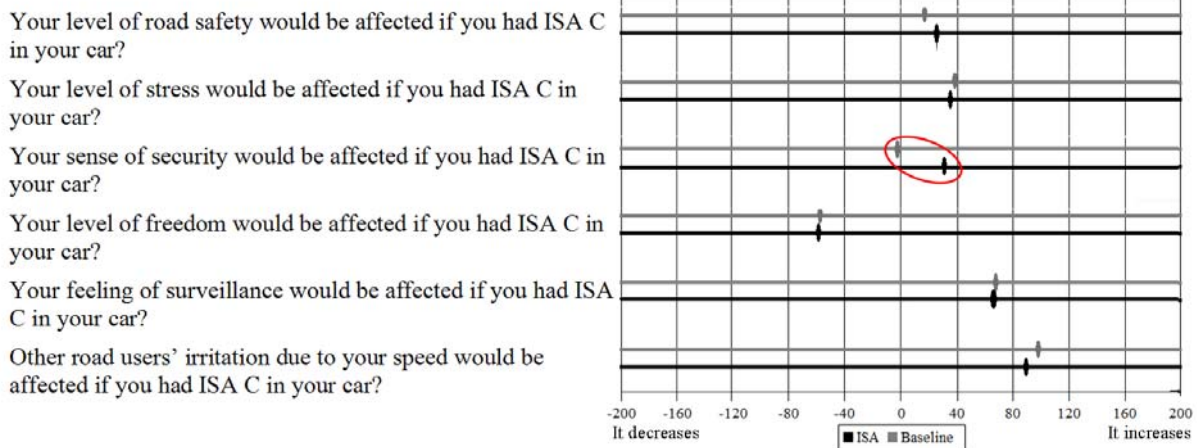


Figure 8. Respondents' attitude to the ISA C equipment

Respondents' attitudes to how the ISA C system would affect their driving experience are expanded in Figure 8. In ISA C the level of safety due to ISA was assessed as slightly positive and almost stable from before to after trying ISA while in the Swedish trials it decreased substantial after ISA was tried [9]. Both irritation from other road users due to ISA and the expected feeling of surveillance were assessed as increased due to ISA. Freedom on the road was assessed as reduced due to ISA, while the sense of security was assessed as slightly positive. The level of stress remained unchanged due to ISA. In the TAC Safecar trial, the

large-scale Swedish trial and a Swedish trial with commercial vehicles the level of stress or irritation was assessed a good deal bigger due to ISA [5,9,10]. It hardly changed in ISA C. The sense of security while driving was significantly higher after activation of ISA ($p=0.0254$). It is also noticeable that except regarding the feeling of freedom while driving, attitudes to the ISA C system were positive rather than negative. The same result was found in the TAC Safecar trial, but here the respondents became markedly less satisfied with ISA after the trial [10]. Opposite to this, driver attitudes in ISA C under ISA conditions did neither differ significantly from the ones found in PAYS nor from the ones in baseline.

DISCUSSION, SUMMARY, AND CONCLUSION

One might perhaps question if the respondents are representative of the average company car driver. However, it is known that not all the drivers were keen on participating but were obliged to do so. Furthermore, one could ask if there is bias among the respondents towards the most positive part of the drivers in the participant companies. Probably, there is such a bias, but the small reward to respondents of the second questionnaire raised the respondent rate and has resulted in more mostly 'negative' respondents than else. However, irrespective of whether or not there is bias, it is reasonable to assume that any bias is significantly lower than for other ISA trials based on voluntary participation. Results from the Danish ISA trial PAYS have e.g. shown that voluntarily participating drivers sped less and were more positive to ISA beforehand than the average driver [11].

ISA C with 26 vehicles and 51 drivers in total was carried out in 2007 to 2008, and the results in this paper are concerned the drivers' attitude to ISA and road safety-related issues in general. The drivers were non-voluntary and some of them were negative towards ISA. In addition to informative and advisory functions, ISA was supplied with an incentive function consisting of penalty points if speeding occurred. Data collected during the trial consist of driving data based on GPS data and two web-based questionnaires regarding drivers' attitudes to traffic-related issues.

ISA seems to have resulted in increased awareness of danger associated with speeding, but it has only changed significantly as regards roads in built-up areas. This result corresponds well with a high acceptance of speed limits here. It was also stated that ISA did not result in significant changes in the reasons for speeding even though pressure from other cars increased and the urge to speed decreased. However, the attitude to complying with speed limits increased significantly among the respondents. On the other hand, except as regards yellow-light driving, ISA did not change drivers' awareness of danger in risky situations. Moreover, when respondents were asked about their own driving style, they assessed it as safer after trying ISA, but they also stated that their behaviour was better in their private car than in their company car. Acceptance of ISA changed only slightly but was, however, regarded quite positively. In general, the acceptance of ISA in company cars was higher than in private cars. ISA also resulted in a feeling of a higher sense of security, while safety, stress, other road users' irritation, and freedom hardly differed from the expected levels. Also, if comparing the results found in ISA C with the Danish PAYS trial involving young car owners, it is evident that the respondents in ISA C were markedly less keen on speeding and more aware of the danger in traffic than were the young. In general the drivers in ISA C were somewhat in between the drivers in PAYS who were rather risky in their attitudes, and the respondents in other trials. It might be so, because the participants in ISA C were older than in PAYS and not all were voluntary participating opposite to participants in the other trials.

Overall, ISA C has increased drivers' awareness of speed limits but has not significantly changed drivers' attitude to dangerous behaviour in traffic. Moreover, ISA was assessed as more positive for company cars than for private cars.

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