isa - UK

intelligent speed adaptation

Results of Field Trial 4

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EXECUTIVE SUMMARY

Introduction

This report documents the last of a series of four field trials with Intelligent Speed Adaptation, i.e. a system in which the vehicle "knows" the speed limit and that knowledge can be used to constrain the maximum speed at which a vehicle can travel. The main focus of the trials is on driver behaviour when using ISA over a relatively long period, i.e. four months of driving. The ISA driving is compared with a pre period and an after period of driving without ISA. Both the pre and after periods are one month in duration, giving a total trial duration of six months. The experimental design allows comparison of driving without ISA in the pre period with driving with ISA active in the "system" period. It also allows comparison of the system period with the after period in order to reveal whether there are any carry-over effects of the ISA driving on subsequent behaviour.

This trial is the fourth and last in the set of project field trials. Like the third trial, it was conducted in a more rural part of England as opposed to the large city environment of Leeds which was the focus of the first two trials. The area in which the study was conducted was South-West Leicestershire. Like the second trial in Leeds, this trial was carried out in a fleet context, in this case using employees of local authorities (including Leicestershire County Council, Leicester City Council, and Hinckley & Bosworth Borough Council) as well as a private company (Kingstone and Mutual Clothing Co). Twenty motorists who did most of their driving in the South-West Leicestershire area were recruited. Each of them was given the use of a modified vehicle for the trial period. These vehicles behaved like "normal" cars apart from the ISA feature. Data was logged automatically on a hard drive that cannot be accessed by the user, and summary data was collected after each trip through a GSM (mobile phone) link. The ISA was overridable by the drivers, by mean of a button on the steering wheel or a kick-down on the throttle pedal. The speed limit map covered South-West Leicestershire, including the city of Leicester, and the national trunk road network. The intention was to give drivers ISA support for almost all their regular driving during the ISA-active phase.

Method

The vehicles used for this trial were the same as those used in the previous three trials. The in-vehicle map used was identical to the one used in the third trial. The vehicles were refurbished between the trials.

Twenty participants were recruited from local authorities as well as a local finance agency. The following recruitment criteria applied:

- Have an average annual mileage exceeding 10,000 miles
- Undertake at least 80% of their driving within the South-West Leicestershire area
- Demonstrate average mileage proportions by weekday/weekend split

Although three of the participants lived outside the mapped area, the majority of their day to day driving was within the map boundaries. In addition, due to a number of participants withdrawing from the study, the data analysis only includes 19 participants. Despite a replacement driver was recruited, the amount of data collected did not warrant their inclusion within the analysis. As before, participants were grouped into 'intenders' and 'non-intenders' based on their intention to exceed the speed limit.

It was intended to recruit equal number of male/female, young/old, and intenders/non-intenders. However, due to weak response at the initial recruitment stage and subsequent participant withdrawal, the demographic characteristics of the final sample for analysis are depicted in Table 1.

Table 1: Characteristics of Trial 4 participants

Gender	Age	Intention to Speed	Number
Male	23–39	Intender	3
Male	23–39	Non-Intender	1
Male	40–60	Intender	2
Male	40–60	Non-Intender	2
Female	23–39	Intender	5
Female	23–39	Non-Intender	0
Female	40–60	Intender	1
Female	40–60	Non-Intender	5

Major Results

Attitudinal changes

Data was generally gathered in the pre-ISA phase (Phase 1), during ISA operation (Phase 2) and after ISA was switched off (Phase 3). Usage of Intelligent Speed Adaptation had generally positive effects in terms of attitudes. Intention to speed was consistently negative across trial phases, meaning that respondents generally did not intend to speed. Intention to speed on motorways, urban and residential roads was reduced after the ISA was switched on. The reduction continued into Phase 3 when the ISA was once again disabled, except the motorway scenario (see Figure 1).

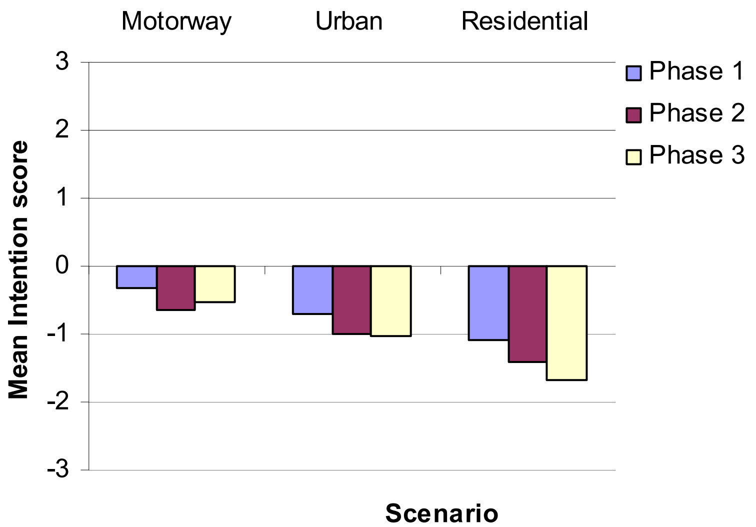

Figure 1: Intention to speed

As in the earlier trials and somewhat surprisingly, there was little change in drivers' perceived behavioural control. It had originally been anticipated that driving with the system would decrease drivers' perceptions of control, since the system was taking control over some aspects of speed choice. Drivers' self-reported propensity to exceed the speed in the previous month, shown in Figure 2, decreased during Phase 2 and slightly further decreased during Phase 3. This suggests that the effects of ISA may have been sustained even with unsupported driving.

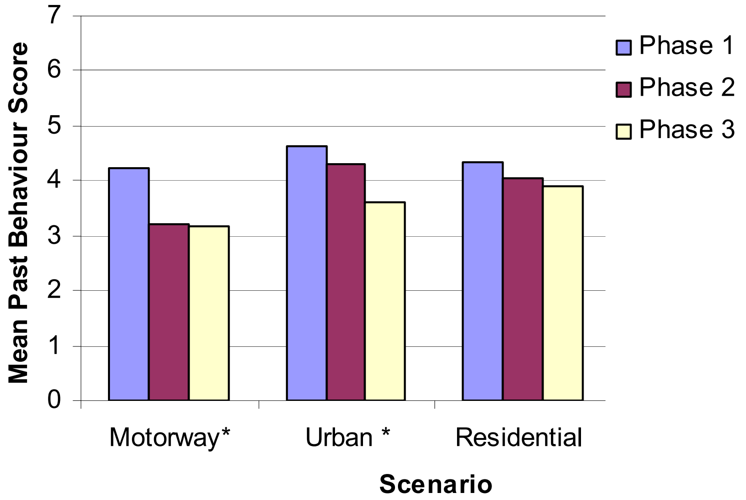

Figure 2: Self-reported speeding

There was a non-significant trend for self-reported violations, errors and lapses to decrease with ISA and for this effect to persist after the ISA was switched off. Acceptability of ISA was ascertained at four time points: in the pre-ISA phase, early in the ISA-enabled phase, late in the ISA-enabled phase, and after ISA was disabled (see Figure 3). The acceptability rating of the ISA system in terms of usefulness and satisfaction was ascertained over time. Usefulness may represent a social utility construct, whereas satisfaction has more to with fulfilment of personal goals. Neither usefulness nor satisfaction changed significantly, but there was a trend for usefulness to dip with initial ISA use and then recover. Ratings of satisfaction of ISA tended to increase with prolonged experience and continued at a high level when the system was removed. The results should be contrasted with those from the EVSC project, where users' satisfaction ratings tended to go down once they used the ISA-equipped car.

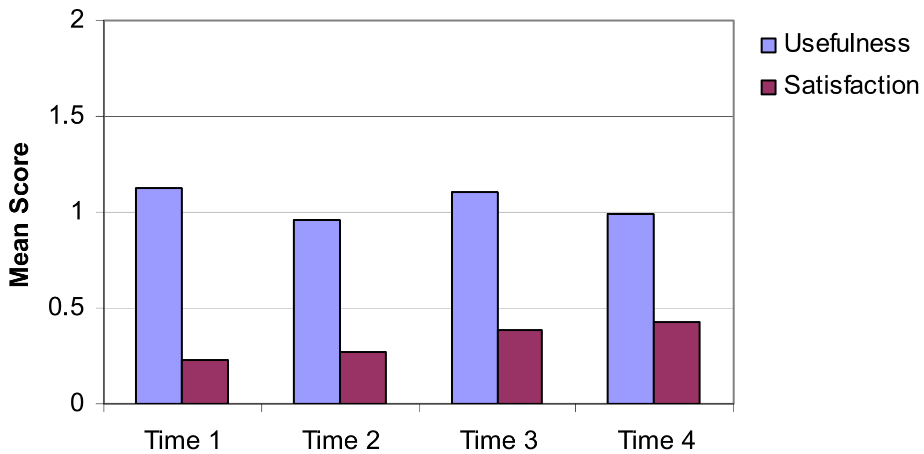

Figure 3: Acceptability of ISA

Behavioural changes

The ISA system was observed to have a distinctive effect in terms of the transformation of the speed distribution across all speed zones. This means that speeds over the speed limit and in particular very high exceeding of the limit was curtailed. When ISA was switched on, a large proportion of the speed distribution initially spread over the speed limit was shifted to around or below the speed limit. Analysis of various statistics related to speed (mean, 85th percentile, etc.) revealed a general 'V' shape across trial phases, i.e. the statistic goes down from Phase 1 to Phase 2, then up from Phase 2 to Phase 3. A change in mean and 85th percentile speeds could be observed in particular on roads with a lower speed limit. This is illustrated in Figure 4 which shows the percentage of distance travelled on 30 mph roads. The change occurred in various parts of the speed distribution. It should be noted that the ISA system used in the trial did not cut off speed sharply at 30 mph; hence the increase in travel at speeds between 30 and 35 mph when ISA was enabled.

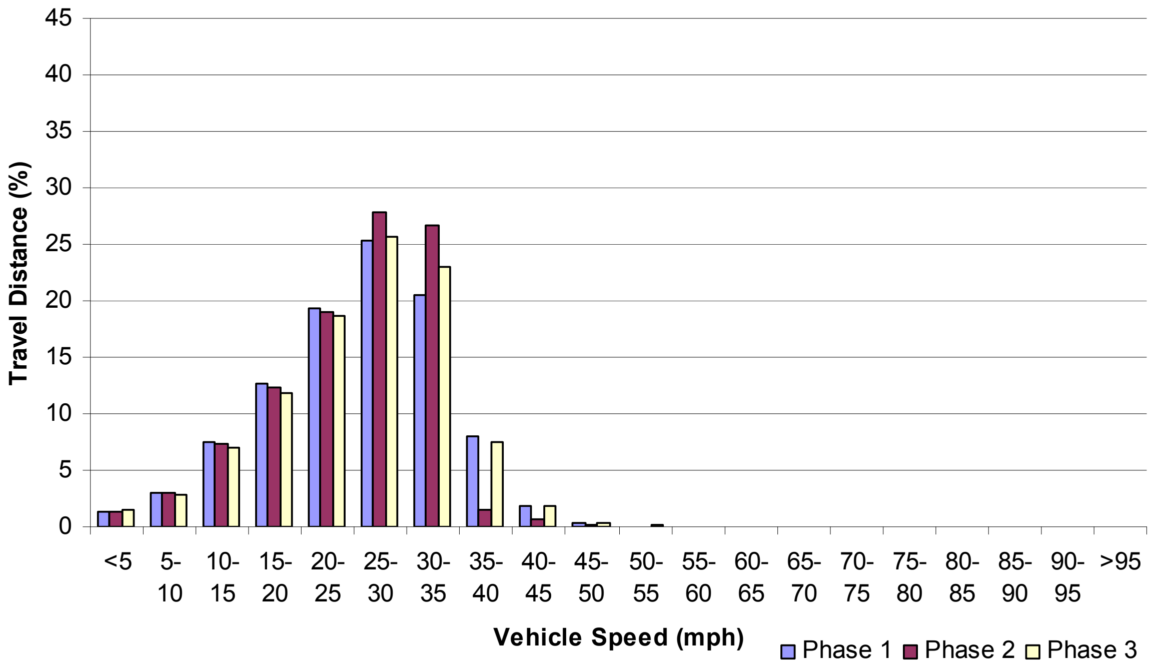

Figure 4: Speed distribution by phase on 30 mph roads

This pattern of change in speed distribution is especially prominent with respect to high percentiles of the speed distribution, which are strong indicators of speeding behaviour. There was a significant reduction in 85th percentile speed on roads with 20 and 30 mph speed limits, i.e. on urban roads in general. In addition, ISA has not only diminished excessive speeding, but also led to a reduction in speed variation and in the probability of jerk with positive implications for a reduction in accident occurrence. Unlike previous trials, the carry-over effect in this trial was not prominent.

The use of an overridable ISA system also provides an opportunity to demonstrate potential resistance from the driving population against its implementation, based on true behaviour instead of opinion. ISA was overridden most often on 70 mph roads (see Figure 5).

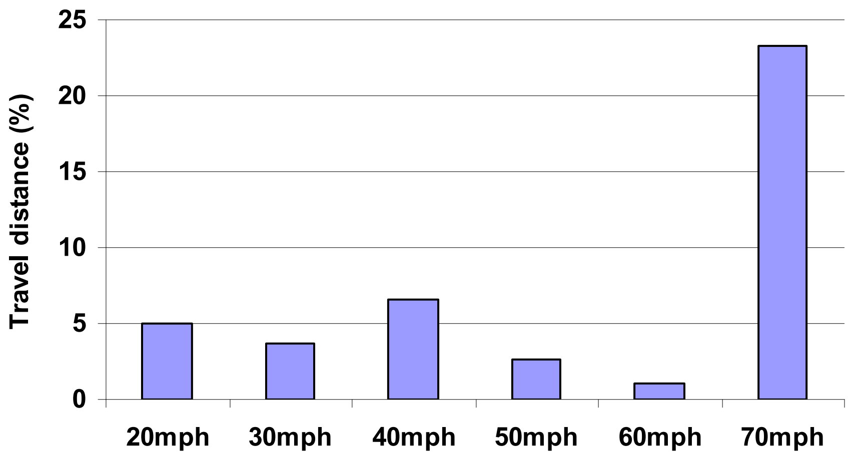

Figure 5: Proportion of distance travelled with ISA when the system was overridden

In terms of demographic groups, males tended to opt out more than females, with the contrast being the greatest on 20 mph roads (5.9% of distance travelled as compared to 2.5%) and 50 mph roads (4.4% compared to 1.2%). Young drivers overrode ISA more than older drivers, particularly on 40 mph (10.5% compared to 3.4%). Intenders generally overrode the system more frequently than non-intenders. The differences on the 20 mph roads (6.0% compared to 2.9%) and on the 70 mph roads (26.9% compared to 19.3%) were particularly marked. As with other safety systems (e.g. seatbelts), there is therefore a tendency for those who need it most to use it least. This suggests that there may be a role for incentives to keep ISA active and discouragement of overriding when ISA is deployed on a voluntary or fleet basis. In addition to improved speed limit compliance, ISA also contributes to diminished negative driving behaviour across all groups, as revealed by the observation drives.

The trial has also revealed that participants adapted their reference to chosen speed between trial phases. During Phase 1 and 3 when the ISA system was turned off, participants were observed to obey the speed limits with reference to speedometer reading. During Phase 2, participants were observed to rely on the ISA system (i.e. throttle cut-off) instead of the speedometer reading. This has implications because the design used here had the speedometer reading high but the ISA system using true speed, meaning that if drivers used the ISA system to regulate maximum speed that speed would be higher than when using the speedometer for the same purpose. The obvious solution is for the speedometer regulations to be changed so that they read accurately. In addition, the current design of the ISA system does not restrict vehicle speed to posted speed limits (i.e. the speed limits provided by the digital maps) to absolute precision. The throttle control permits vehicle speed to go somewhat over the speed limit, due to hysteresis in the ISA system response to driver throttle demand. If drivers relied on the system to keep them within the speed limit, they might actually be above the limit. This would need to be considered in setting standards for real-world ISA.

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1. INTRODUCTION

The ISA-UK project has as its major objective to investigate user behaviour with Intelligent Speed Adaptation (ISA) by means of set of field trials. Twenty identical vehicles were converted with the capability to provide a voluntary (overridable) ISA system and to record data on each drive. Four successive trials were carried out, each of six months duration. The four field trials were:

Trial 1: Leeds area with private motorists
Trial 2: Leeds area with fleet motorists
Trial 3: Leicestershire with private motorists
Trial 4: Leicestershire with fleet motorists

The trials were designed to be non-intrusive — the vehicles behaved like "normal" cars apart from the ISA feature. Data was logged automatically, and summary data was collected after each trip through a GSM link. The ISA system designed for the four field trials was user overridable. The intention was to give drivers ISA support for almost all their regular driving.

The main focus of the trials was on driver behaviour when using ISA over a relatively long period, i.e. four months of driving. There was one-month driving without ISA functions before and after the four-month driving with ISA respectively. The inclusion of the post-ISA driving allowed the investigation of any carry-over effects of the ISA intervention.

This report presents the results of Field Trial 4 and is structured into six chapters. The next chapter describes the design of the field trial, followed by analysis results of vehicle data, questionnaire data, and the observation drives. Finally, the sixth chapter summaries the findings and implications of the analysis results.

2. FIELD TRIAL METHODOLOGY

2.1 Introduction

The methodology for this trial was in line with the first three trials (Lai et al, 2005a; Lai et al, 2005b; Lai et al, 2006), with a few minor revisions. A brief description of the methodology is presented in this chapter and relevant revisions are reported.

2.2 The vehicles

The ISA system was installed on a fleet of 20 Skoda Fabia Elegance 1.4 litre estates. The system consisted of two computers installed in the boot of the host vehicle (one to provide the information function, i.e. vehicle position and current speed limit, and the other to provide speed limiting and data recording), as well as additional hardware wired to the vehicle's fuel and brake systems, the instrument panel, and the steering wheel. The appearance of the ISA vehicles was like that of ordinary Skoda Fabias.

2.2.1 Digital speed limit map

The speed limit map installed on one of the computers in the vehicle's boot provided essential information for the ISA system to function correctly. The speed limit map used for this trial was identical to the one developed for Trial 3 which covered the South-West Leicestershire area. Table 1 shows the length of road for each road type on the speed limit map, while the map boundary and distribution of speed limit zones are illustrated in Figure 1 and Figure 2.

Table 1: Total length of road for each road type

Road Type	Total Length (miles)
Motorway	59.12
Dual Trunk	29.15
Single Trunk	17.92
A Dual	66.16
A Single	66.20
B	74.02
C and unclassified	1,161.88
Total for all Road Types	**1,474.45**

Note: C and Unclassified Road are grouped together, as they were calculated using Ordnance Survey OSCAR Traffic-Manager data, which uses "feature code 3004 for minor or other roads…including C roads" (Ordnance Survey, 2001)

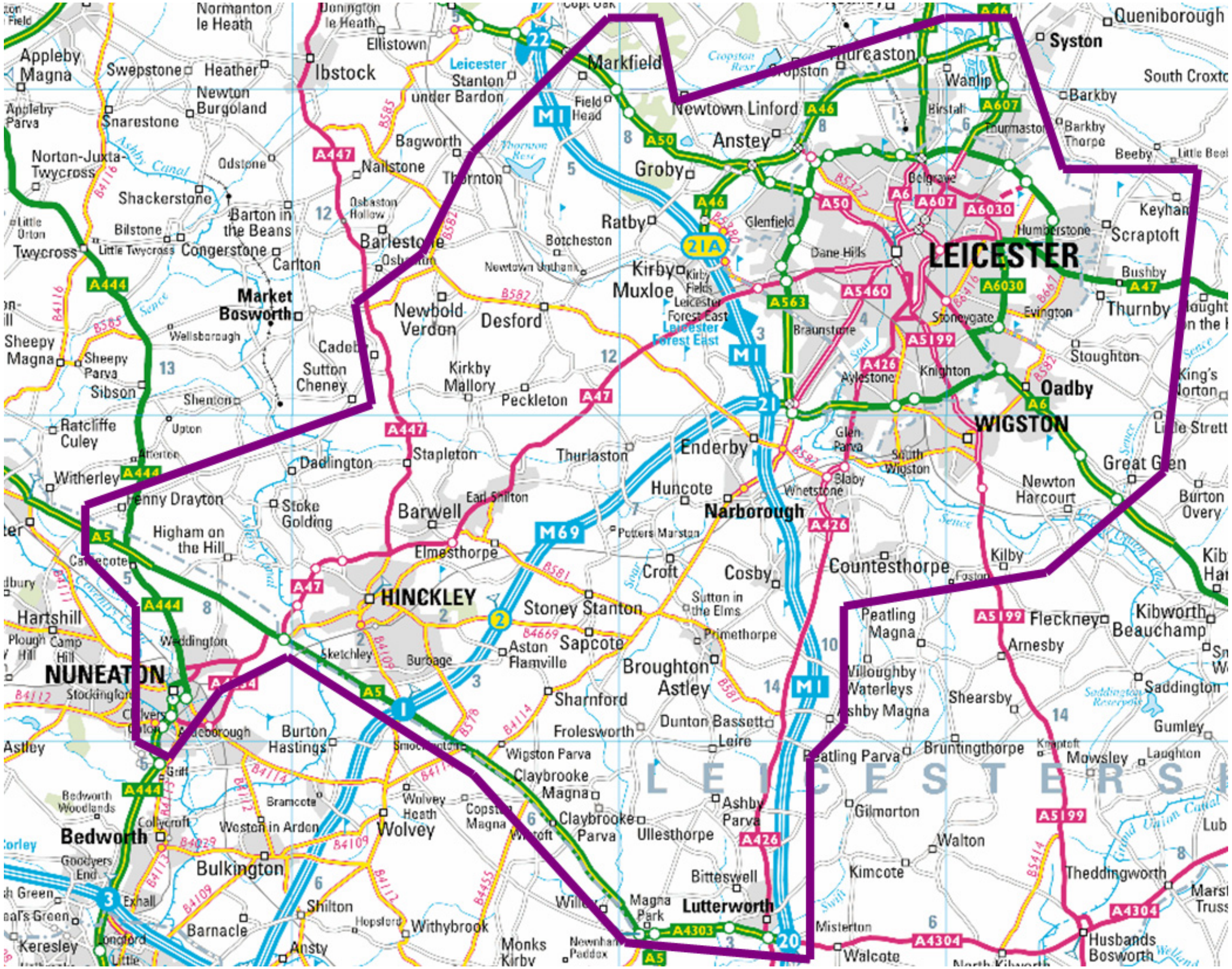


Figure 1: Boundary of the South-West Leicestershire speed limit map

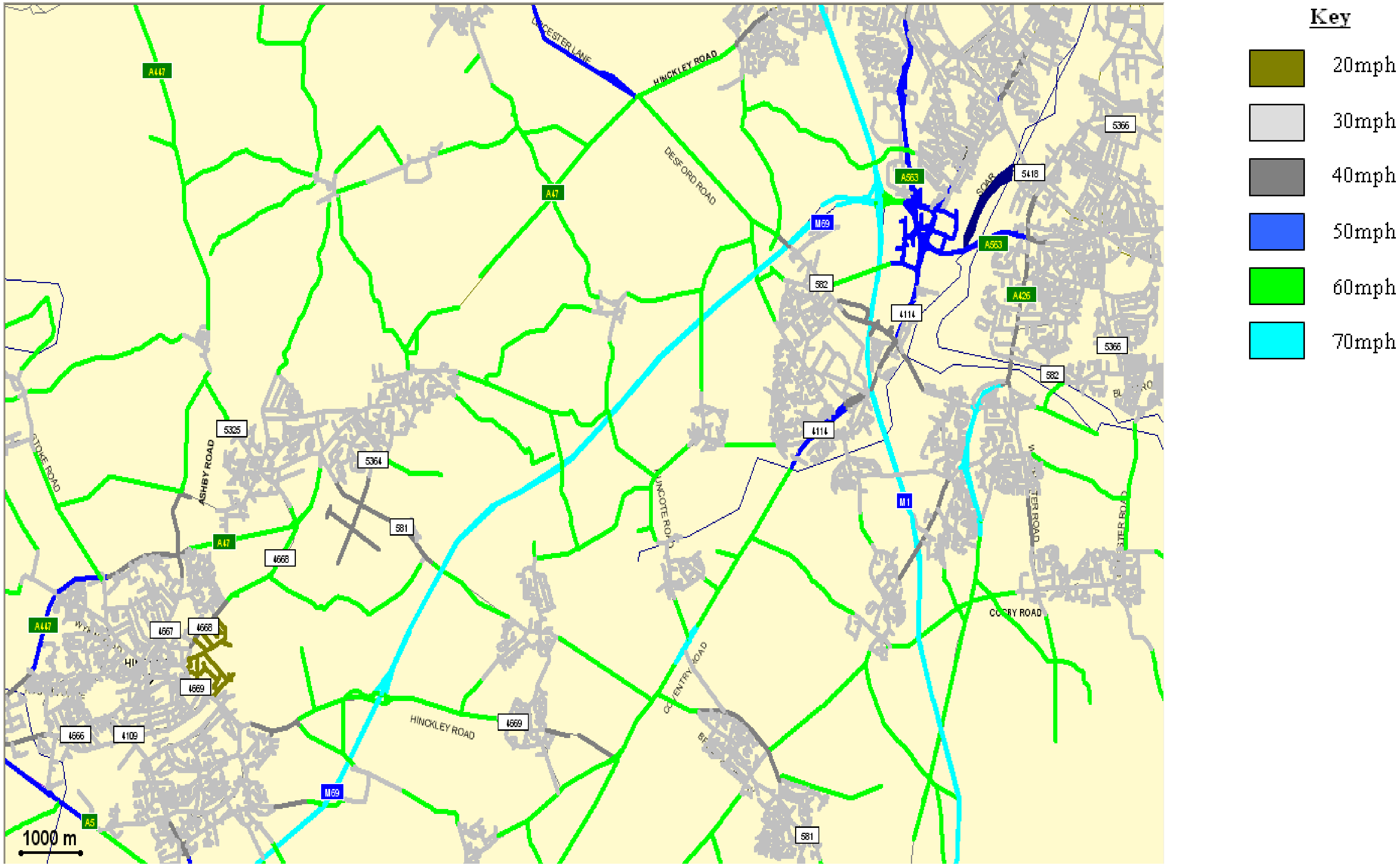


Figure 2: Illustration of speed limit distribution within the South-West Leicestershire area

Figure 3 illustrates the distribution of speed zones within the map boundary (as defined in Figure 1). Speed limits ranged from 20 mph to 70 mph but the majority of the roads in the trial area were in the 30 mph zone. This is due to the inclusion of the whole Leicester City in the speed limit map, although most areas within the survey boundary were rural.

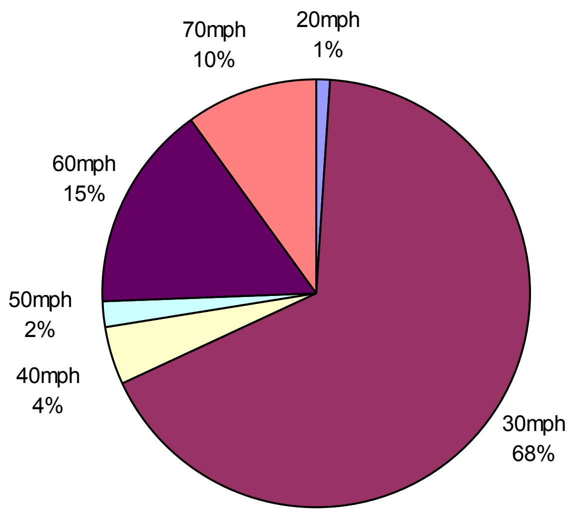


Figure 3: Distribution of speed zones in the South-West Leicestershire area

2.3 Trial design

The field trial comprised three distinct phases over a six-month duration, as illustrated in Figure 4. This structure was identical to the previous three trials.

Phase 1	Phase 2		Phase 3
ISA OFF	ISA ON		ISA OFF
28 days	28 days	84 days	28 days

↑ Observation Drive 1 ↑ Observation Drive 2 ↑ Observation Drive 3 ↑ Observation Drive 4

Figure 4: The structure of the ISA field trial

2.4 Participant recruitment

Eight males (age range 23-50 years, M = 36.88, SD = 12.21) and eleven females (age range 31-58 years, M = 42.55, SD = 7.79) took part in the trial. Participants were recruited from local companies in the South-West Leicestershire area. It was initially intended that all drivers would be recruited from the same company. This proved difficult however given the number of companies that already had company car fleets in place. Attempts were therefore made to recruit participants from the local authorities. Again however responses were weak. The selected participants were recruited from local authorities and a finance agency. Due to a number of participants withdrawing from the study, the data analysis only includes 19 participants. Although a replacement driver was found, the amount of data collected did not warrant their inclusion within the analysis.

Participants were again grouped into 'intenders' and 'non-intenders' based on participants' intention to exceed the speed limit. This classification was regarded as more reliable than the original grouping method which was based on participants' attitudes towards a system with which they had no experience. The respondents were asked to complete a questionnaire that identified their general intentions to exceeding the speed limit on an urban road and motorway using the Theory of Planned Behaviour. Intentions were assessed by 3 items 'I would intend to exceed the 70mph speed limit on a motorway', strongly disagree-strongly agree, scored −3 to +3. Participants were selected to reflect those who intended to speed (scores above 0) and those who did not (scores below 0).

As can be seen in Table 2, participants were split as evenly as possible. Thirteen non intenders and six intenders took part with an equal split of young and old drivers. Given that a number of participants withdrew from the trial due to medical conditions and accidents it was difficult to obtain an equal split of participants.

Table 2: Characteristics of Trial 4 sample

Participant	*Gender*	*Age*	*Exposure*	*History*	*Intention Group*
1	male	young	All participants will have reported average annual mileages of >10,000 miles. In addition, all will have a high proportion of their driving in the specified map area.	No history of driving convictions and no more that 2 (at-fault) accidents in 3 years.	intender
2	male	young			intender
3	male	young			intender
4	male	young			non intender
5	male	old			intender
6	male	old			intender
7	male	old			non intender
8	male	old			non intender
9	female	young			non intender
10	female	young			non intender
11	female	young			non intender
12	female	young			non intender
13	female	young			non intender
14	female	old			intender
15	female	old			non intender
16	female	old			non intender
17	female	old			non intender
18	female	old			non intender
19	female	old			non intender

Although three of our participants lived outside the mapped area, the majority of their day to day driving was within the survey boundaries illustrated in Figure 1.

Respondents selected to take part in the trial were then required to sign an agreement between the University of Leeds and themselves covering issues such as data collection, insurance claims and car maintenance procedures.

2.4.1 Demographic and driving characteristics

Several items sought information about key demographic and driving characteristics in order to give a brief overview of the sample.

As can be seen in **Error! Not a valid bookmark self-reference.**, it was difficult to recruit participants at the extremes of the age group ranges with the majority aged within the 30–50yr age bracket.

Table 3: Age by attitude group

	N	Mean	Standard Deviation	Minimum	Maximum
Intenders	6	35.67	10.86	23	50
Non-Intenders	13	42.23	9.28	24	58

Figure 5 shows little variation across the groups in terms of their marital status with 71% of those participants who responded married or living with a partner. Fifty six percent of the participants also had one or more children aged 18 or under living with them (see Figure 6).

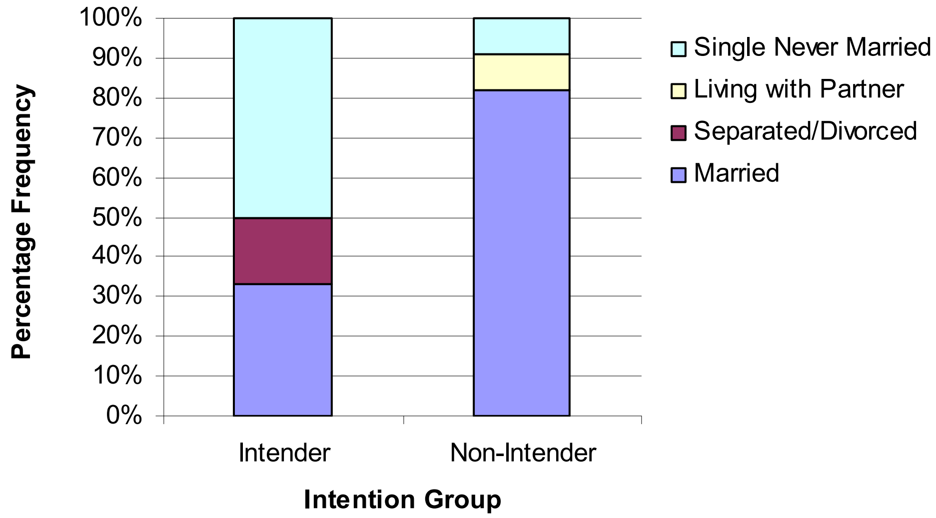


Figure 5: Marital status by intention group

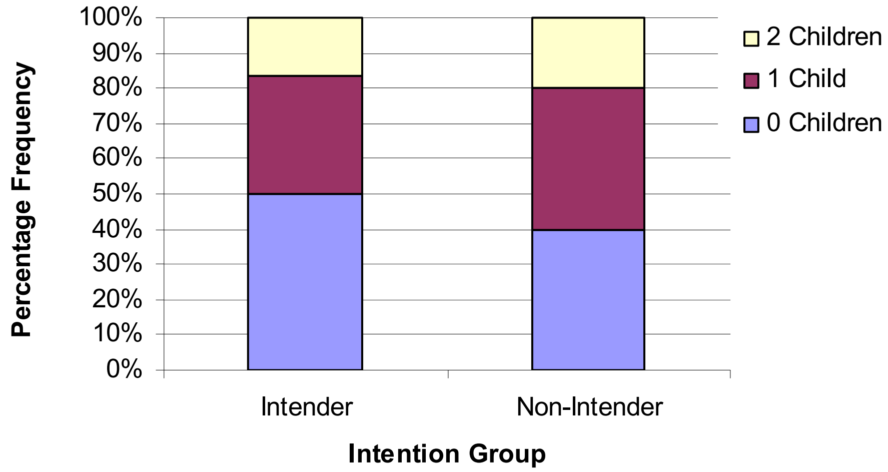


Figure 6: Number of children (18yrs and under) living at home by intention group

When comparing participants' National Statistics Socio Economic classification there was again little variation across the groups. Non-intenders tended to hold more managerial and professional occupations (see Figure 7).

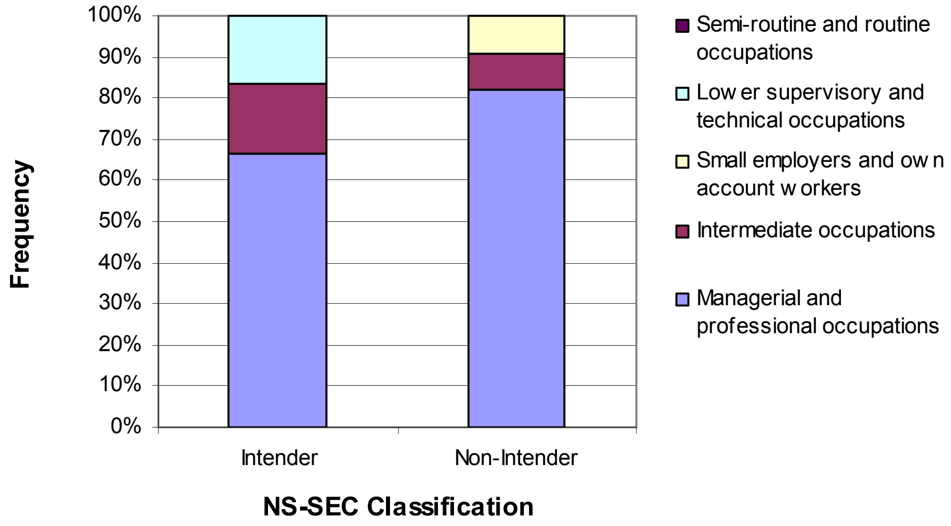


Figure 7: NS-SEC classification by intention group

Table 4 provides an overview of the participants' self reported mileage and trip frequency. As required the participants generally accrued an average annual mileage that exceeded 10,000 miles and spent at least 80% of their time driving within the South-West Leicestershire area. Comparison across the groups suggested that although the number of trips made by participants did not differ across groups, intenders covered more miles than non-intenders.

Table 4: Participants self-reported mileage and trip statistics

	Intenders	Non-Intenders
SW Leicestershire weekday mileage	215.58	143.50
SW Leicestershire weekend mileage	48.50	33.15
SW Leicestershire total weekly mileage	264.08	176.65
SW Leicestershire monthly mileage	1056.33	706.62
SW Leicestershire annual mileage	13732.33	9186.00
Total annual mileage	16913.00	10970.00
% of driving in SW Leicestershire area	84.17	92.38
No. weekday trips	22.67	24.92
No. of w/end trips	4.50	4.08
Total weekly trips	27.17	29.00

Four participants (2 intenders, 2 non-intenders) had received three points for speeding within the last five years. One non intender has received six points for speeding. Three of the participants (all intenders) had been involved in an accident in the last 5 years.

2.5 Data collection

A wide range of data was collected during the trial, including objective measures recorded by the vehicle, and subjective measures obtained through questionnaires. These are specified in the following sections, followed by a description of the data management system.

2.5.1 Objective measures

Although the focus of this project was travelling speed and speed limits, many other parameters were recorded during the course of a trip, such as time stamps and coordinates etc, at 10 Hz (i.e. 10 records per second) by the data logging system installed in the vehicle. The purpose of recording coordinates was to enable replication of a trip should it be required at a later date. Many trip based parameters, for example trip length, trip duration and fuel usage, were also recorded by the vehicle's logging system.

2.5.2 Subjective measures

2.5.2.1 Questionnaire administration

Questionnaires were generally administered at four time points:
Time 1: one month prior to ISA control,
Time 2: following one month of ISA control,
Time 3: following four months of ISA control and
Time 4: following a one month return to non-ISA-controlled driving.

The majority of questionnaires were administered according to this timetable so that behavioural changes to ISA could be monitored. However as can be seen in Table 5 certain questionnaires were administered at a differing schedule. Personality measures such as the sensation seeking, conscientiousness and the driving style questionnaire were administered at Time 1 only since personality traits are assumed to remain constant over time. It was also felt too difficult to expect participants to make certain judgments regarding system safety and design without any experience of the system. At Time 4 questionnaires relating to ISA usage became irrelevant. The TPB was administered at 3 time points only.

Table 5: Administration schedule for questionnaire

Questionnaire	Phase 1	Phase 2		Phase 3
	Time 1	Time 2	Time 3	Time 4
Demographic/general driving	✓			
TPB	✓		✓	✓
NASA RTLX	✓	✓	✓	✓
Acceptability	✓	✓	✓	✓
DBQ	✓	✓	✓	✓
Sensation Seeking	✓			
Conscientiousness	✓			
General speeding	✓	✓	✓	✓
Concentration	✓	✓	✓	
Experience of system	✓	✓	✓	
System design and safety		✓	✓	
System trust		✓	✓	
Stakeholder	✓		✓	

2.5.2.2 General speeding and experience with system

Items sought information regarding participants' experience of the system including perceptions of the risk and frustration associated with driving under ISA control on certain roads.

2.5.2.3 The Theory of Planned Behaviour

The TPB was applied to four risky driving behaviours. These behaviours were:

Speeding on a motorway: Imagine you are driving along a motorway. It is a fine, dry day and the traffic is fairly light. The speed limit of the road is 70mph.

Speeding on a residential road: Imagine you are driving along a residential road with cars parked either side or connecting side roads at various points. Pedestrians are also visible. The speed limit of the road is 30 mph.

Speeding on an urban road: Imagine you are driving along an urban road. The traffic is fairly light. Although there are houses either side of the road there does not appear to be many pedestrians. The speed limit of the road is 40 mph.

Disengaging an ISA system: Imagine you are driving a car that is fitted with Intelligent Speed Adaptation. When you start up the car you are automatically speed limited. You cannot drive above the posted speed limit unless you decide to press one of the override buttons and disengage the system. If you disengage the system you are free to travel at your desired speed.

Individual TPB measures

The questionnaires included direct and indirect measures of the TPB constructs. *Intention* was assessed using three items. Items sought to measure *intentions* (one item; 'I would intend to exceed the 70mph speed limit on a motorway', strongly disagree-strongly agree, scored −3 to +3), *desire* (one item; 'I would want to exceed the 30mph speed limit on a residential road', strongly disagree-strongly agree, scored −3 to +3) and *planning* (one item; 'I would plan to exceed the 40mph speed limit on an urban road', strongly disagree-strongly agree, scored −3 to +3). Distinctions here were based on Conner and Sparks (1996) recommendations and higher scores reflect stronger intentions to perform the behaviour. Factor analysis confirmed that the three items loaded onto one dimension for each behaviour. The mean of these three items produced a composite scale for each of the four questionnaires. Reliability scores for the intention measures were generally good, as shown in Table 6.

Table 6: Reliability scores of intention measures

Scenario	Pre ISA	During ISA	Post ISA
Motorway 70 mph	0.84	0.96	0.97
Residential 30 mph	0.87	0.88	0.96
Urban 40 mph	0.89	0.95	0.94
Disengage ISA	0.83	0.83	0.90

Perceived behavioural control (PBC) was assessed using six items. These items were differentiated in terms of perceived difficulty (two items; e.g., 'For me to disengage the ISA system would be…', difficult-easy, scored +1 to +7), perceived control (three items; e.g., 'How much control would you have over exceeding the speed limit on a motorway?', no control-complete control, scored +1 to +7) and self efficacy (one item; 'How confident are you that you will be to exceed the 30mph speed limit on a residential road?', not very confident-very confident, scored +1 to +7), as proposed by Conner and Sparks (1996) and Trafimow, Sheeran, Conner and Finlay (2002). Factor analysis with varimax rotation revealed inconsistent loading onto the three factors (perceived difficulty, perceived control and self efficacy) across the four questionnaires. Therefore the three indexes for perceived behavioural were collapsed to form one scale. The mean of these six items produced a composite scale for each of the behaviours. Higher scores reflected greater perceptions of control in the commission of the behaviour. Reliability scores for the PBC measures were generally good, as shown in Table 7.

Table 7: Reliability score for PBC measures

Scenario	Pre ISA	During ISA	Post ISA
Motorway 70 mph	0.85	0.75	0.75
Residential 30 mph	0.77	0.81	0.80
Urban 40 mph	0.89	0.95	0.89
Disengage ISA	0.85	0.78	0.74

Attitude was assessed by eight semantic differential scales following the statement 'Exceeding the 40mph speed limit on an urban road would be…' Following Lawton, Parker, Manstead and Stradling's (1997) distinction, the seven point scales measured both instrumental (useless-useful, harmful-beneficial, negative-positive, bad-good) and affective attitudes (unsafe-safe, unsatisfying-satisfying, not enjoyable-enjoyable, reckless-cautious). Factor analysis with varimax rotation revealed inconsistent loading onto two factors across the four questionnaires. The two separate indexes for instrumental and affective attitudes were collapsed to form one attitude scale for each behaviour. The mean of the eight items (all scored −3 to +3) produced a composite scale for each of the behaviours such that higher scores indicate attitudes that were in favour of the commission of the behaviour. Reliability scores for the attitude measures were generally good, as shown in Table 8.

Table 8: Reliability scores for attitude measures

Scenario	Pre ISA	During ISA	Post ISA
Motorway 70 mph	0.94	0.96	0.92
Residential 30 mph	0.96	0.98	0.96
Urban 40 mph	0.97	0.97	0.98
Disengage ISA	0.89	0.79	0.94

Normative beliefs Four salient referents were identified; the police, family, other road users and other spouse/partner. Four items measured normative beliefs (e.g., 'The police would disapprove of me disengaging the ISA system', strongly disagree-strongly agree, scored −3 to +3). Higher scores reflected normative beliefs that supported or opposed the behaviour (see findings).

Motivations to comply were assessed using four items (e.g., 'Generally speaking how much do you want to do what your family think you should do?', not at all-very much, scored +1 to +7). Higher scores reflected a stronger motivation to comply with the referents.

Behavioural beliefs were measured using six items (e.g., 'Exceeding the 70mph speed limit on a motorway would risk causing an accident', unlikely-likely, scored −3 to +3). Higher scores reflected beliefs that the outcome was likely.

Outcome evaluations were assessed using six items (e.g., 'Making rapid progress would be…, bad to good, scored −3 to +3). Higher scores reflected outcome evaluations that were positive.

Control Beliefs were measured using seven items ('Driving at night time makes my exceeding the 40mph speed limit', unlikely-likely, scored −3 to +3). Higher scores reflected beliefs that the outcome was likely. Three additional items were included for disengage scenario.

Frequency of beliefs was measured using seven items ('I drive on urban roads at night time', never-frequently, scored +1 to +7). Higher scores reflected behaviours that were more frequent. Three additional items were included for disengage scenario.

Moral norm was assessed using a single seven-point item ('It would be quite wrong for me to exceed the 30mph on a residential road, strongly disagree-strongly agree, scored +1 to +7). Higher scores reflected stronger moral norms.

Anticipated regret was measured as the mean of two seven-point items (e.g., 'I would regret exceeding the 40mph speed limit on an urban road', unlikely-likely, scored −3 to +3). Higher scores reflected stronger feelings of anticipated regret.

Table 9: Reliability scores for anticipated regret measures

Scenario	Pre ISA	During ISA	Post ISA
Motorway 70 mph	0.93	0.88	0.97
Residential 30 mph	0.90	0.98	0.94
Urban 40 mph	0.95	0.88	0.96
Disengage ISA	0.96	0.83	0.99

Past behaviour was tapped by two seven point items (e.g., 'In the past I have frequently disengaged the ISA system', strongly disagree-strongly agree, and scored 1 to 7). Higher scores reflected more frequent commission of the behaviour in the past.

Table 10: Reliability scores for past behaviour measures

Scenario	Pre ISA	During ISA	Post ISA
Motorway 70 mph	0.94	0.94	0.92
Residential 30 mph	0.98	0.88	0.66
Urban 40 mph	0.89	0.70	0.82
Disengage ISA	-	0.85	-

Self-identity was measured using one single item (e.g., 'I see myself as a safe driver', strongly disagree-strongly agree, scored +1 to +7). Higher scores reflected a stronger sense of self-identity.

Risk perception was assessed using one item (e.g., What is the risk of being involved in a accident if you exceed the 70mph speed limit on a motorway', very low risk-very high risk, scored +1 to +7). Higher scores reflected higher perceptions of risk.

2.5.2.4 Acceptability

Driver acceptance of the ISA system under different penetration levels was measured using an acceptability scale of advanced transport telematics developed by Van der Laan, Heino and De Waard (1997). The simple scale provided a direct measure of attitudes towards systems. Nine items measured participant's views of ISA allowing system evaluation across the dimensions of usefulness and satisfaction. Administration of the questionnaire at four time points allowed the calculation of an end score for each participant on the two dimensions of "usefulness" (e.g., useful-useless, scored +2 to –2) and "satisfaction" (e.g., pleasant-unpleasant, scored +2 to –2). A practical system evaluation was gauged by the usefulness score, whilst satisfaction scores reflected the systems pleasantness. High scores reflected positive appraisals of the systems usefulness and high satisfaction with the system. In a comparison of six studies high scale reliability was found (Van der Laan, Heino and De Waard, 1997). De Waard, Van der Hurst and Brookhuis (1999) have since utilised the scale. Comte's (2000) inclusion of the acceptability scale in her investigation into the impact of Intelligent Speed Adaptation on driver behaviour alludes to its merit in the present study.

Table 11: Reliability scores for acceptability measures

Measure	Time 1	Time 2	Time 3	Time 4
Usefulness	0.90	0.88	0.84	0.94
Satisfaction	0.94	0.96	0.93	0.98

2.5.2.5 Driver Behaviour Questionnaire

Self reported driving violations and errors were assessed using the shortened 24-item version of the Driver Behaviour Questionnaire (Parker, Reason, Manstead and Stradling, 1995). This instrument measured the frequency with which individuals commit various types of errors and violations when driving, identifying three distinct types of aberrant driving behaviours; errors, lapses and violations. Participants were presented with 24 aberrant driving behaviours and asked to rate how often they have committed these (0 = never, 1 = hardly ever, 2 = occasionally, 3 = quite often, 4 = frequently, 5 = nearly all the time). In a comparison between the 50-item and 24-item scale good internal consistency has been found for each of the three subscales (Cronbach's α coefficients 0.84 for the errors, 0.8 for the violations, and 0.72 for lapses). The three factors first identified in Reason, Manstead, Stradling, Baxter and Campbell (1990) was confirmed. Test-retest correlation's also demonstrated reliability over time (time1 and time 2 correlations were 0.69 for error scale, 0.81 for the violation scale and 0.75 for the lapse scale).

Eight items measured *errors* (e.g., 'Attempt to overtake someone that you hadn't noticed to be taking a right turn', never-nearly all the time; scored 0 to +5). High scores reflected a greater propensity to perform the behaviour.

Eight items measured *lapses* (e.g., 'Attempt to drive away from traffic lights in third gear', never-nearly all the time; scored 0 to +5). High scores reflected a greater propensity to perform the behaviour.

Eight items measured *violations* (e.g., 'Disregard the speed limits late at night or early in the morning', never-nearly all the time; scored 0 to +5). High scores reflected a greater propensity to perform the behaviour.

Table 12: Reliability scores for DBQ measures

Measure	Time 1	Time 2	Time 3	Time 4
Lapse	0.25	0.44	0.73	0.80
Error	0.80	0.82	0.79	0.93
Violation	0.81	0.68	0.72	0.73

2.5.2.6 Sensation seeking

The Arnett (1996) Sensation Seeking Scale was used. Although the Sensation Seeking Scale Form V (Zuckerman, 1994) is one of the most popular and widely used sensation seeking scales (especially in driver behaviour research, see Jonah, 1997) it was felt that the 40 forced choice items would overload the respondents given the lengthy nature of the TPB questionnaires. As Arnett points out, it is often hard for individuals to chose between these items when both or neither applies. Secondly, since many of the items relate to physical activity, it may be that any age differences in responses would indicate differences in physical strength and not sensation seeking. The Arnett sensation seeking scale provided a short 20 item questionnaire which asked respondents to rate how likely each described them. The scale is composed of two dimensions; novelty and intensity. The internal reliability of each was tested.

Novelty subscale 10 items measured novelty (e.g., ‘I think it fun and exciting to perform or speak in front of a group’, does not describe me at all-describes me very well, scored +1 to +4; Cronbach’s α =0.52).

Intensity subscale 10 items assessed intensity (e.g., ‘When I listen to music I like it to be loud’, does not describe me at all-describes me very well scored +1 to +4; Cronbach’s α = 0.69).

Higher scores reflected a higher level of sensation seeking.

This questionnaire will be included within the analysis of the four trials.

2.5.2.7 Driving Style Questionnaire

The DSQ (West, Elander and French, 1992) contains 15 items based on behaviours that are associated with risky driving behaviour. Participants were asked on what basis they engaged in these behaviours (never or very infrequently-very frequently or always; scored +1 to +5).

This questionnaire will be included within the analysis of the four trials.

2.5.2.8 Conscientiousness

The facets of conscientiousness were measured using a questionnaires developed as part of the International Personality Item Pool. Five facets were taken to represent those in the NEO-PI-R (http://ipip.ori.org/newNEOKey.htm)

Self efficacy 10 items measured self efficacy (e.g., ‘complete task successfully’, very inaccurate-very accurate scored +1 to +5; Cronbach’s α = 0.79).

Orderliness 10 items measured orderliness (e.g., ‘like order’, very inaccurate-very accurate scored +1 to +5; Cronbach’s α = 0.84).

Dutifulness 10 items measured dutifulness (e.g., ‘try to follow the rules, very inaccurate-very accurate scored +1 to +5; Cronbach’s α = 0.67).

Achievement Striving 10 items measured achievement striving (e.g., ‘demand quality’ very inaccurate-very accurate scored +1 to +5; Cronbach’s α = 0.81).

Self Discipline 10 items measured self discipline (e.g., ‘get chores done right away’, very inaccurate-very accurate scored +1 to +5; Cronbach’s α = 0.90).

Cautiousness 10 items measured cautiousness (e.g., 'Avoid mistakes' very inaccurate-very accurate scored +1 to +5; Cronbach's $\alpha = 0.59$).

Higher scores reflected a higher level of conscientiousness.

This questionnaire will be included within the analysis of the four trials.

2.5.3 Data management

2.5.3.1 In-vehicle data logging system

Data collected by the vehicle was stored in three separate files at the end of each trip. These are specified as follows:

The main data file is a continuous ASCII stream recording vehicle speed, speed limits, coordinates, and time stamps etc at 10 Hz.

The summary file contains trip based information such as time stamps and coordinates of the origin and destination, date, trip length, fuel usage, ISA usage etc.

The error log file records any system failures during the trip and is only used for fault investigations.

All of the above files are stored on the hard disk in the vehicle. Identical files are also duplicated on a second hard disk to reduce the potential impact of data loss due to failure of a hard disk. The available space on each disk is checked during each trip. When the capacity has fallen below 20% of the full capacity, a warning message was sent to an SMS workstation at Leeds University.

2.5.3.2 SMS workstation

Although the summary file was recorded on the in-vehicle hard disks, it was also sent as an SMS message through mobile phone network at the end of each trip to a dedicated workstation at Leeds University. The workstation was equipped with a SMS receiver. After the SMS had reached the workstation, the content was converted and written into a Microsoft Access database via a Java application, Swiftnote. The software was developed by NCL Ltd, Ireland, and was provided to the project free of charge on an academic licence.

2.5.3.3 Data server

The ISA data server was a Dell PowerEdge 2600 equipped with an Intel Xeon processor and 1GB memory which run Microsoft SQL server 2000. The data files stored in the vehicles were downloaded to a laptop at the end of each trial phase, which were subsequently converted and written into the SQL database. The SQL database contained various tables hosting data from different sources and provided links to integrate data across the tables when data analysis was carried out.

To prevent data loss due to accidental events, the content of the SQL server was backed up incrementally onto DVDs upon the addition of new data. At the end of each trial, the complete data set was also backed up onto DVDs separately.

2.5.3.4 Operational logs

A comprehensive logging system was established to enable efficient management of the ISA fleet and data collection activities. The research team at Leeds University keeps two log files. The first file was dedicated to recording all activities regarding data collection such as the date and time for vehicle handover, vehicle swapping (i.e. due to ISA system malfunction), and observation drives etc. This file was essential for identifying correct blocks of data from the SQL database with respect to individual participants and associated vehicles that they had driven. The second file was dedicated to recording vehicle faults, which built up a system malfunction history for individual vehicles enabling the technical team at MIRA to develop appropriate remedies. The technical team at MIRA also kept a log file of remedies applied to individual system malfunctions.

3. ANALYSIS OF VEHICLE DATA

3.1 Introduction

This chapter presents analysis of vehicle data. Data completeness is reported in the next section, followed by analyses of vehicle speed. In addition to analysing speed distributions in individual speed zones, the effect of ISA intervention was also examined by demographic factors in terms of gender, age, and intention to speed.

3.2 Data completeness

As specified in Section 2.3, each participant was expected to generate 168 days of travelling data. Interruption to data collection was attributable to occasional ISA system malfunctions. The overall completion rate was 95.4%. Table 13 presents the completion rate achieved by individual participants, while Figure 8 illustrates a breakdown of data completeness per participant across trial phases.

Table 13: Data completeness in Field Trial 4

Participant ID	Completed days	Completion rate (%)
80	168	100.0
81	162	96.4
82	168	100.0
83	168	100.0
84	166	98.8
85	153	91.1
87	165	98.2
88	140	83.3
89	168	100.0
90	161	95.8
91	162	96.4
92	168	100.0
93	163	97.0
94	164	97.6
95	168	100.0
96	154	91.7
97	167	99.4
98	158	94.0
99	123	73.2
Overall completion rate		**95.4 %**

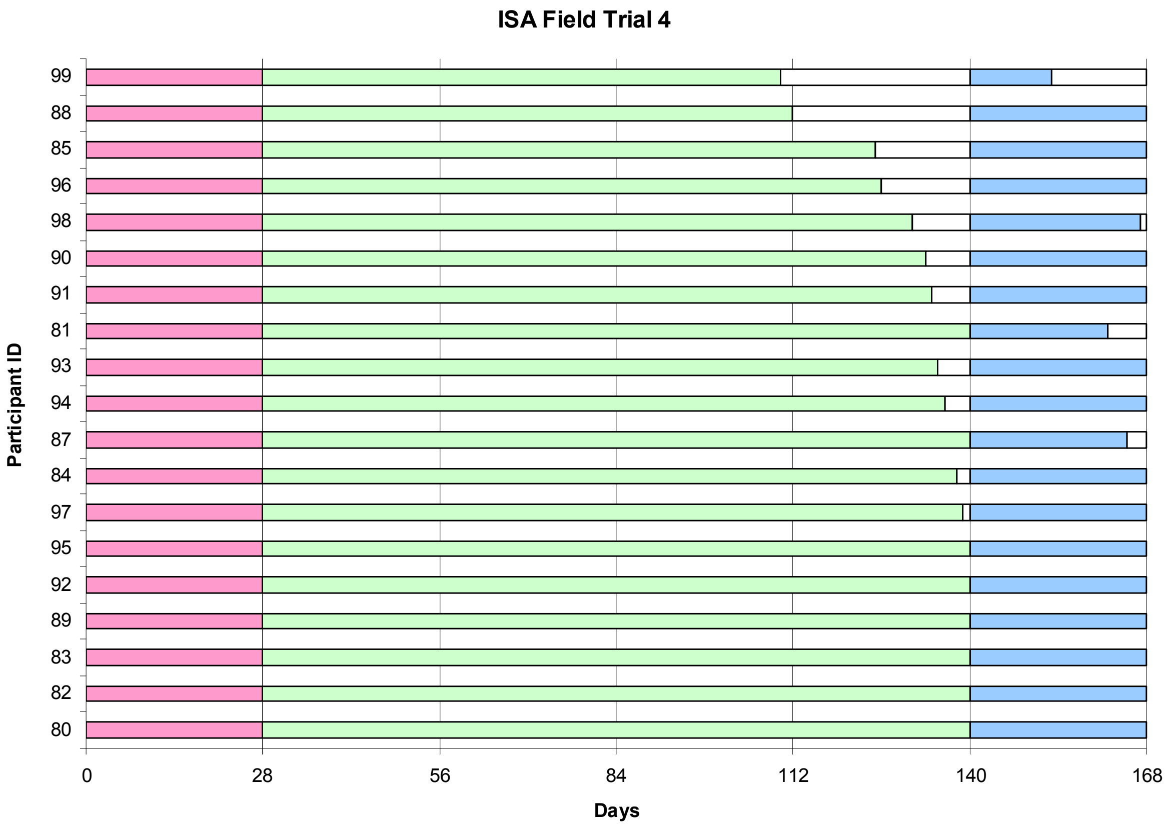


Figure 8: Completion rate in Field Trial 4

3.3 Analysis of vehicle speed

3.3.1 Data processing

Although the data logging system in the vehicle generates data at 10Hz (i.e. 10 records per second), data used for analysis was distance based rather than time based. While time based data is intuitively valid, it introduces undue weight to the data stream when vehicle speed is zero (e.g. the vehicle stops at junctions) or very low (e.g. the vehicle moves slowly on a congested road). Conversion algorithms were therefore developed for extracting a record per 5 metres of travelling distance from the data stream. This data processing also filtered out records without a valid speed limit attached to them, attributable to the vehicle being driven on roads which were not given speed limits by NavTech, such as private roads (e.g. supermarket car parks) or non-trunk roads outside the South-West Leicestershire area. The above process led to a data file containing 29,889,265 valid records, across all participants and trial phases, ready for analysis.

Weighting across participants to equalise individuals' contribution of travel distance during the trial to the data was considered in order to prevent the data from being possibly distorted by participants with high annual mileage. However, it was eventually decided not to apply weights to retain a valid representation of the sample against the whole driving population, as annual mileage inherently differs from one driver to another.

3.3.2 Vehicle kilometres

Following data processing and reduction, the final data file ready for analysis represents a total travel distance of 141,517 kilometres. A breakdown of vehicle kilometres with respect to speed zones is illustrated in Figure 9. The largest portion of vehicle kilometres was attributable to 30 mph zones, followed by 70 mph zones. Although this trial was designed to investigate driver behaviour primarily in rural environments, the majority of the travel occurred in *urban* areas, as the vehicle kilometres recorded in the 20, 30, and 40 mph zones accounted for over 50% of distance travelled. This is considered to be due to the distance travelled by a large portion of the participants was in urban area, as a result of their work trips.

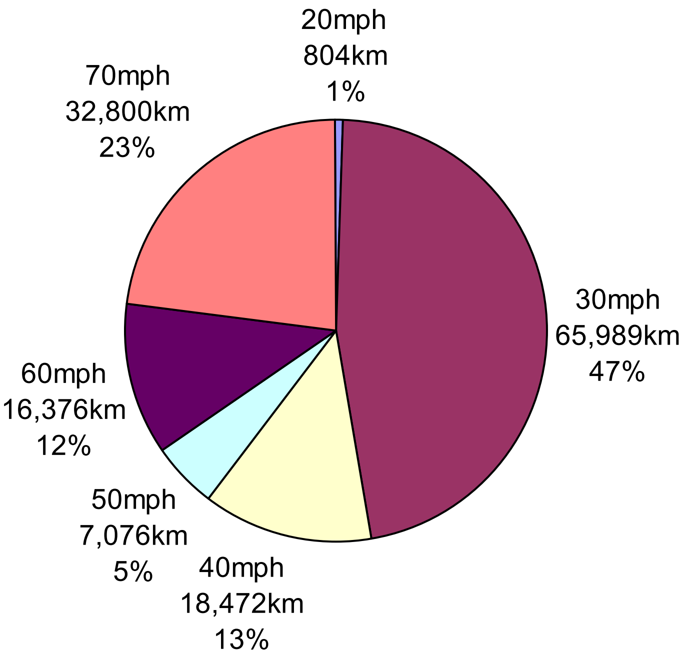


Figure 9: Distribution of total vehicle kilometres with respect to speed zones

Table 14 provides a further breakdown of the proportion of vehicle kilometres within individual trial phases, which suggests that the contribution of each speed zones to the total vehicle kilometres remains a very similar pattern across trial phases.

Table 14: Vehicle kilometres across trial phases

Speed zone	Vehicle Kilometres			Distribution based on trial phase (%)		
	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
20 mph	168	494	142	0.5	0.6	0.6
30 mph	15,310	39,044	11,635	46.9	45.7	49.6
40 mph	4,390	10,954	3,128	13.4	12.8	13.3
50 mph	1,909	4,134	1,033	5.8	4.8	4.4
60 mph	4,314	9,472	2,589	13.2	11.1	11.0
70 mph	6,581	21,282	4,936	20.1	24.9	21.0
Sum	32,674	85,381	23,463	100	100	100

3.3.3 Speed distribution

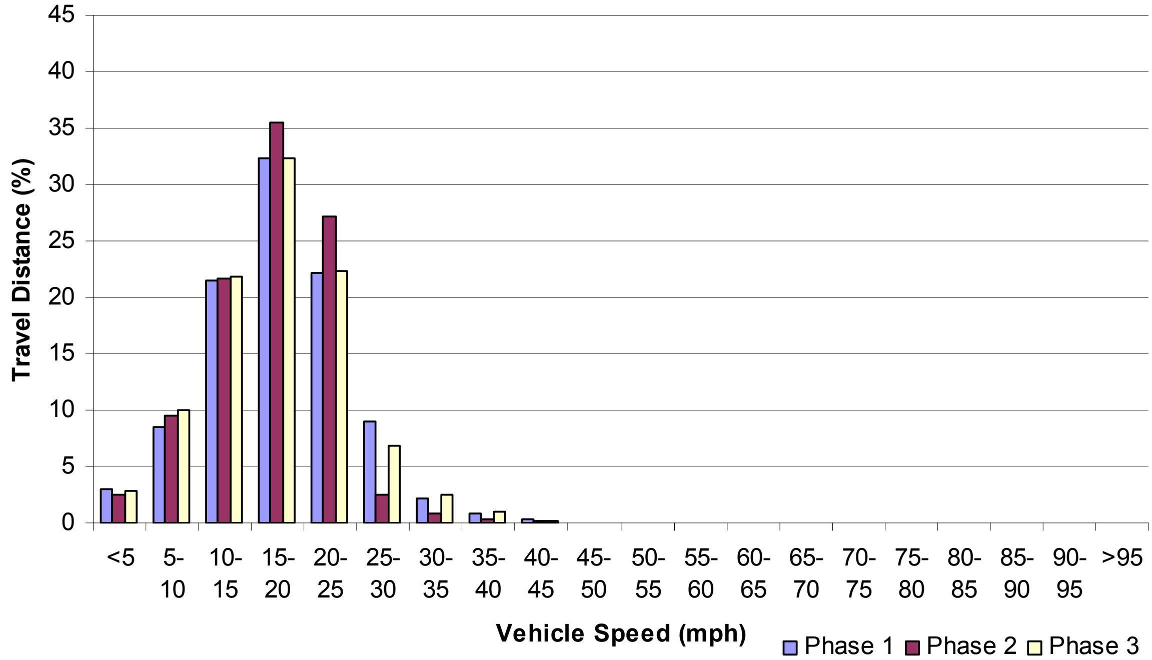
The logged vehicle data provides a comprehensive database of the speed distribution. Figure 10 through Figure 15 illustrate speed distribution across speed zones from 20 mph to 70 mph respectively. Each figure consists of two graphs; the top graph shows speed distribution across trial phases, and the bottom graph shows speed distribution in Phase 2 only (i.e. when ISA was switched on), with a breakdown of system engaged (Opt-In) and system overridden (Opt-Out).

It is worth noting that participants seemed to have adapted their reference for their chosen speed between trial phases. During Phase 1 and 3 when the ISA system was turned off, many participants were observed to obey the speed limits with reference to the speedometer reading. During Phase 2, most participants were observed to rely on the ISA system (i.e. throttle feedback) instead of the speedometer reading. The current design of the ISA system does not precisely restrict vehicle speed to posted speed limits (i.e. the speed limits provided by the digital speed limit map stored in the vehicle) all the time. Considering that trial participants may encounter a wide variety of road gradients, tolerance has been given to the throttle cut-off thresholds allowing the vehicle to be able to reach the speed limits on uphill roads. This design however leads to the vehicle being able to cross the speed limits on flat or downhill roads.

Since the participants used the ISA system to provide feedback on the limit and went for the maximum throttle allowance, a slight distortion to the speed distribution when ISA was turned on was observed. This led to a slight drift of the speed distribution in Phase 2 around the legal speed limits, especially in lower speed zones. For example, in 30 mph zones (e.g. Figure 11), the peak of the speed distribution derived from Phase 2 was in the band of 30-35 mph rather than 25-30 mph. Nevertheless, the trial results still undoubtedly demonstrate the effectiveness of the ISA system on reshaping speed distribution.

The effect of ISA intervention on the shape of the speed distribution is prominent across speed zones, except for the 60 mph zones, in which speeding behaviour had already rarely been recorded when ISA was not available. This is considered to be primarily due to the constrains on driving speed imposed by road geometry, as the 60 mph speed limit is applicable to most rural roads where the layout is usually single carriageway. It is worth noting that ISA led to considerably higher percentage of travel distance in the 65-70 mph band in Figure 15, which is considered to be attributable to the differences in participants' reference for their chosen speed across trial phases. As explained earlier in this section, most participants were observed to rely on throttle feedback instead of the speedometer reading for their chosen speed when ISA was switched on. Therefore they might have unintentionally pushed the accelerator further down than they normally would (i.e. when ISA was off), because ISA control still allowed them to do so before reaching the speed limit.

Analysis of the above speed distribution figures also reveals that the shapes of the speed distribution from Phase 1 and Phase 3 were generally very similar, apart from the 70 mph zones. This suggests that, although ISA effectively changed the speed distribution, the carry-over effect was not prominent. The differences between speed distribution between Phase 1 and 3 in the 70 mph zones are discussed following the presentation of the graphs.



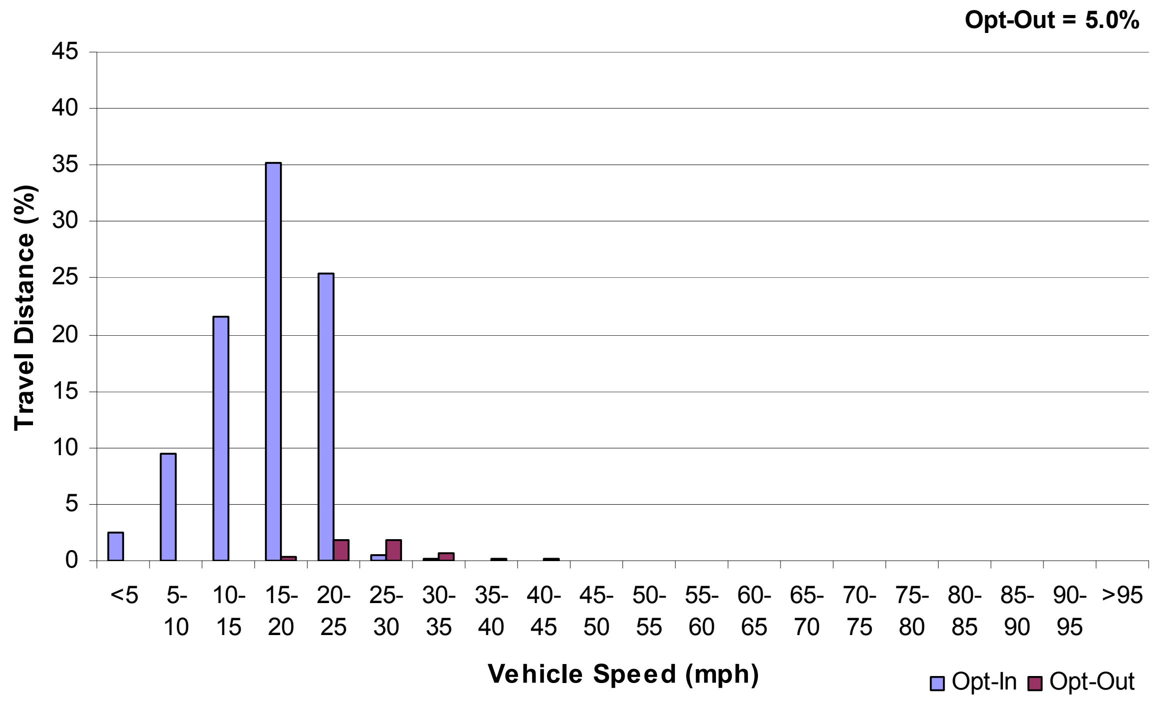


Figure 10: Overall speed distribution in 20 mph zones

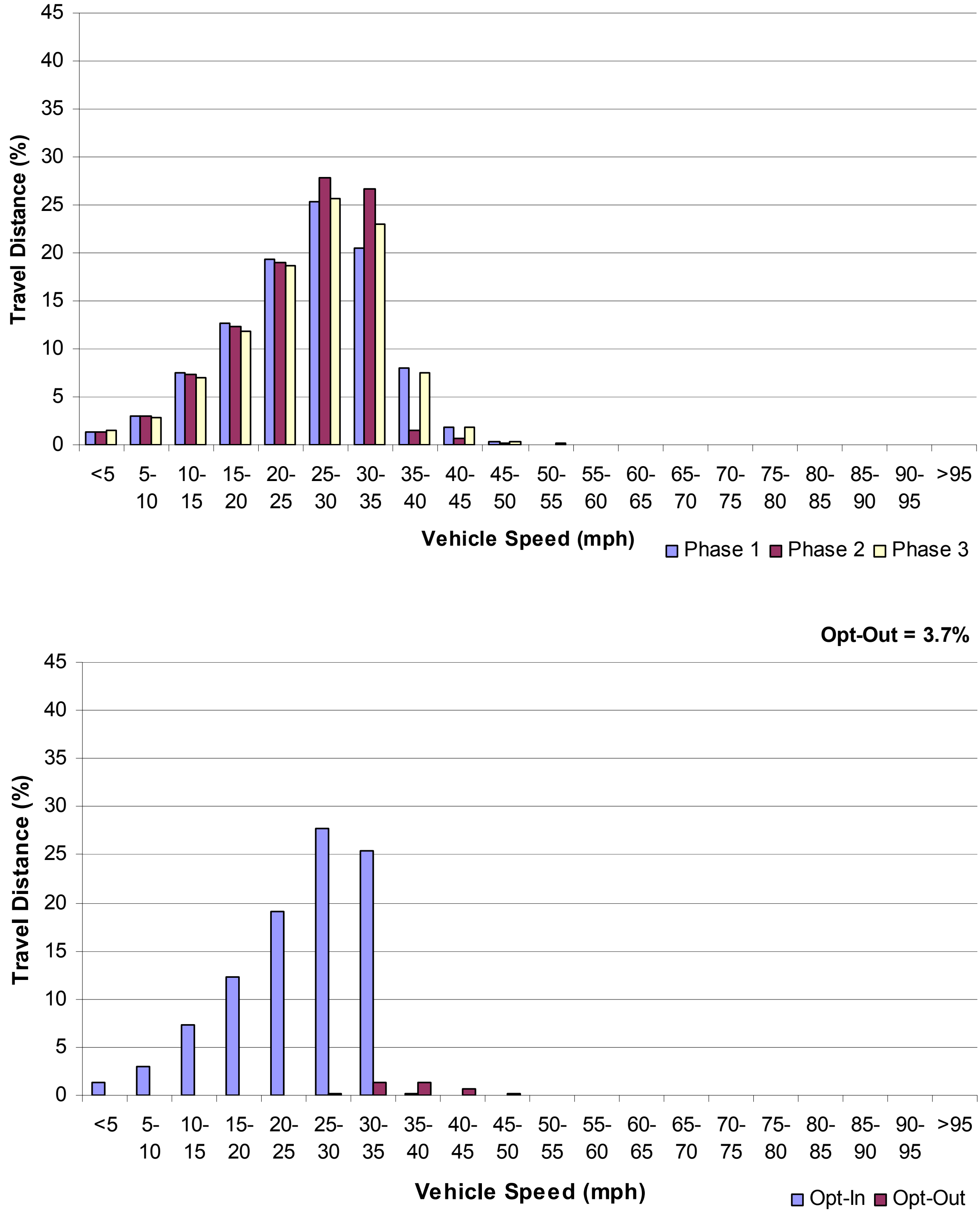
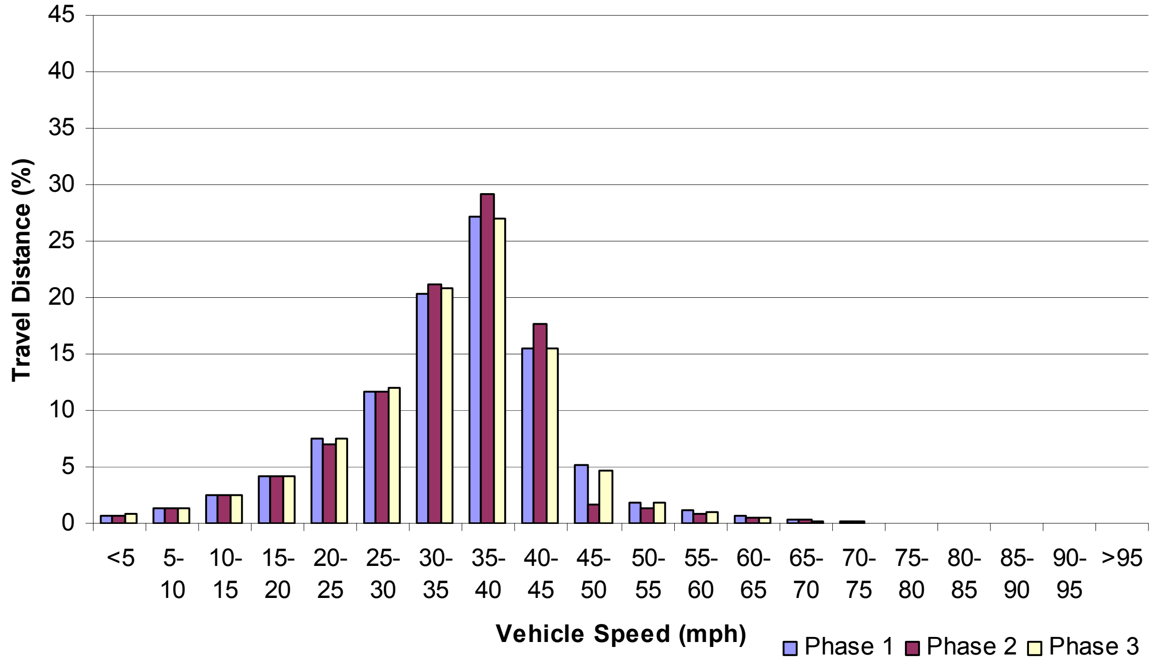


Figure 11: Overall speed distribution in 30 mph zones



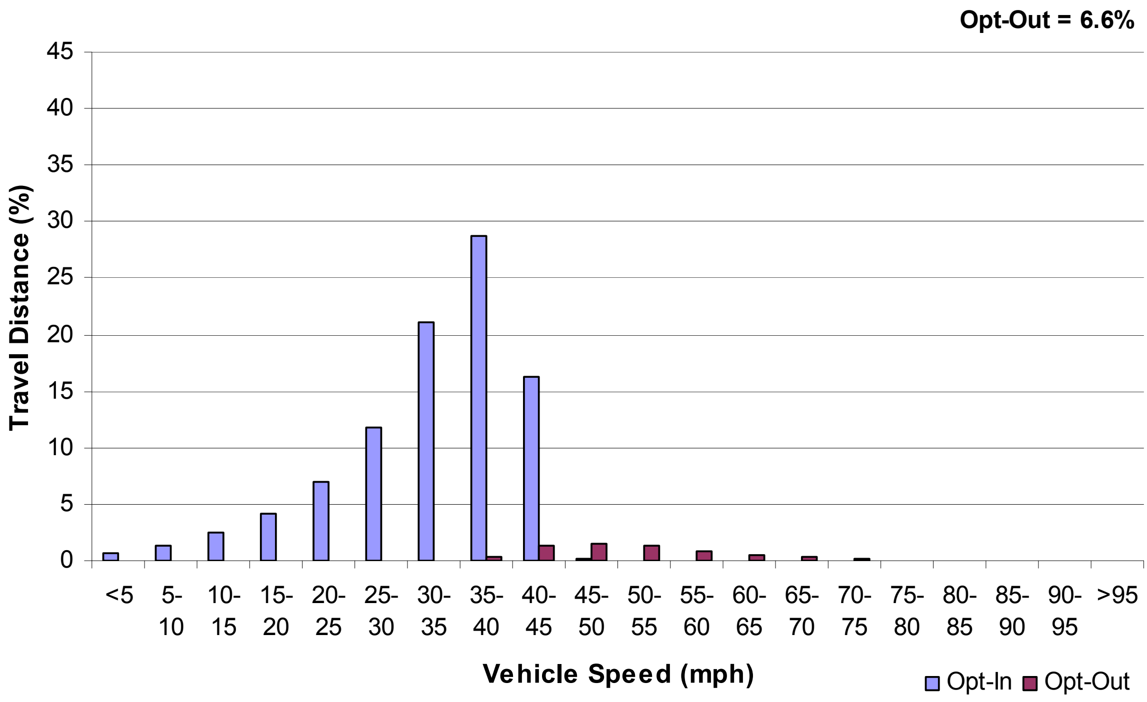
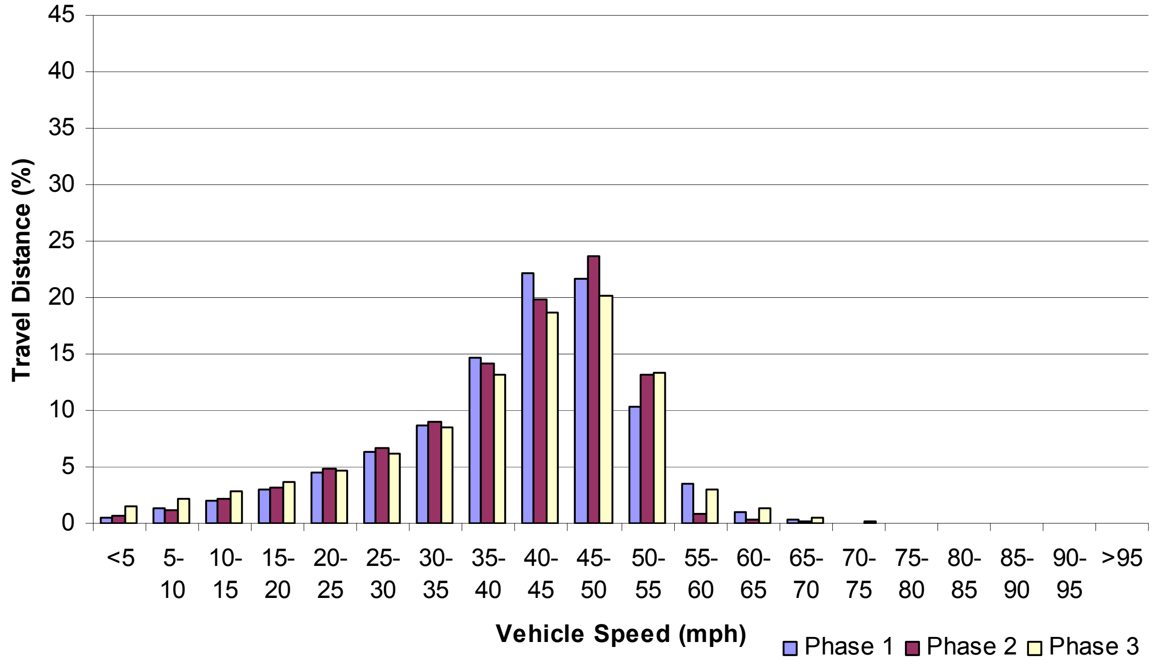


Figure 12: Overall speed distribution in 40 mph zones



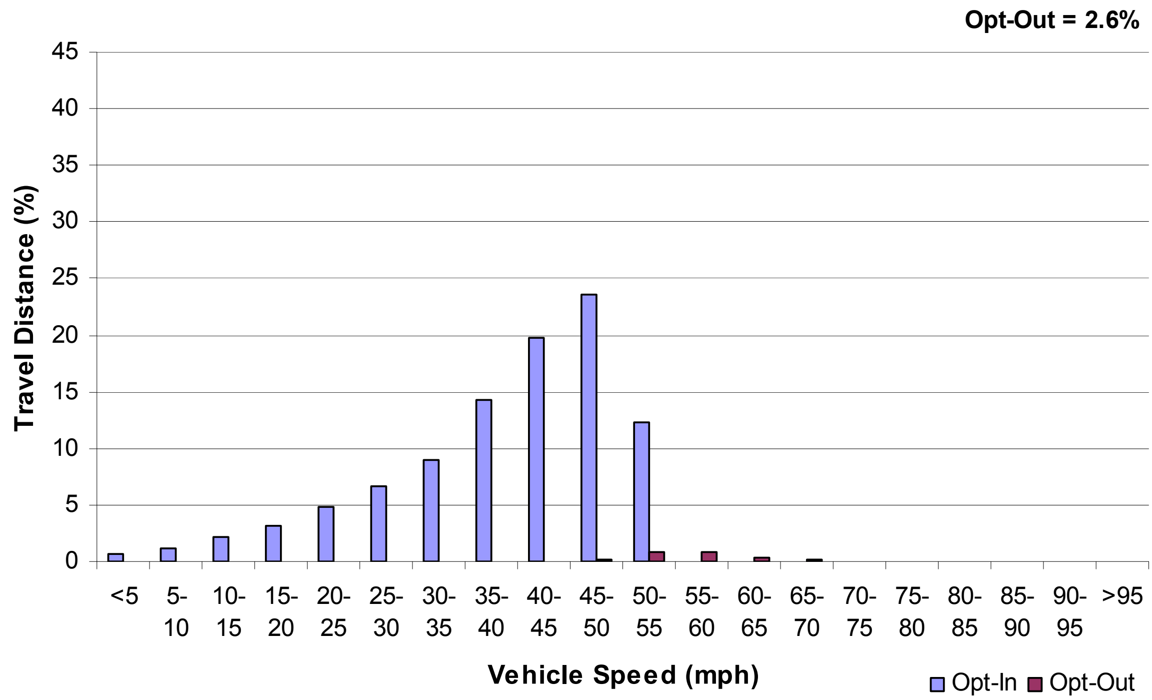


Figure 13: Overall speed distribution in 50 mph zones

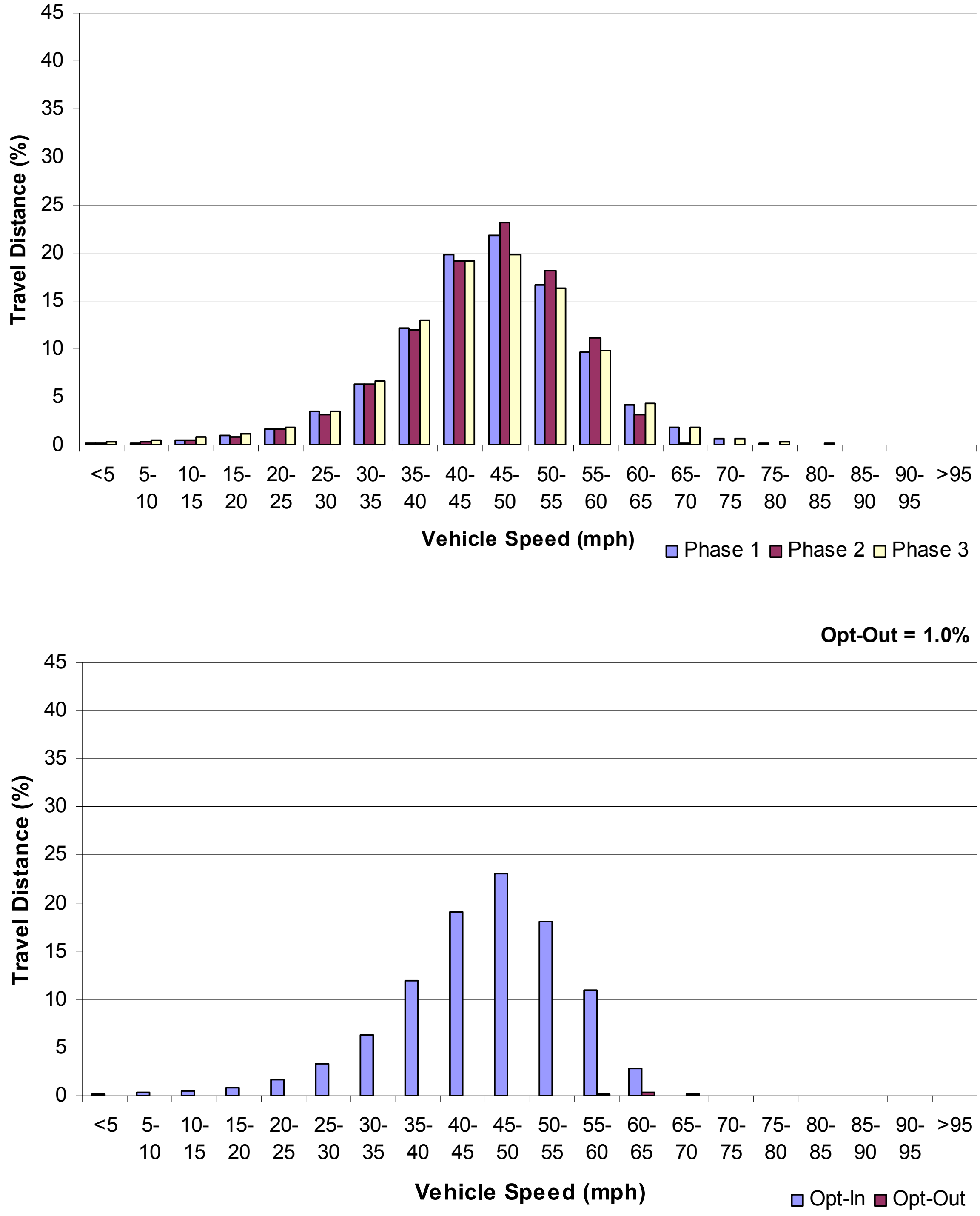


Figure 14: Overall speed distribution in 60 mph zones

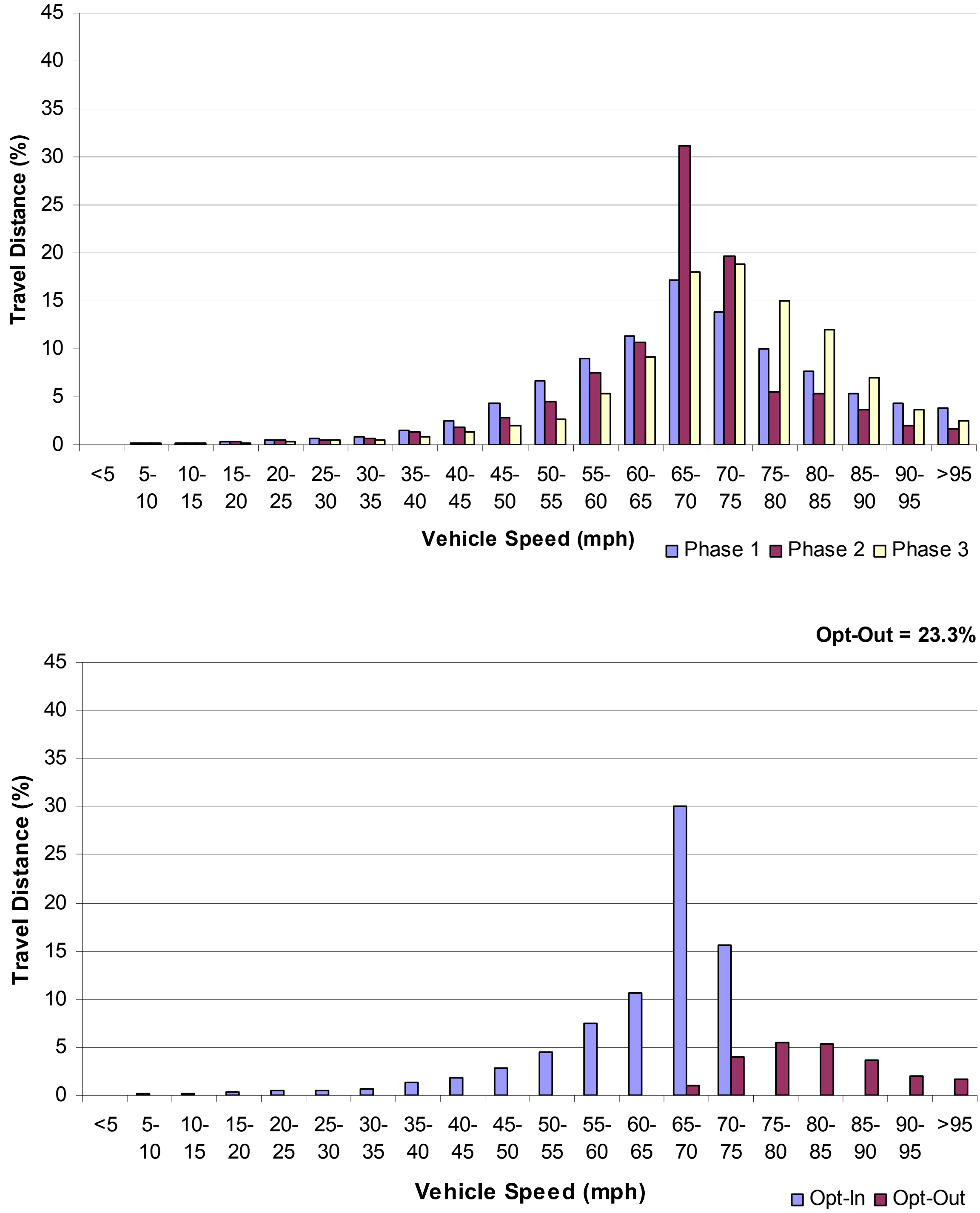


Figure 15: Overall speed distribution in 70 mph zones

Table 15 compares distance travelled, individual's contribution of travel distance within each trial phase, and the percentage of distance travelled exceeding the speed limit across the three trial phases. It clearly demonstrates that the travel patterns of some participants were very different between Phase 1 and Phase 3. For example, Participant 91 contributed 1% of travel distance in Phase 1 while he contributed 5% of travel distance in Phase 3. In addition, he spent 21% of his travel distance in Phase 1 exceeding the speed limit while the percentage increased dramatically to 78% in Phase 3. Similar cases indicating differences between Phase 1 and 3 from individual participants are highlighted in Table 15. These cases inevitably enlarged the variances in the speed distribution in Phase 1 and 3 respectively.

Table 15: Distortion of speed distribution across trial phases on 70 mph roads

Sub id	Distance travelled (km)			Individuals' contribution of travel distance within each phase (%)			% of distance travelled exceeding speed limit		
	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
80	133	369	142	2	2	3	14	9	14
81	169	229	13	3	1	0	13	4	11
82	763	2127	440	12	10	9	52	57	67
83	790	5475	882	12	26	18	70	50	78
84	788	2088	896	12	10	18	28	26	36
85	64	273		1	1	0	38	32	
86	377	749	303	6	4	6	56	44	58
87	112	1078	45	2	5	1	8	24	17
88	541	1088	393	8	5	8	47	65	44
89	51	1813	18	1	9	0	5	13	0
90	92	106	19	1	0	0	11	7	12
91	41	137	269	1	1	5	21	45	78
92	47	289	14	1	1	0	3	18	41
93	122	589	6	2	3	0	7	7	0
94	146	553	96	2	3	2	12	6	12
95	601	298		9	1	0	89	64	
96	289	740	429	4	3	9	23	16	73
97	639	2187	921	10	10	19	68	50	73
98	670	418	32	10	2	1	23	9	0
99	148	675	17	2	3	0	7	38	32

3.3.4 Compliance with ISA intervention

Figure 16 compares the observed overriding behaviour across speed zones, which highlights concerns over the influence of ISA intervention on diminishing excessive speed due to the system being overridden. It is notable that ISA was overridden most frequently in the 70 mph zones. Participants may have felt that speeding on 70 mph roads (mainly motorways) was acceptable whereas speeding on urban roads was not. However, participants' overriding behaviour on urban roads are still of concern: on 20 mph roads ISA was overridden for 5% of distance travelled, on 30 mph roads for 3.7% and on 40 mph roads for 6.6%. These are the roads where drivers are most likely to encounter conflicts with vulnerable road users such as pedestrians and cyclists than in the rest of speed zones.

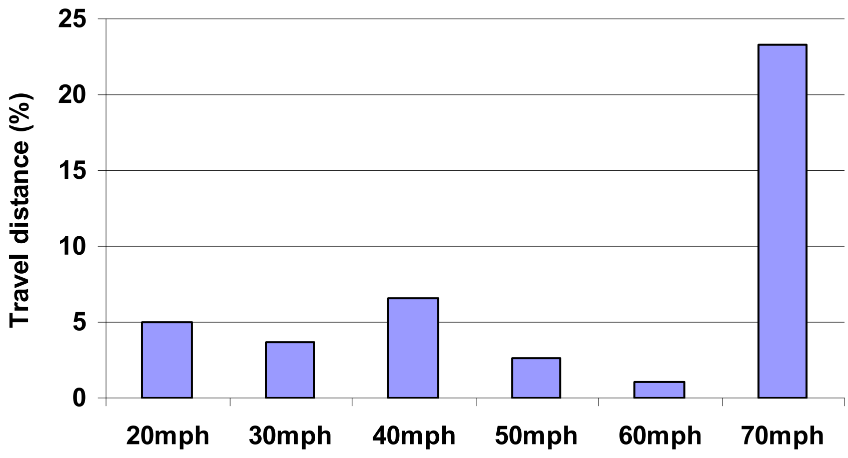


Figure 16: Comparison of overriding behaviour across speed zones

Figure 17 illustrates the distribution of overriding behaviour across speed zones based on the total travel distance when the ISA system was overridden, and demonstrates that over one fourth of overriding behaviour occurred in the urban environment (29%, contributed by 30 and 40 mph zones), where it could be argued that on safety grounds it was needed most. In addition, nearly two third of the travel distance when ISA was overridden was recorded on 70 mph roads, which is primarily due to the participants' overriding behaviour being magnified by travel distance achieved on high-speed roads; i.e. a combined effect of vehicle kilometre (Figure 9 in Section 3.3.2) and proportion of travel distance overridden (Figure 16).

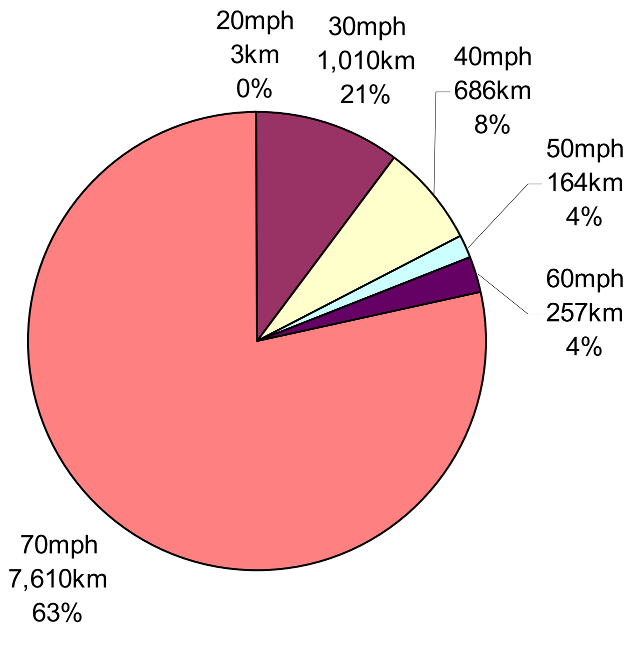


Figure 17: Distribution of travel distance with ISA overridden

3.3.5 Comparison of vehicle speed across trial phases

In addition to discussions of ISA changing the shape of speed distribution, the statistical differences among speed distributions was examined by central tendency (e.g. mean, median, and mode) as well as key percentiles towards the right end of the distribution (e.g. the 85th, 90th and

95th percentile). The high percentiles of the speed distribution offer very useful information for inspecting the presence of speed violation, especially the 85th percentile which closely corresponds to one standard deviation above the mean of a normal distribution. Moreover, traffic engineers have commonly used the 85th percentile of the speed of free flow traffic for determining speed limits. Therefore, a reduced value of the 85th (as well as the 90th and the 95th) percentile speed would be an indication of diminished speed violation. Statistics tests were carried out against central tendency of the distribution via the mean, the median, and the mode, and against the skewness of the distribution towards the right end via the 85th, the 90th, and the 95th percentile. Given that the ANOVA results and the trend of changes across trial phases were very similar for the three statistics indicating central tendency and across the three high percentiles, one measure was chosen to reflect each. Due to the importance of the mean and the 85th percentile of the speed distribution to research into subjective choice of speed, only these two statistics are presented and discussed as follows.

Figure 18 illustrates comparison of these two key statistics across trial phases in each speed zone, which suggests that ISA effectively reduced the mean and the 85th percentile of the speed distribution with the most prominent effect shown in lower speed zones; i.e. a 'V' shape, the statistic in question goes down from Phase 1 to Phase 2, then rises again from Phase 2 to Phase3. The absence of the 'V' shape in the 50 and 60 mph zones is considered to be primarily attributable to the behavioural changes in participants' reference for their chosen speed between trial phases, as discussed earlier in this section.

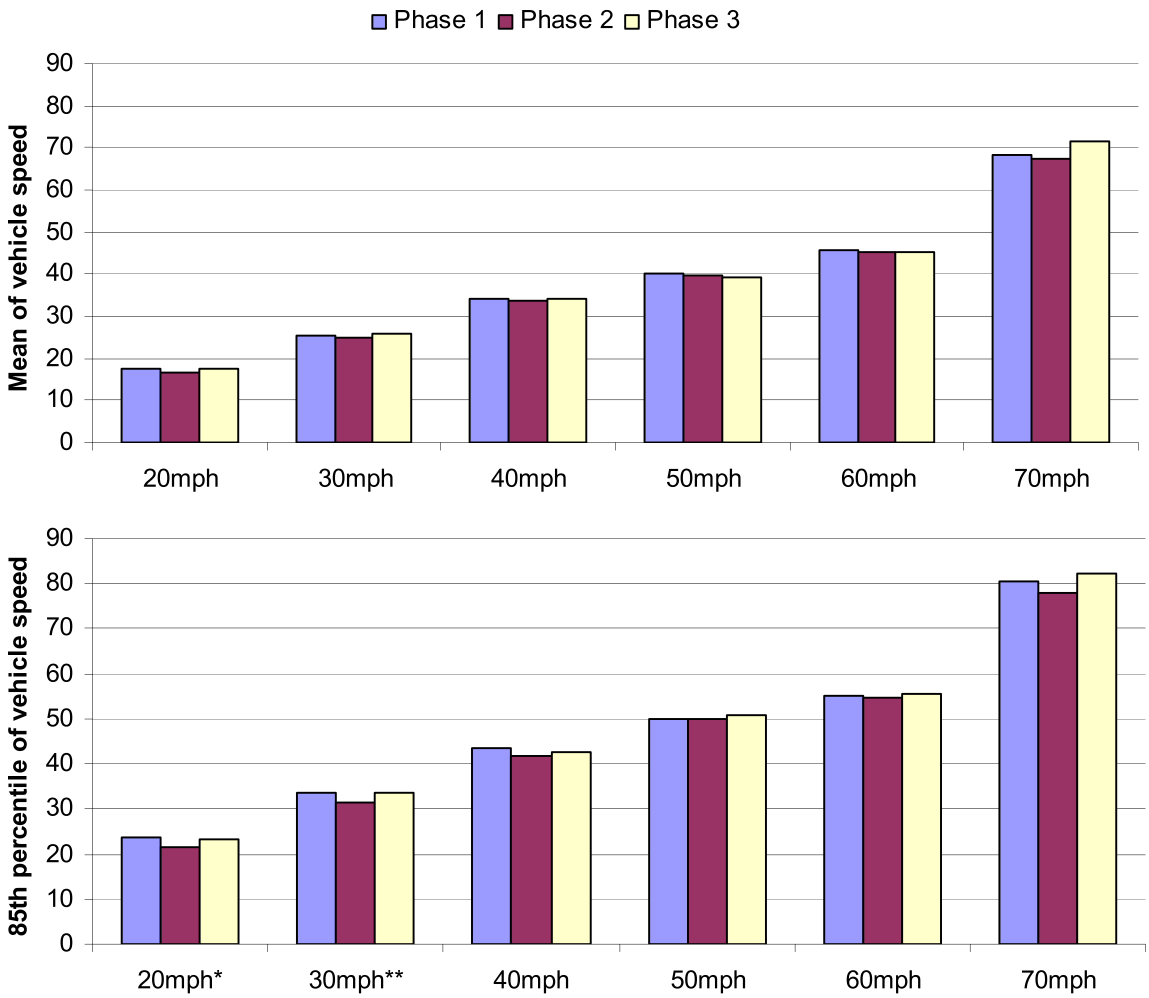


Figure 18: Comparison of key statistics of the speed distribution across trial phases

Table 16 presents the test results of a series of ANOVAs. Although statistical tests did not reveal significant differences with respect to mean speeds, this is considered to be primarily due to small sample size (i.e. 19 participants). However, the results of the ANOVA suggest that ISA intervention was more effective in reducing excessive speed than mean speed, which is demonstrated by larger effect sizes derived from the 85th percentiles than from the mean speeds across speed zones (except the 70 mph zones in which slight data distortion was observed, as explained earlier). Since injury severity is related to speed reduction (Nilsson, 1981), the cut-down of excessive speed delivers promising implications to road safety. In addition, the data used for the ANOVA include the travel distance when ISA was overridden in Phase 2, which suggests that the effectiveness of ISA intervention in diminishing excessive speed has not been traded off by the system being overridable. This undoubtedly boosts the confidence in suggesting that a mandatory ISA system will further diminish excessive speed.

Table 16: Results of ANOVA for key statistics of the speed distribution

Statistic	Speed zone	Phase 1	Phase 2	Phase 3	Repeated measures ANOVA			Post-hoc t-tests		
					F statistic	significance	Effect size	PH1–PH2	PH1–PH3	PH2–PH3
Mean speed	20	17.74	16.79	17.40	F(2,50) = 0.56	0.576	0.022	×	×	×
	30	25.40	24.78	25.69	F(2,56) = 3.06	0.055	0.098	×	×	*
	40	34.19	33.81	33.93	F(2,56) = 0.20	0.823	0.007	×	×	×
	50	39.93	39.49	39.20	F(2,55) = 0.18	0.840	0.006	×	×	×
	60	45.60	45.31	45.27	F(2,56) = 0.15	0.862	0.005	×	×	×
	70	68.25	67.25	71.67	F(2,54) = 1.56	0.220	0.055	×	×	×
85th percentile	20	23.65	21.49	23.28	F(2,50) = 3.38	0.042*	0.186	*	×	×
	30	33.46	31.26	33.50	F(2,56) = 25.80	< 0.0005**	0.480	**	×	**
	40	43.32	41.88	42.66	F(2,56) = 0.67	0.517	0.023	×	×	×
	50	50.09	49.76	50.98	F(2,55) = 0.83	0.441	0.029	×	×	×
	60	55.13	54.57	55.62	F(2,56) = 0.43	0.654	0.015	×	×	×
	70	80.42	77.76	82.13	F(2,54) = 1.41	0.253	0.050	×	×	×

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. × denotes the mean difference is not significant

3.3.6 Speed variability

Table 17 presents the coefficient of variation (CV) derived from individual trial phases as well as speed zones, which indicates the variability of vehicle speed. CV is a dimensionless measure that allows comparison of the variation of populations having considerably different mean values, which is of particular use for this analysis since the speed zones range from 20 mph to 70 mph. ISA led to a reduction in CV in most speed zones, as the CV derived from Phase 2 was generally smaller than that from Phase 1 or 3 (i.e. a 'V' shape), apart from the difference between Phase 2 and 3 in the 70 mph zones which again is considered to be primarily attributable to the distortion of speed distribution in the 70 mph zones explained earlier. At the overall level, ISA also led to a reduction in CV.

The effect of ISA intervention on reducing speed variability was most prominent in lower speed zones, i.e. the urban area. This delivers a promising implication of implementing ISA to accident reduction, as it has been suggested that the CV of speed is significantly correlated with accident occurrence in urban areas but the relationship is less prominent in rural areas (Taylor, Lynam, and Baruya, 2000; Taylor, Baruya, and Kennedy, 2002).

Table 17: Coefficient of variation of vehicle speed across trial phases

Speed zone	Phase 1	Phase 2	Phase 3
20 mph	0.376	0.326	0.380
30 mph	0.325	0.298	0.318
40 mph	0.293	0.280	0.289
50 mph	0.284	0.281	0.331
60 mph	0.224	0.212	0.245
70 mph	0.224	0.190	0.186
Overall	0.507	0.504	0.528

3.3.7 Jerks

It has been widely argued that braking is the most common evasion manoeuvre in traffic conflicts, ranging from 63% to 98% of traffic conflicts (van der Horst, 1984; Hyden, 1987; Garder, 1990; Hantula, 1994). Jerks, the sudden onset of *severe* deceleration, would therefore provide a useful indication of the occurrence of potential traffic conflicts.

The number of jerks was identified from the data stream, as shown in

Table 18. Although Phase 2 appeared to be leading to more jerks than Phase 1 and 3, this is a distorted picture due to Phase 2 lasted four months while Phase 1 and 3 only lasted one month respectively. When travelling distance in each trial phase was taken into account, Phase 2 demonstrated a diminished probability of jerk occurrence per vehicle-kilometre in comparison with Phase 3. Moreover, when the occurrence of jerk was analysed by dichotomous categories (i.e. ISA present against no ISA), ISA clearly demonstrated a diminished probability of jerk occurrence per vehicle-kilometre in comparison with Phase 1, as presented in Table 19. It is in fact not surprising that the number of jerks identified from this trial was small. According to Nygård (1999), only 6 serious traffic conflicts occurred during a field trial involving 24,080 samples of junction negotiation (i.e. 0.02%). However, it is expected that when data from all of the four field trials are pooled together, further analysis (e.g. ANOVA) may be able to be carried out.

Table 18: Analysis of jerk based on trial phases

Participant id	Trial phase		
	Phase 1	Phase 2	Phase 3
80			1
81	1		
82		2	
83			1
84			
85		1	
86	1		
87			
88		2	
89	1	1	
90	2	2	
91			
92			
93			
94			
95			
96			
97			
98			
99			
sum	5	8	2
Veh-km	32,674	85,381	23,463
Prob of jerk occurrence (per veh-km)	**0.015 %**	**0.009 %**	**0.009 %**

Table 19: Analysis of jerk based on dichotomy

	ISA	No ISA
Frequency of jerk	4	11
Veh-km	78,031	63,486
Prob of jerk occurrence (per veh-km)	**0.005 %**	**0.017 %**

3.4 Analysis of vehicle speed by demographic groups

This section presents analysis of the speed distribution in terms of participants' demographic characteristics: gender, age, and intention to speed. The number of participants in each demographic group used in the analysis presented in this section is specified in Table 20. As explained in Section 2.4, the amount of data collected from the replacement participant did not warrant their inclusion within the analysis.

Table 20: Number of participants by demographic categories

	Male		Female		Total
	Intender	Non-Intender	Intender	Non-Intender	
Young	3	1	0	5	9
Old	2	2	1	5	10
Total	5	3	1	10	19

3.4.1 Gender

Table 21 depicts a breakdown of vehicle kilometres across trial phases, speed zones and participants' gender groups, which shows that the contribution to overall travel distance from male and female participants were very close. Figure 19 further compares the distribution of travel distance between the two gender groups, which reveals that female participants travelled in rural area (i.e. the 60 and 70 mph zones) more than male participants, and male participants travelled in urban area (i.e. the 30 mph zones) more than female participants.

Table 21: Vehicle kilometres across gender groups, trial phases, and speed zones

Speed zone	Male			Female		
	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
20 mph	130	372	114	38	122	28
30 mph	8,499	21,578	7,444	6,811	17,466	4,191
40 mph	2,025	5,037	1,820	2,365	5,917	1,307
50 mph	713	1,739	494	1,196	2,395	539
60 mph	1,206	2,583	1,129	3,108	6,889	1,460
70 mph	2,825	11,267	1,946	3,756	10,015	2,990
Sum	70,922			70,596		

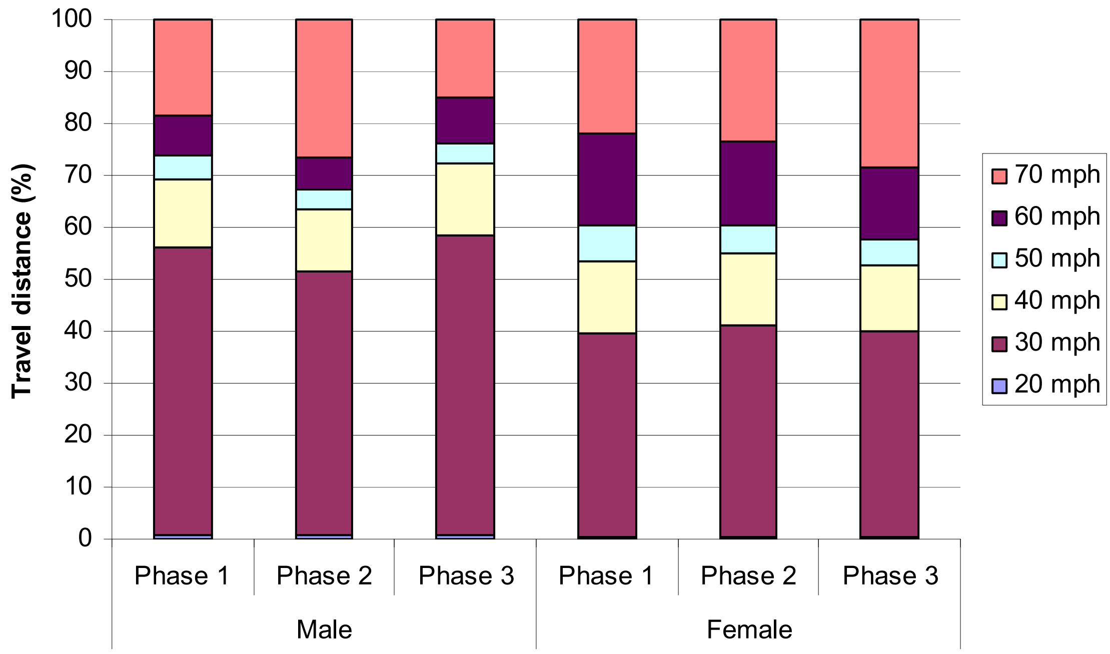


Figure 19: Comparison of patterns of travel distance between gender groups

Figure 20 through Figure 25 compare speed distribution across trial phases between the two gender groups. ISA effectively reshaped the speed distribution for both groups across speed zones. Male participants were also observed to have overridden the system more frequently than female participants across all of the speed zones, except the 40 mph zones.

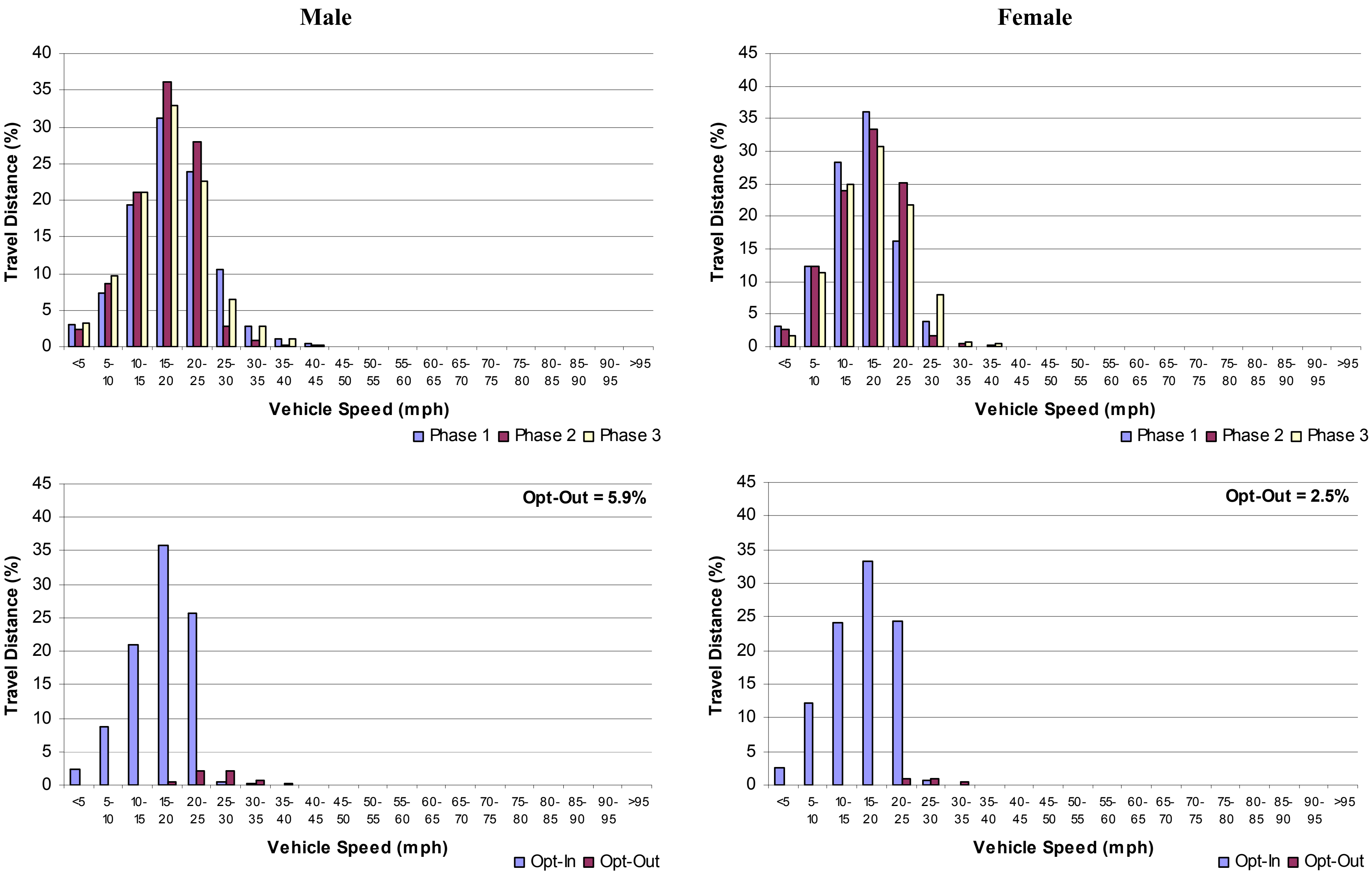


Figure 20: Comparison of the speed distribution in 20 mph zones between gender groups

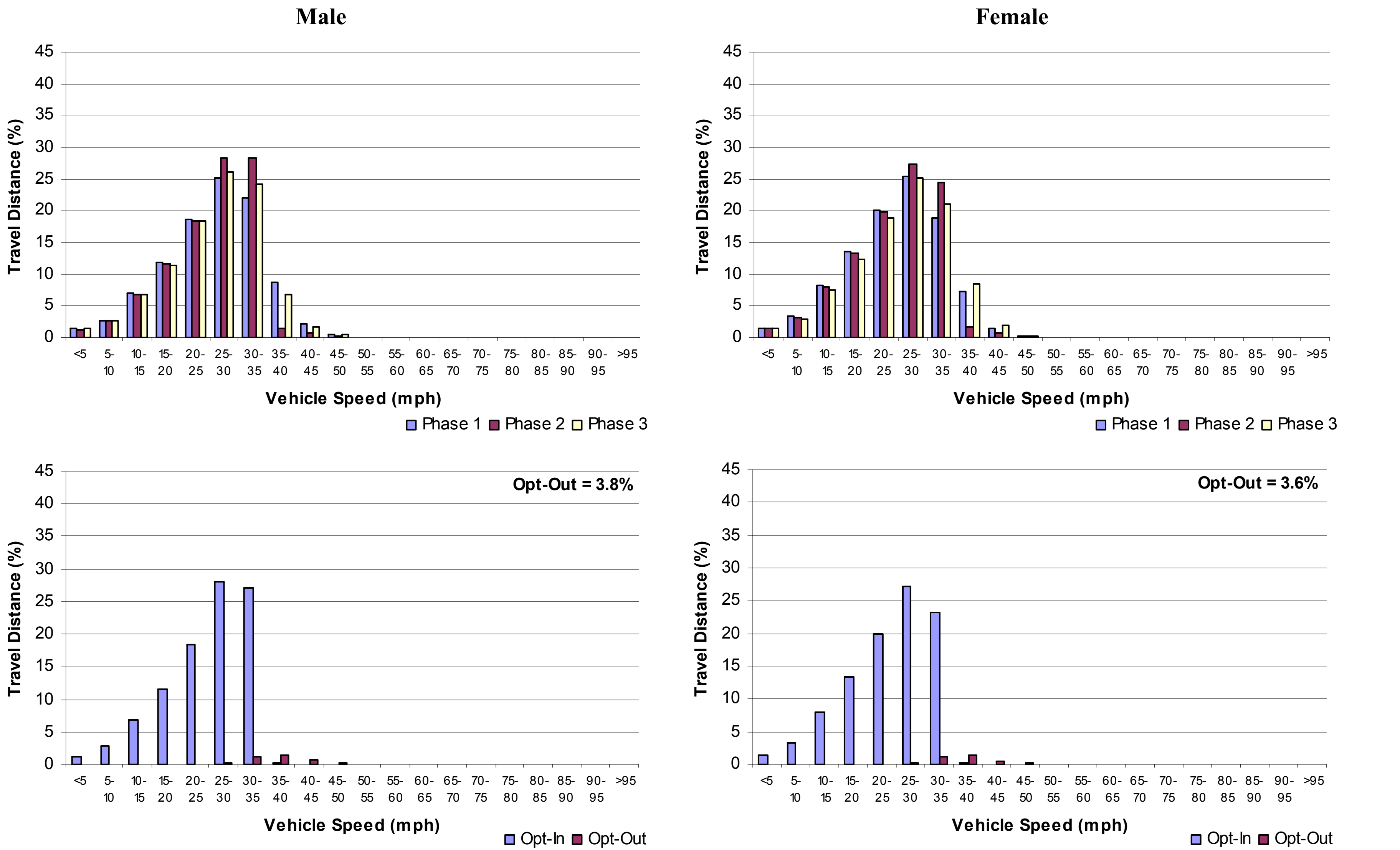


Figure 21: Comparison of the speed distribution in 30 mph zones between gender groups

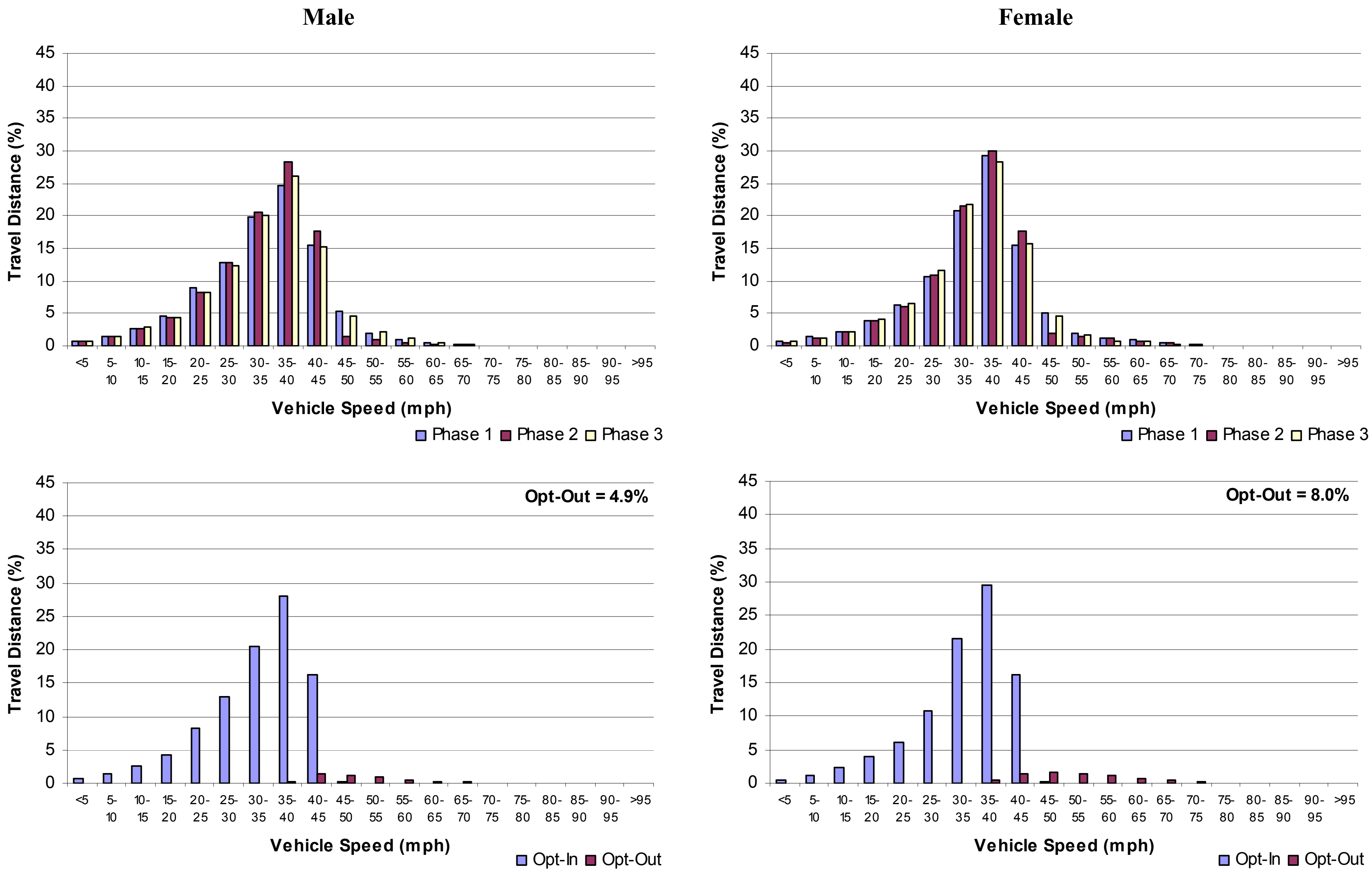


Figure 22: Comparison of the speed distribution in 40 mph zones between gender groups

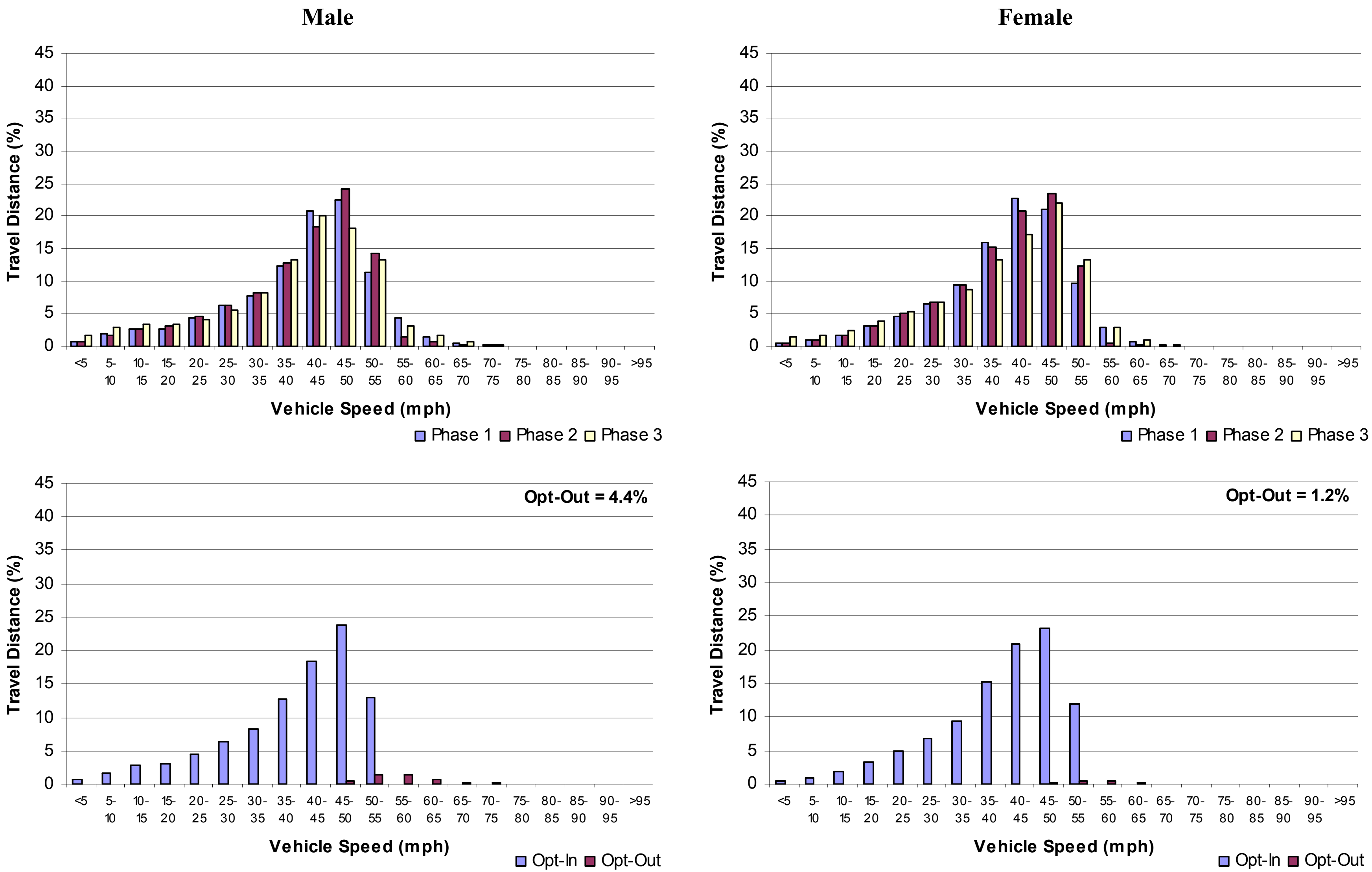


Figure 23: Comparison of the speed distribution in 50 mph zones between gender groups

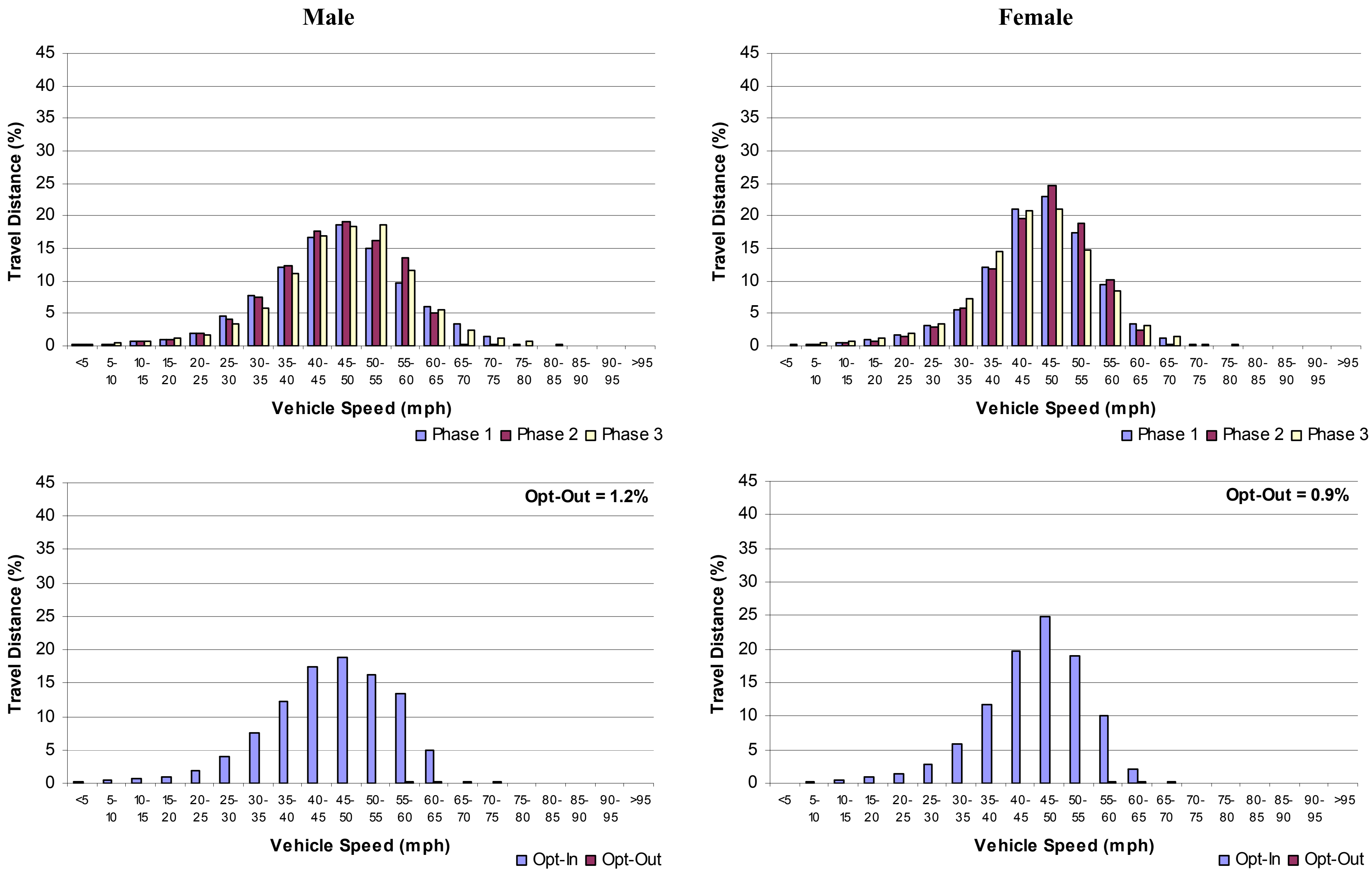


Figure 24: Comparison of the speed distribution in 60 mph zones between gender groups

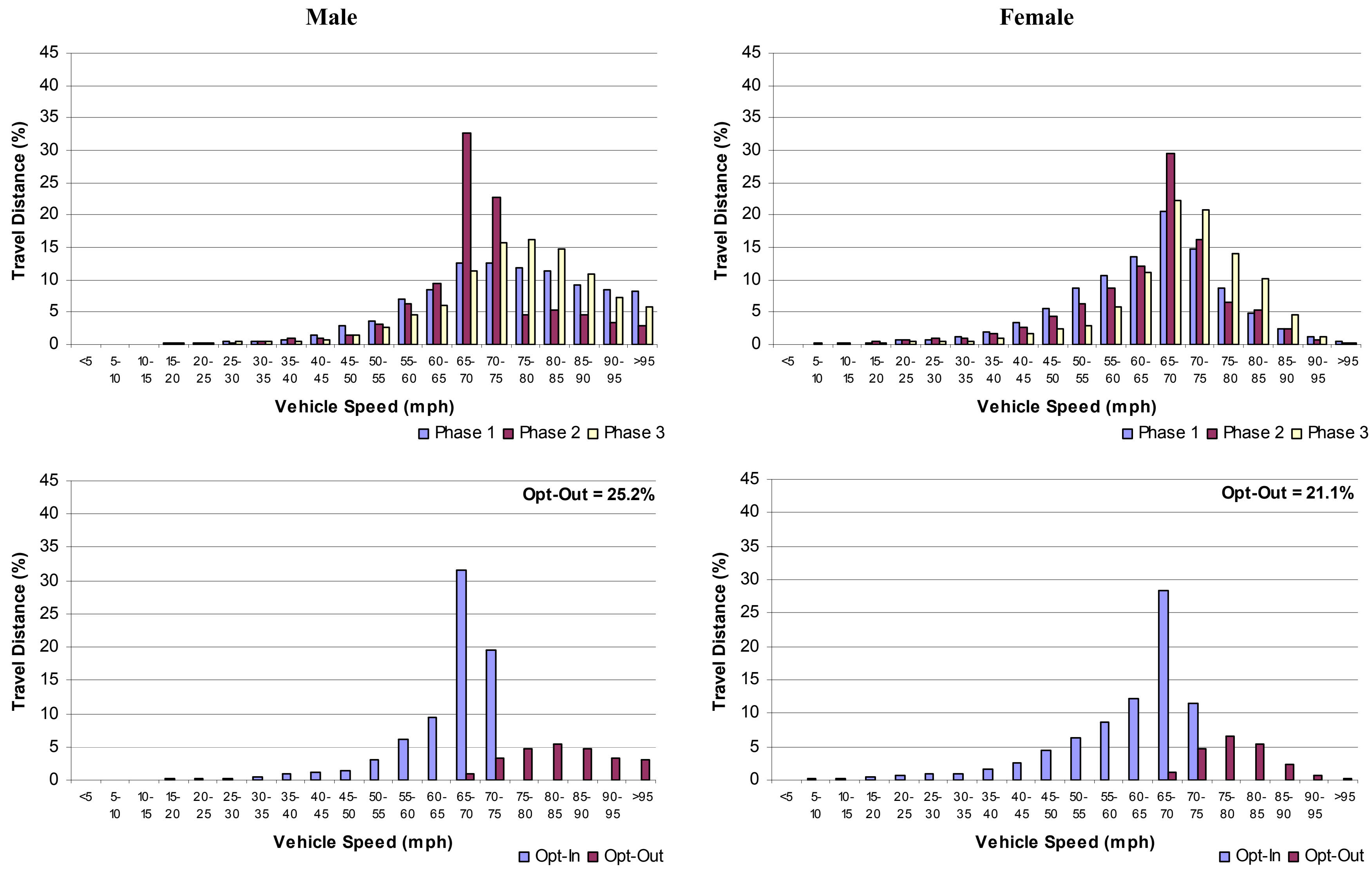
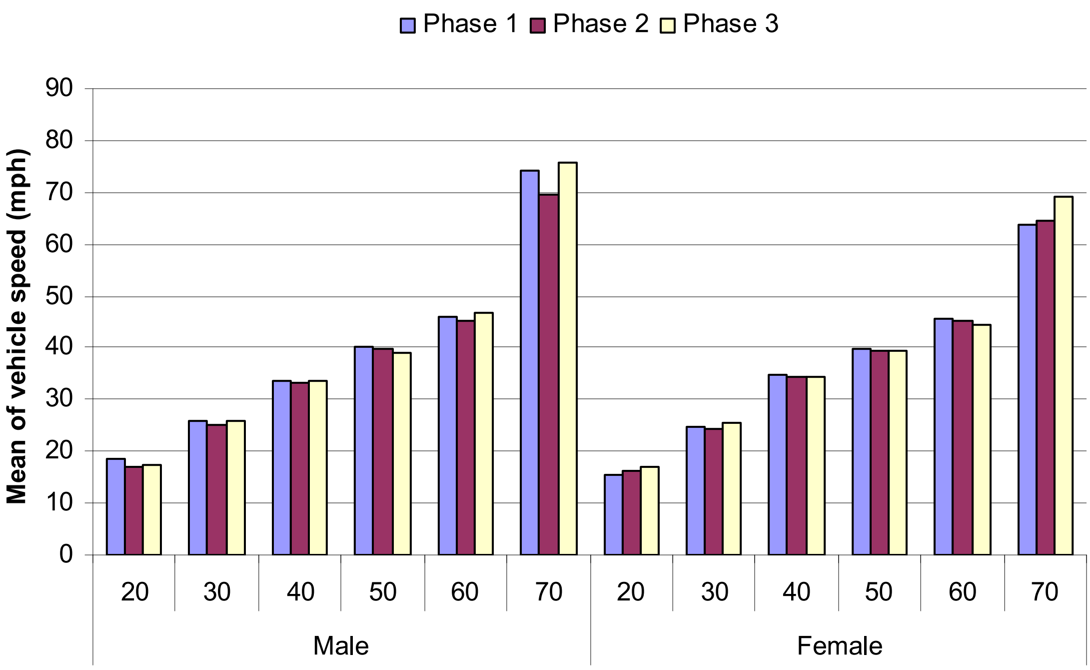


Figure 25: Comparison of the speed distribution in 70 mph zones between gender groups

Figure 26 compares the mean and the 85th percentile across trial phases in each speed zone between the two gender groups. ISA led to a reduction in vehicle speed across the gender groups, except some speed zones. As explained earlier, the absence of the 'V' shape in these speed zones was presumably attributable to differences in participants' reference for choice of speed across trial phases. In addition, male participants generally demonstrated slightly higher mean and 85th percentile across speed zones than female participants. A series of ANOVAs were carried out to confirm the difference across trial phases in individual speed zones; significant results are annotated in Figure 26 but detailed test results are given in Appendix B.



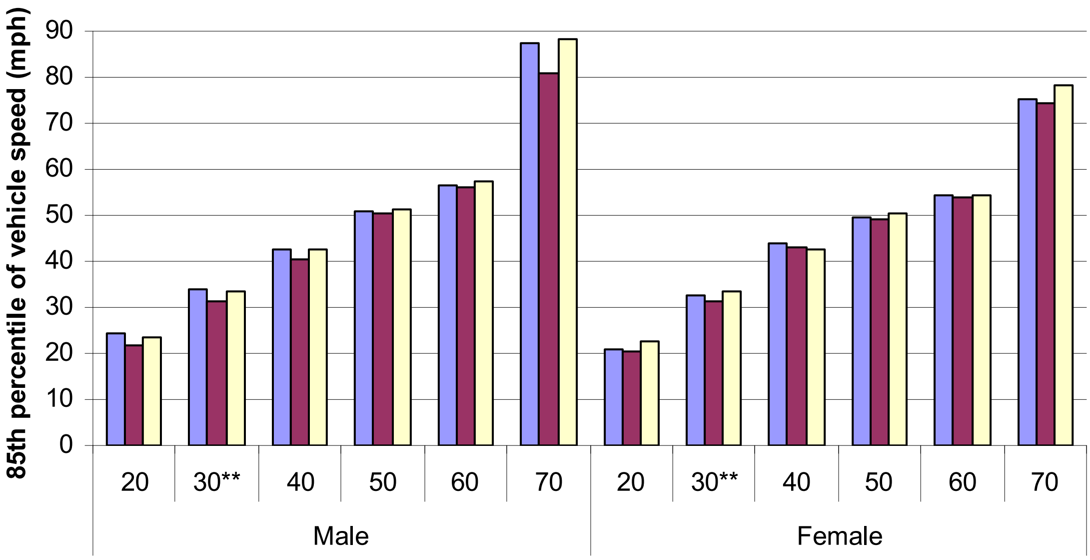


Figure 26: Comparison of key statistics of the speed distribution across trial phases between gender groups

3.4.2 Age

Table 22 depicts a breakdown of vehicle kilometres across trial phases, speed zones and participants' age groups, which shows that older participants contributed a considerably larger amount of data than younger participants. Figure 27 further compares the distribution of travel distance between the two age groups, which suggests that the travel patterns of the two groups were fairly similar.

Table 22: Vehicle kilometres across age groups, trial phases, and speed zones

Speed zone	Young			Old		
	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
20 mph	115	367	101	54	127	42
30 mph	6,784	17,069	4,113	8,527	21,975	7,521
40 mph	1,785	4,869	994	2,605	6,085	2,134
50 mph	832	2,133	487	1,077	2,001	546
60 mph	1,310	3,352	580	3,004	6,121	2,009
70 mph	3,102	11,317	2,252	3,479	9,965	2,684
Sum	61,561			79,956		

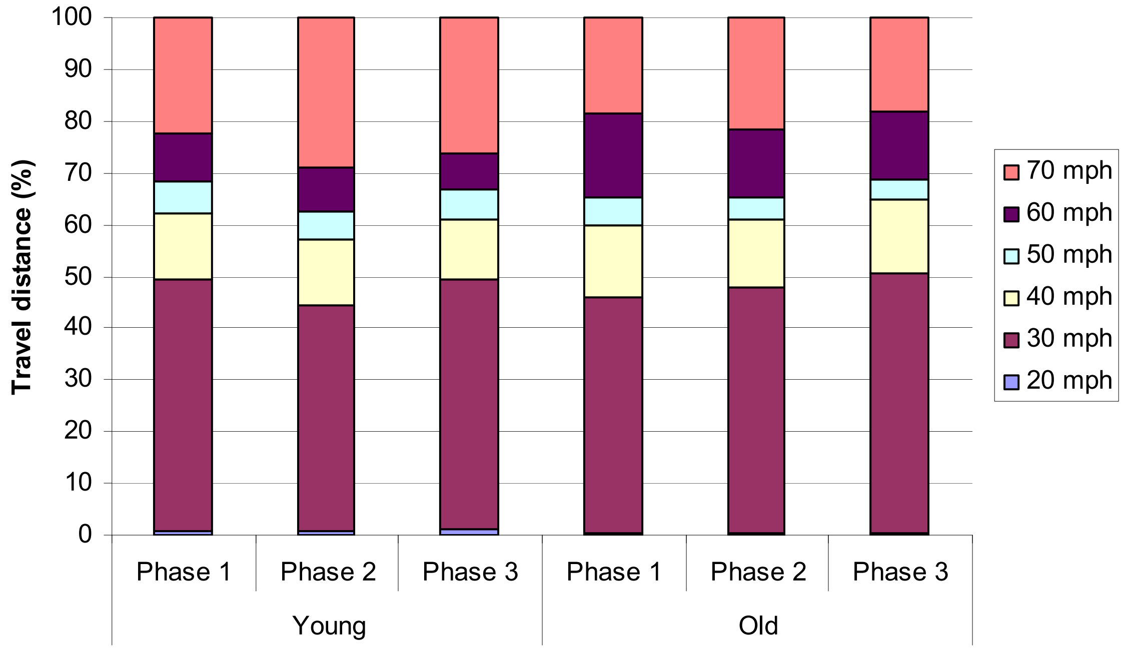


Figure 27: Comparison of patterns of travel distance between age groups

Figure 28 through Figure 33 compare speed distribution across trial phases between the two age groups. ISA effectively reshaped the speed distribution for both groups across speed zones but younger participants were observed to have overridden the system more frequently than older participants in most speed zones, the exception being the 20 and 50 mph zones.

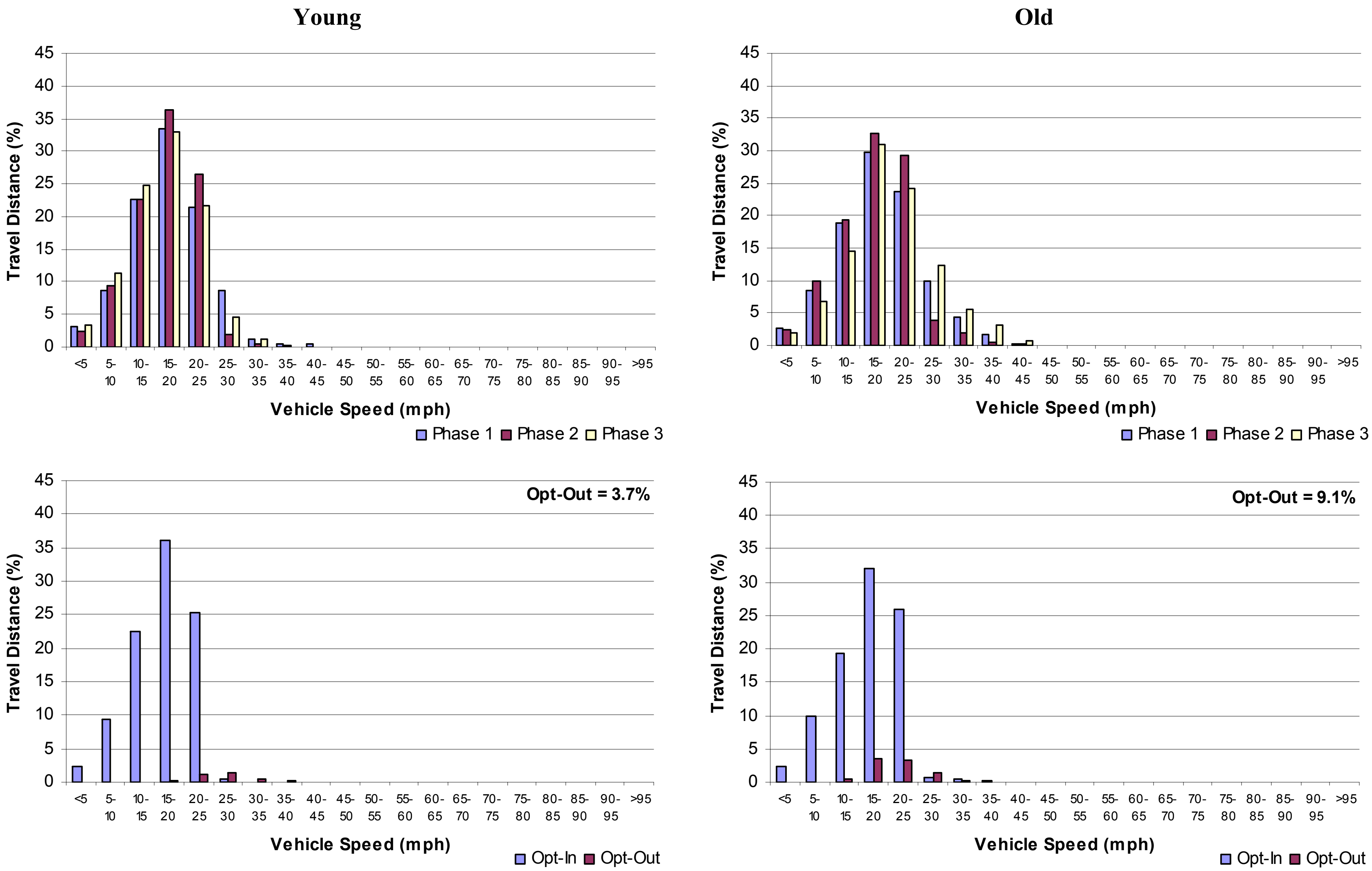


Figure 28: Comparison of the speed distribution in 20 mph zones between age groups

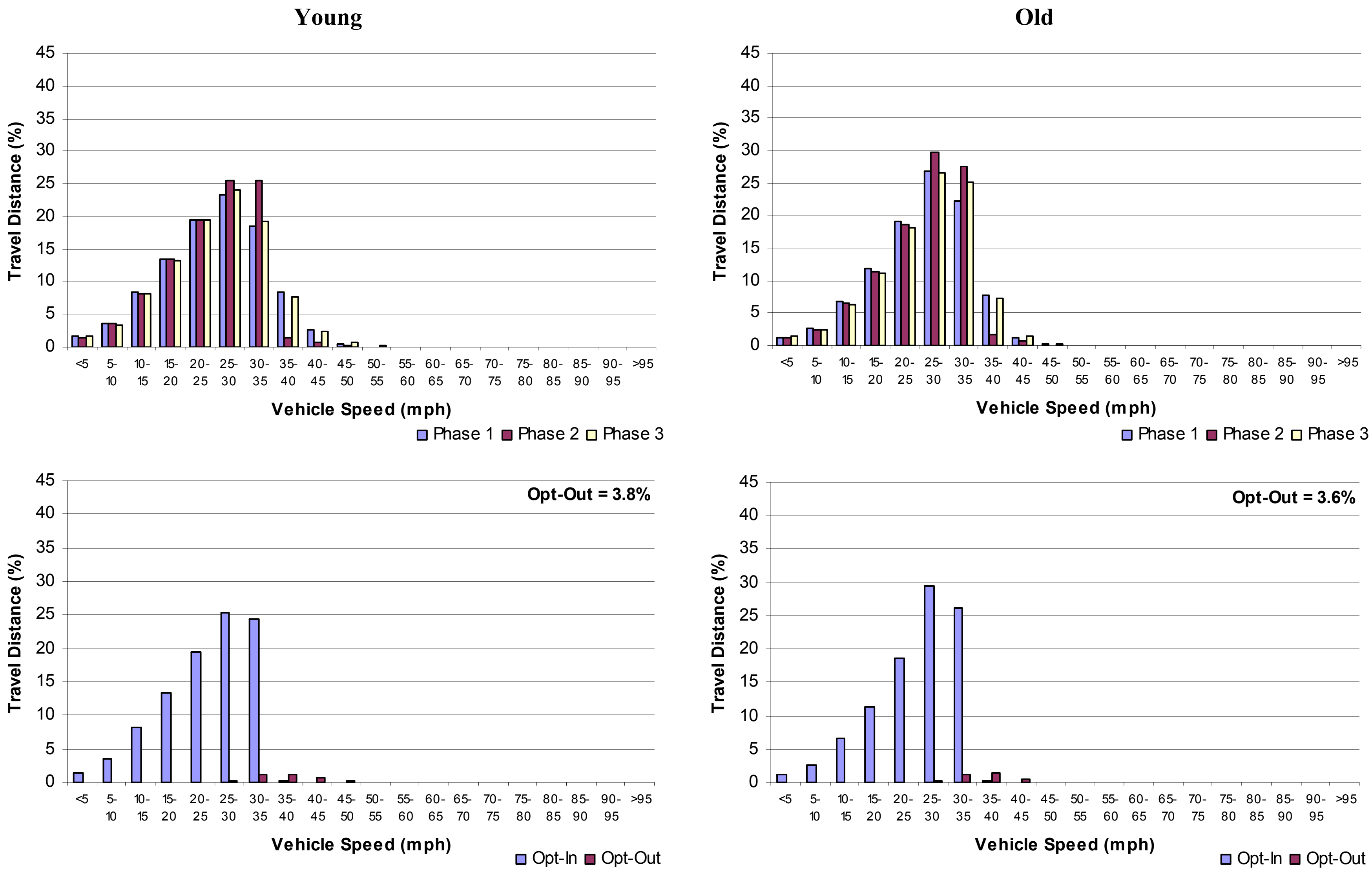


Figure 29: Comparison of the speed distribution in 30 mph zones between age groups

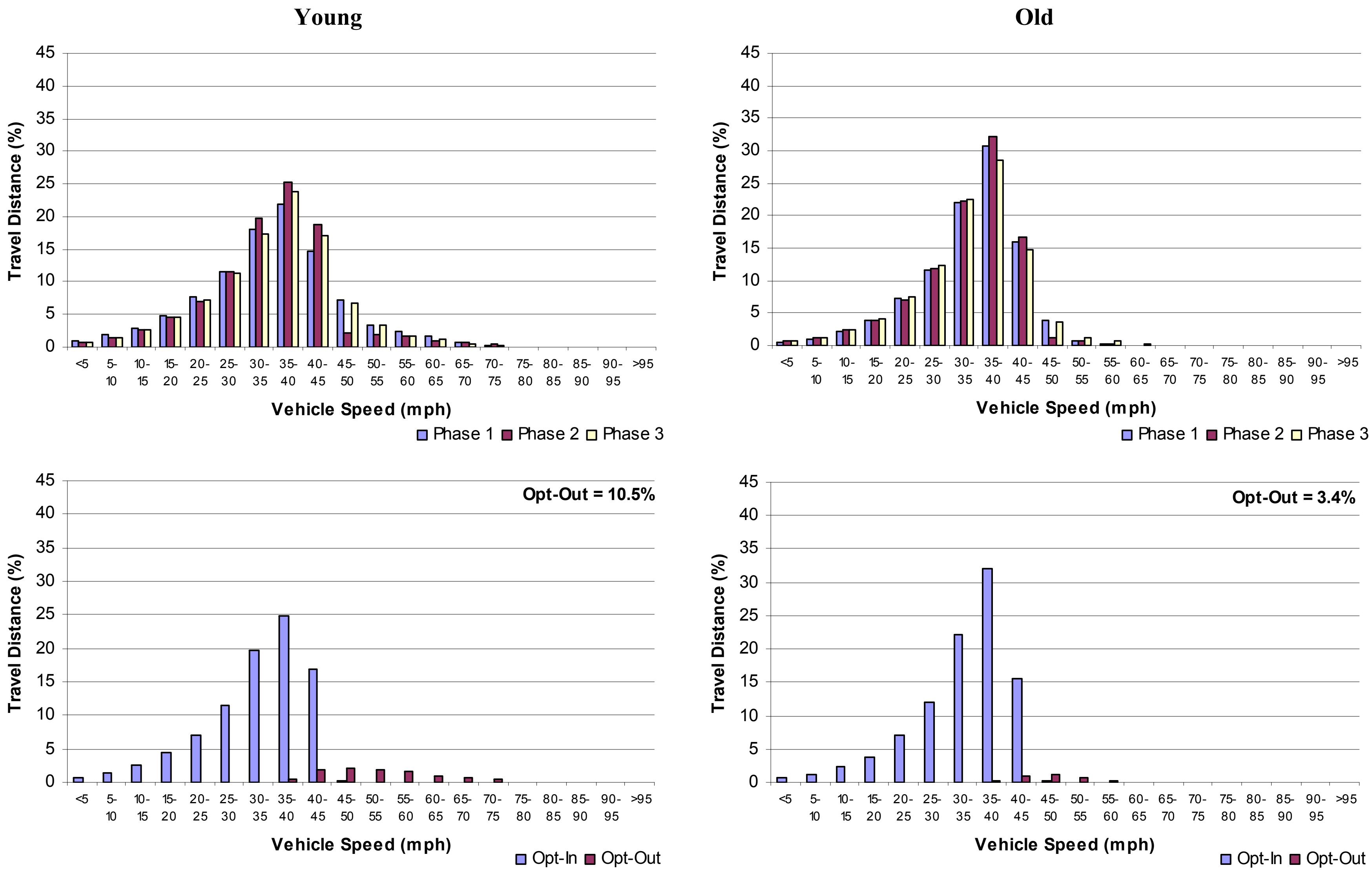


Figure 30: Comparison of the speed distribution in 40 mph zones between age groups

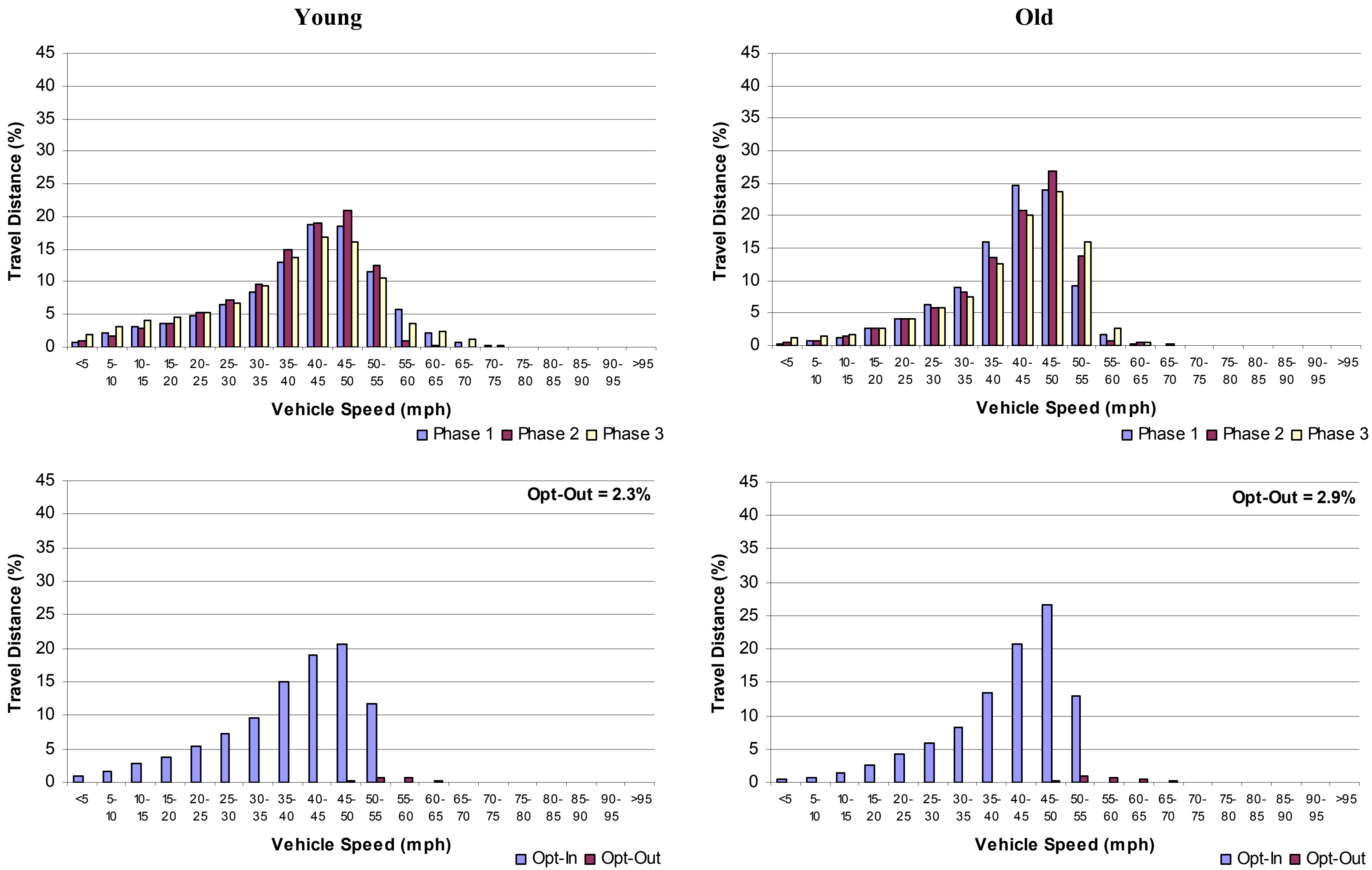


Figure 31: Comparison of the speed distribution in 50 mph zones between age groups

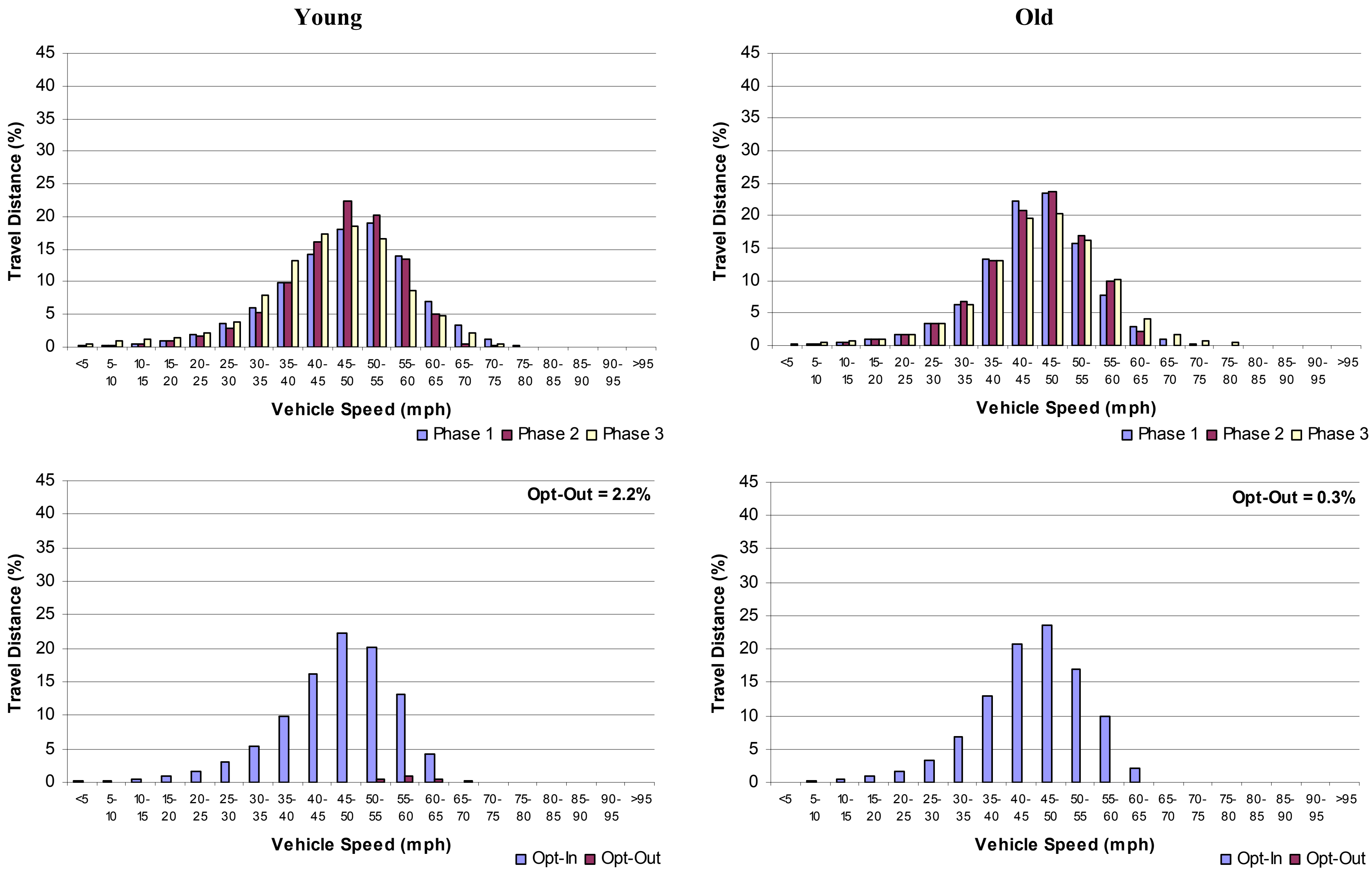


Figure 32: Comparison of the speed distribution in 60 mph zones between age groups

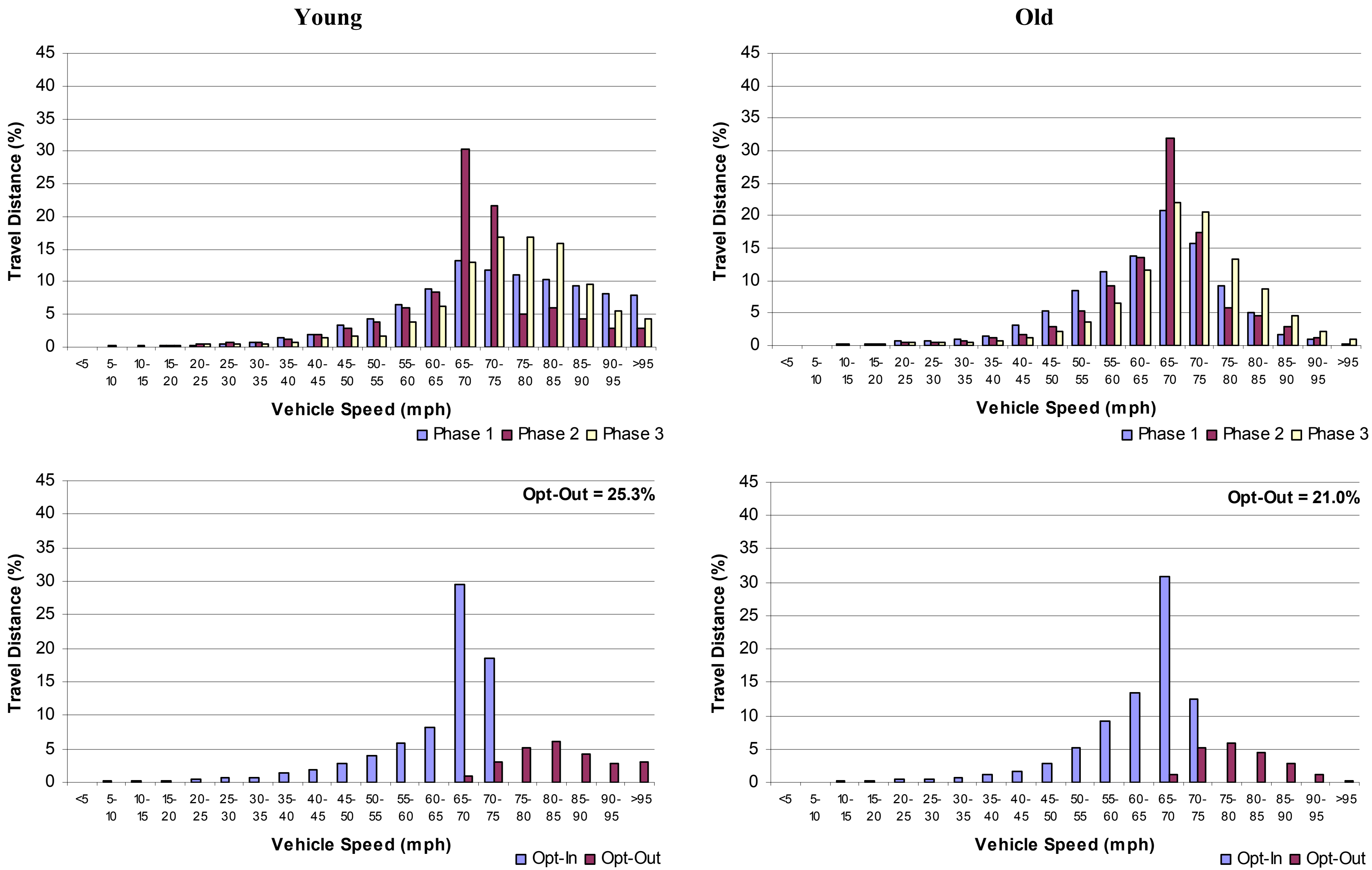


Figure 33: Comparison of the speed distribution in 70 mph zones between age groups

Figure 34 compares the mean and the 85th percentile across trial phases in each speed zone between the two age groups. As previously observed, ISA led to a 'V' shape across trial phases, more prominently in lower speed zones and the 70 mph zones. In addition, younger participants generally demonstrated slight higher mean speeds and higher 85th percentiles than their counterpart on rural roads (i.e. 60 and 70 mph zones). A series of ANOVAs were carried out to confirm the difference across trial phases in individual speed zones; significant results are annotated in Figure 34 while detailed test results are given in Appendix B. ISA appeared to have a greater effect on reducing excessive speeds, especially in the urban areas.

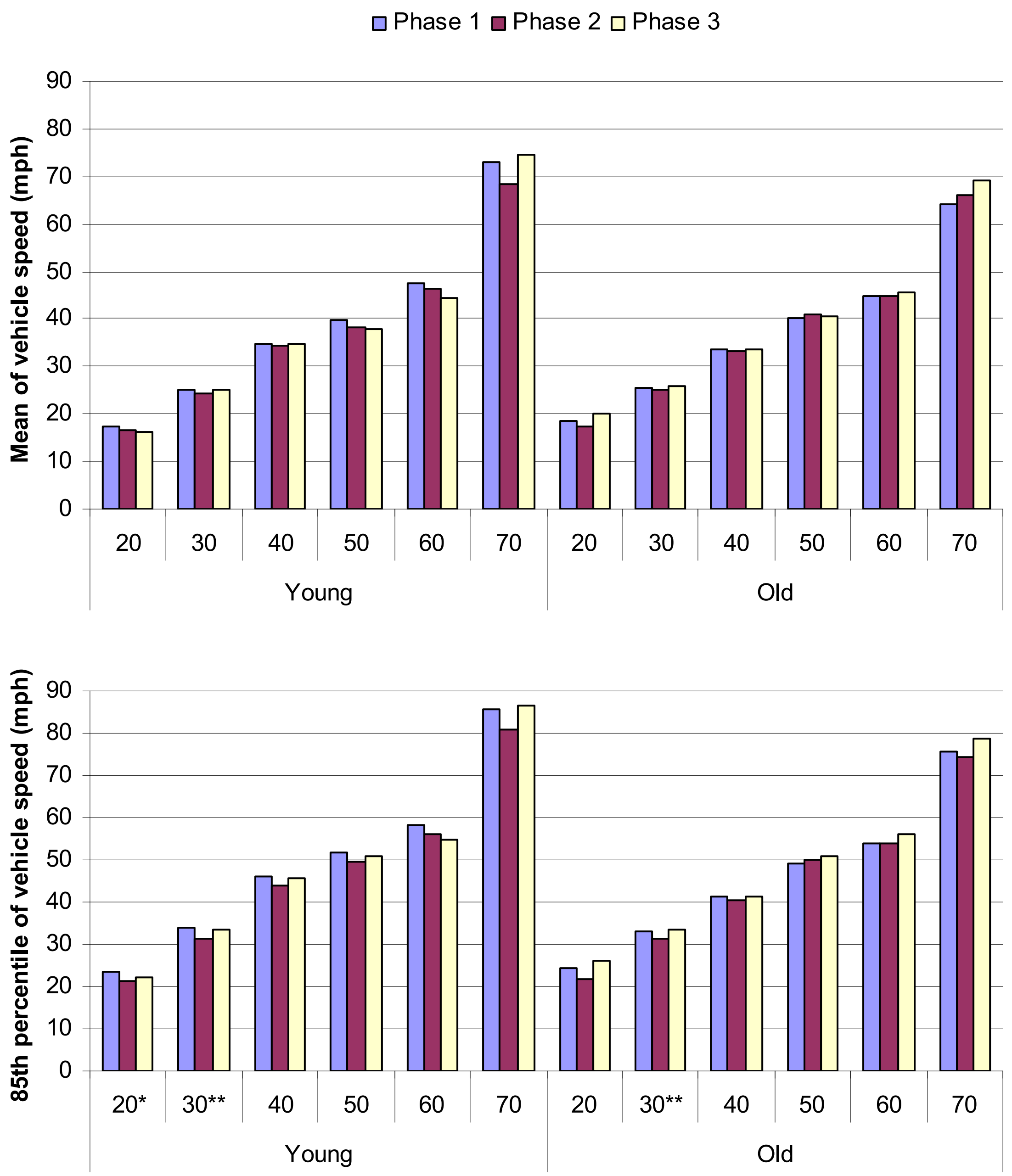


Figure 34: Comparison of key statistics of the speed distribution across trial phases between age groups

3.4.3 Intention to speed

Table 23 depicts a breakdown of vehicle kilometres across trial phases, speed zones and participants' intention to speed, which shows that non-intenders contributed a considerably larger amount of data than intenders. This is considered to be primarily due to the imbalanced number of intenders and non-intenders in this trial (i.e. Table 20 on Page 33). Figure 35 further compares the distribution of travel distance between the two groups, and reveals that non-intenders travelled in urban environment more than intenders (e.g. 30 and 40 mph zones).

Table 23: Vehicle kilometres across intention groups, trial phases and speed zones

Speed zone	Intender			Non-intender		
	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
20 mph	119	342	104	49	152	38
30 mph	4,501	11,019	3,811	10,809	28,025	7,824
40 mph	876	2,335	833	3,515	8,619	2,295
50 mph	673	1,382	384	1,236	2,752	649
60 mph	1,538	3,168	1,240	2,777	6,304	1,349
70 mph	3,474	11,117	2,541	3,108	10,166	2,395
Sum	49,456			92,061		

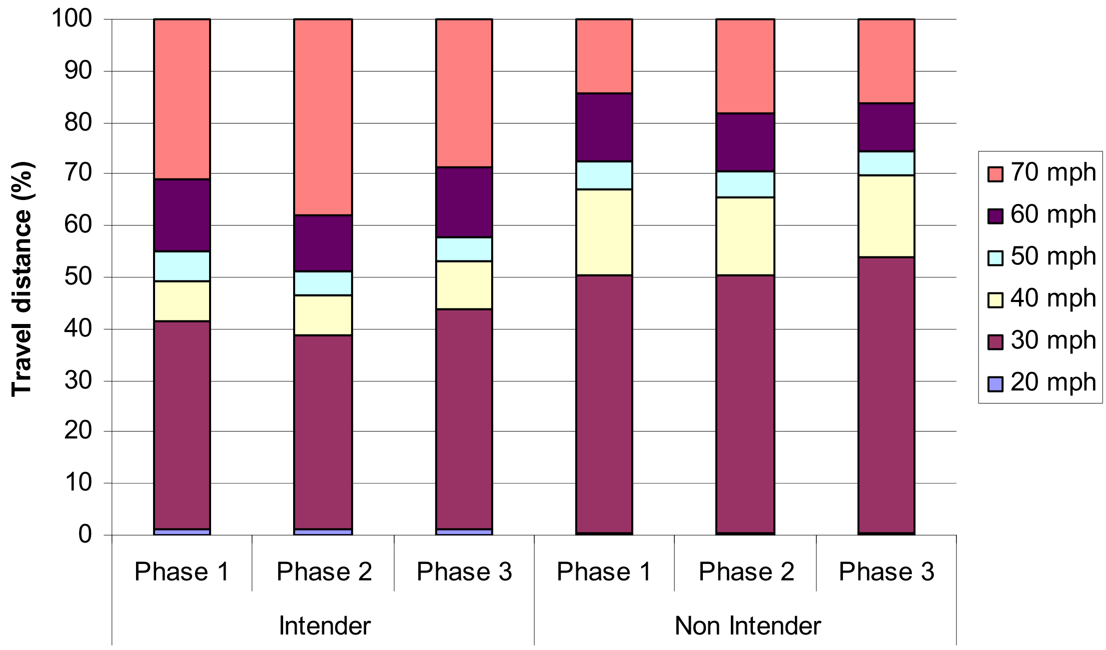


Figure 35: Comparison of patterns of travel distance between intention groups

Figure 36 through Figure 41 compare speed distribution across trial phases between the two intention groups. ISA effectively reshaped the speed distribution for both groups across speed zones but intenders were observed to have overridden the system more frequently than non-intenders in most of the speed zones.

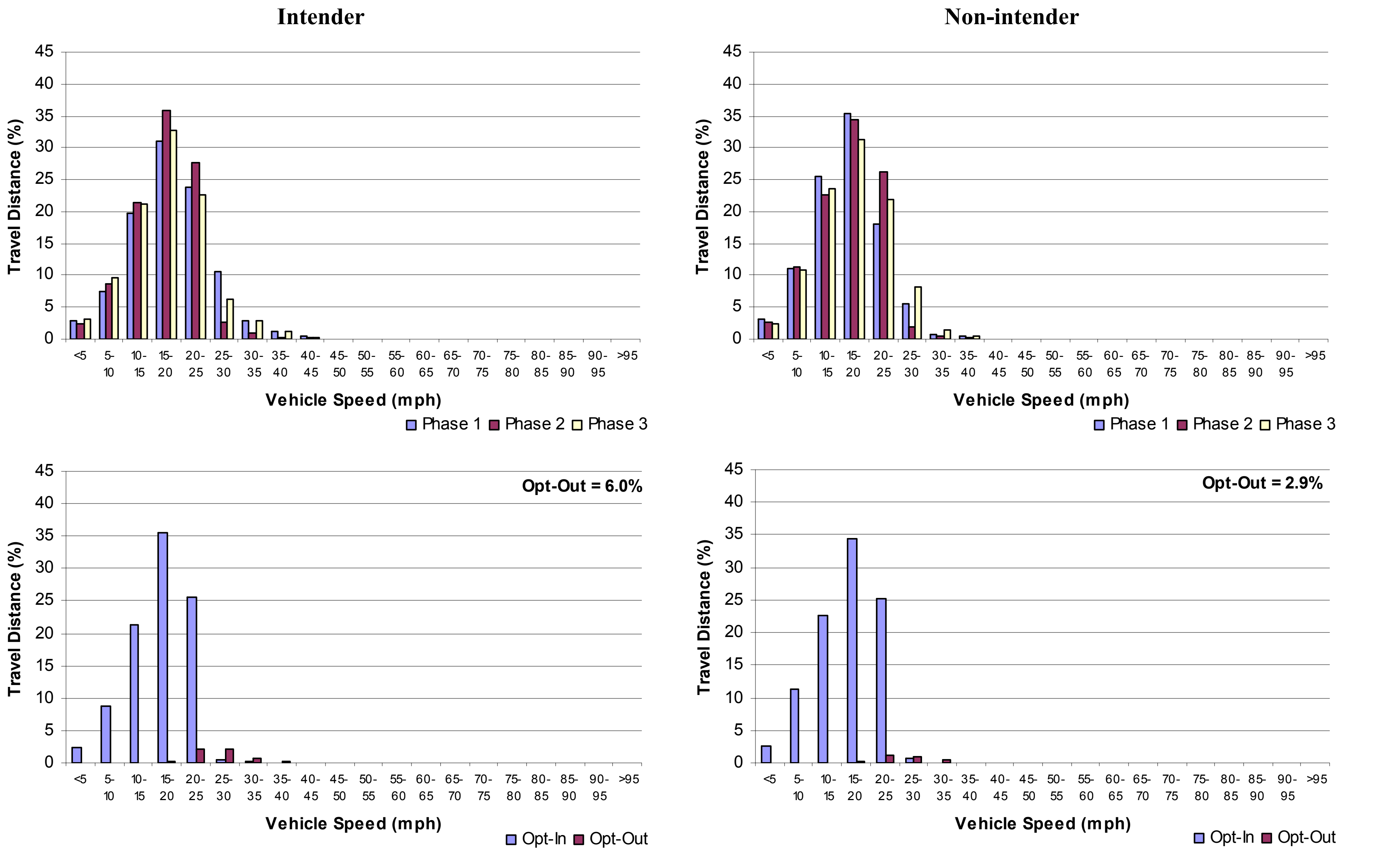


Figure 36: Comparison of the speed distribution in 20 mph zones between intention groups

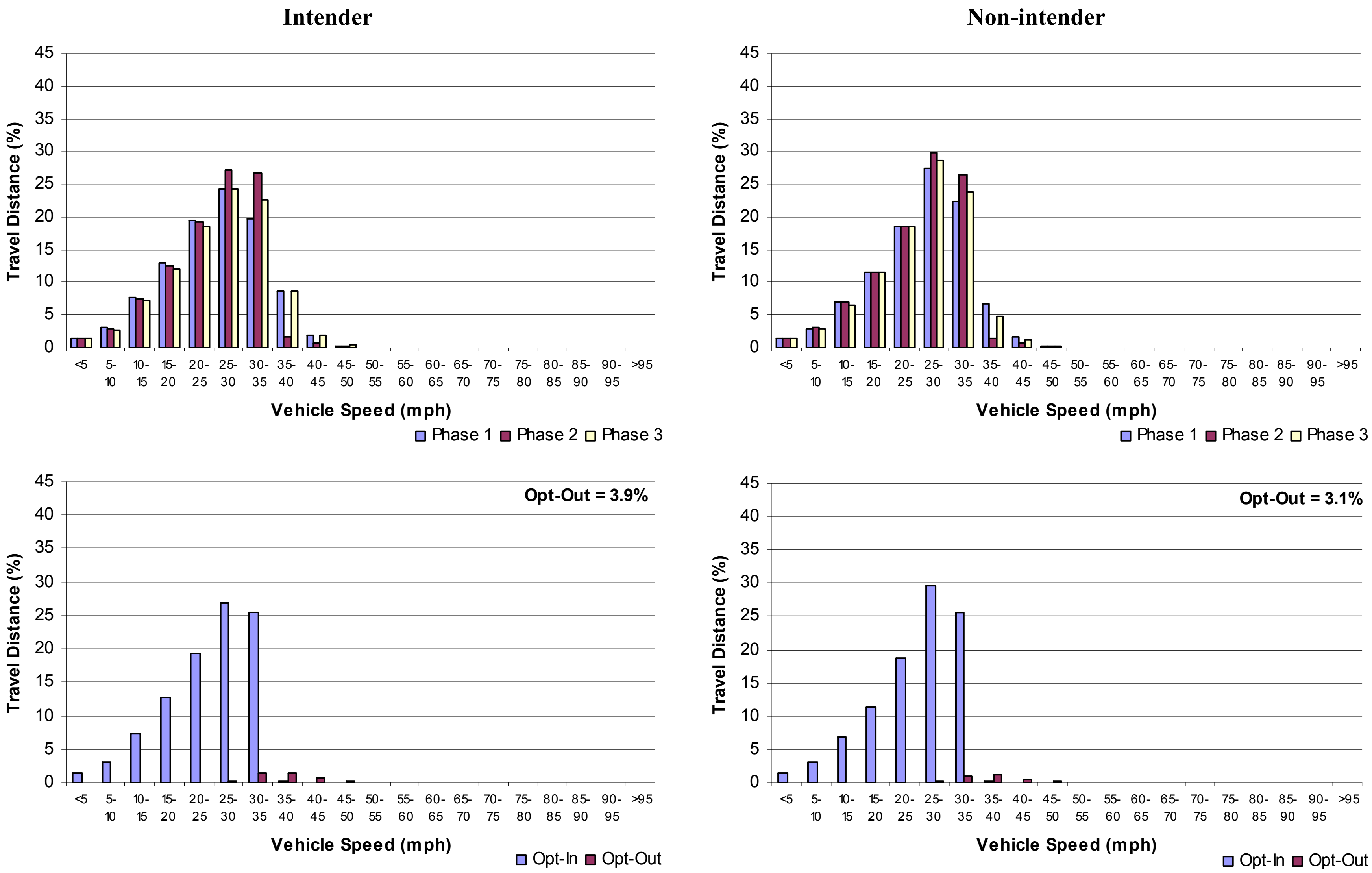


Figure 37: Comparison of the speed distribution in 30 mph zones between intention groups

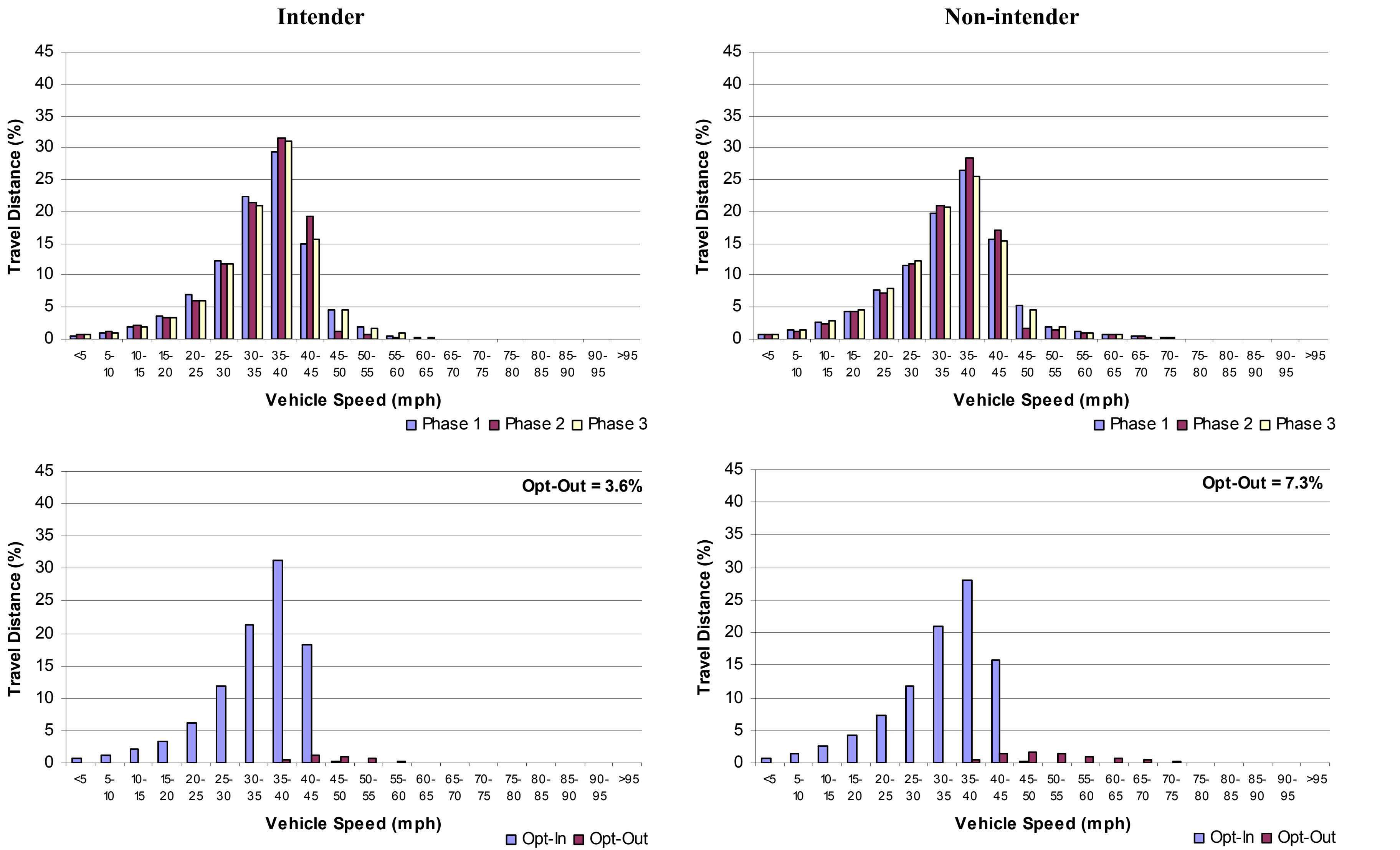


Figure 38: Comparison of the speed distribution in 40 mph zones between intention groups

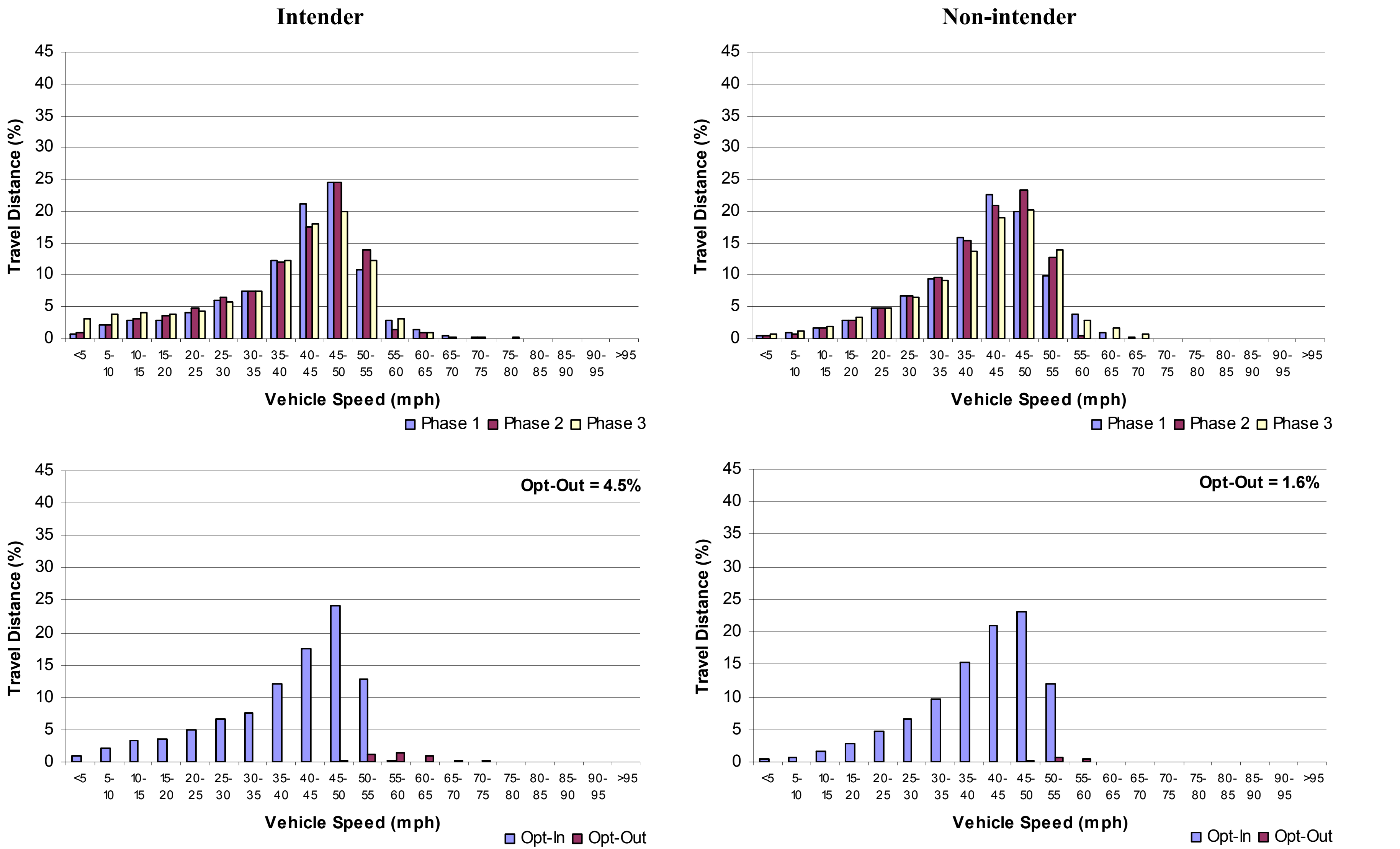


Figure 39: Comparison of the speed distribution in 50 mph zones between intention groups

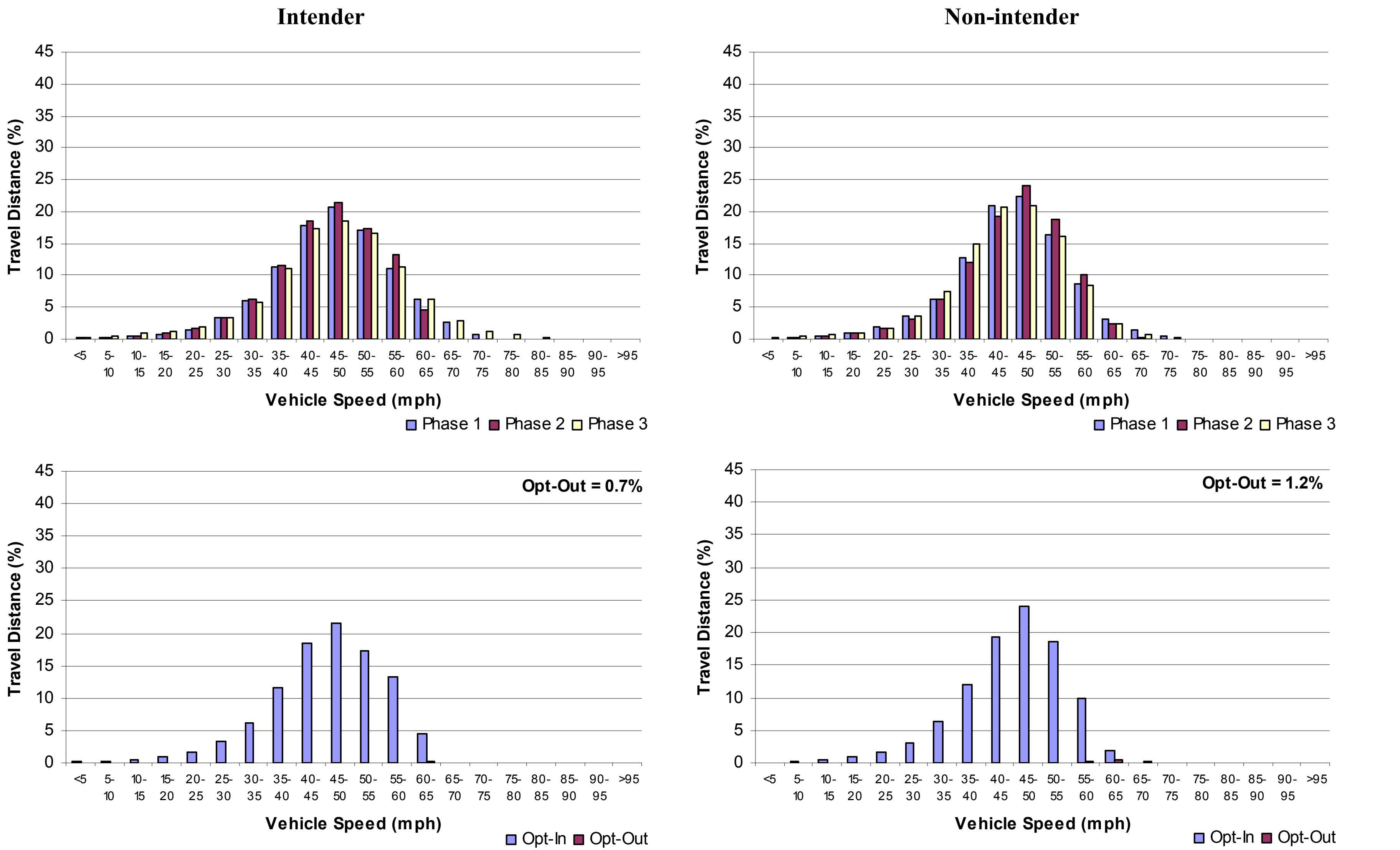


Figure 40: Comparison of the speed distribution in 60 mph zones between intention groups

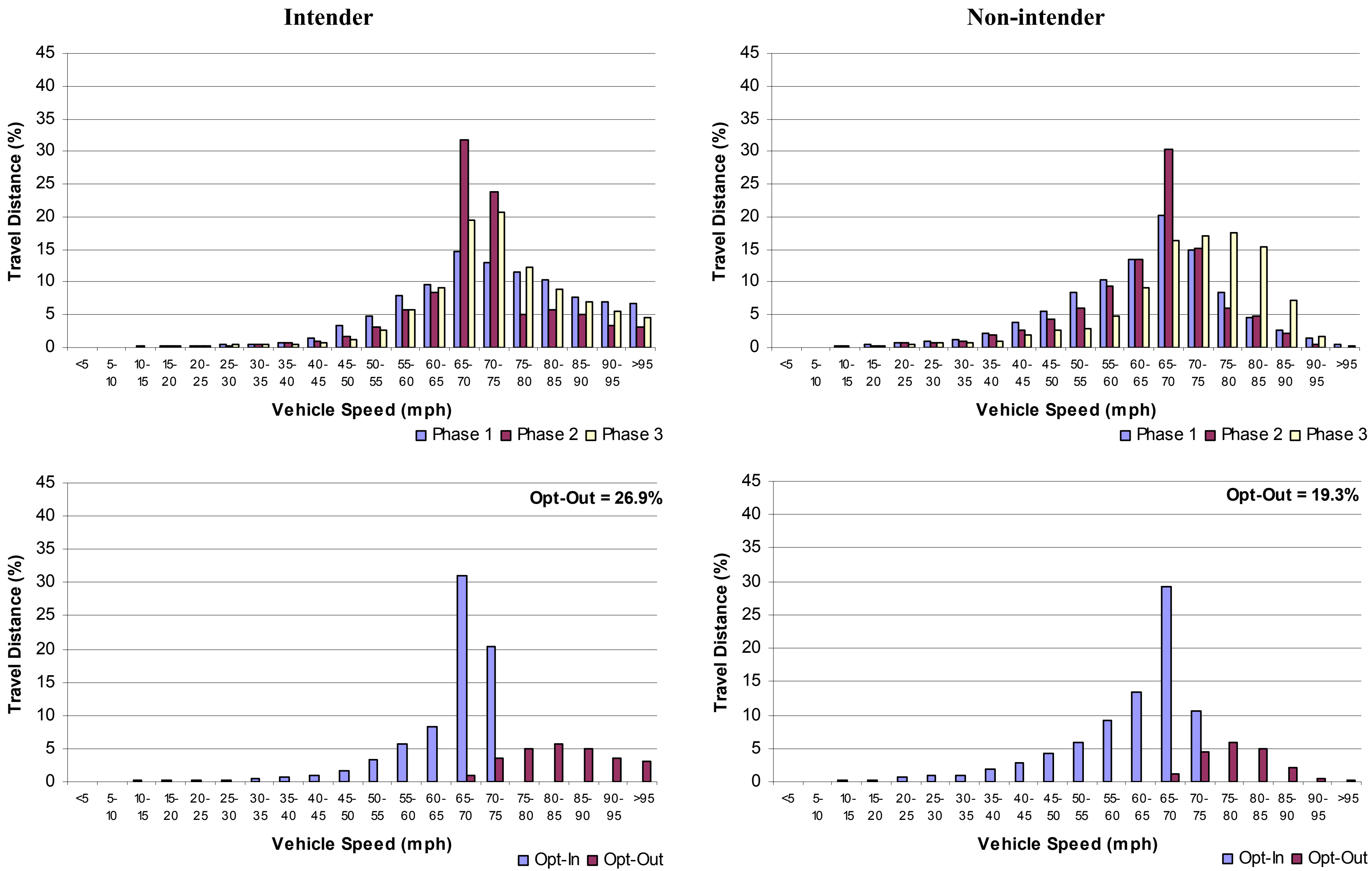


Figure 41: Comparison of the speed distribution in 70 mph zones between intention groups

Figure 42 compares the mean and the 85th percentile speed across trial phases in each speed zone between the two intention groups of participant. Notably, intenders appeared to drive much faster than non-intenders in the 70 mph zones. A series of ANOVA were carried out to confirm the differences across trial phases in individual speed zones; significant results are annotated in Figure 42, although detailed test results are given in Appendix B. As annotated in Figure 42, ISA demonstrated a greater effect on reducing excessive speeds, especially in the urban areas.

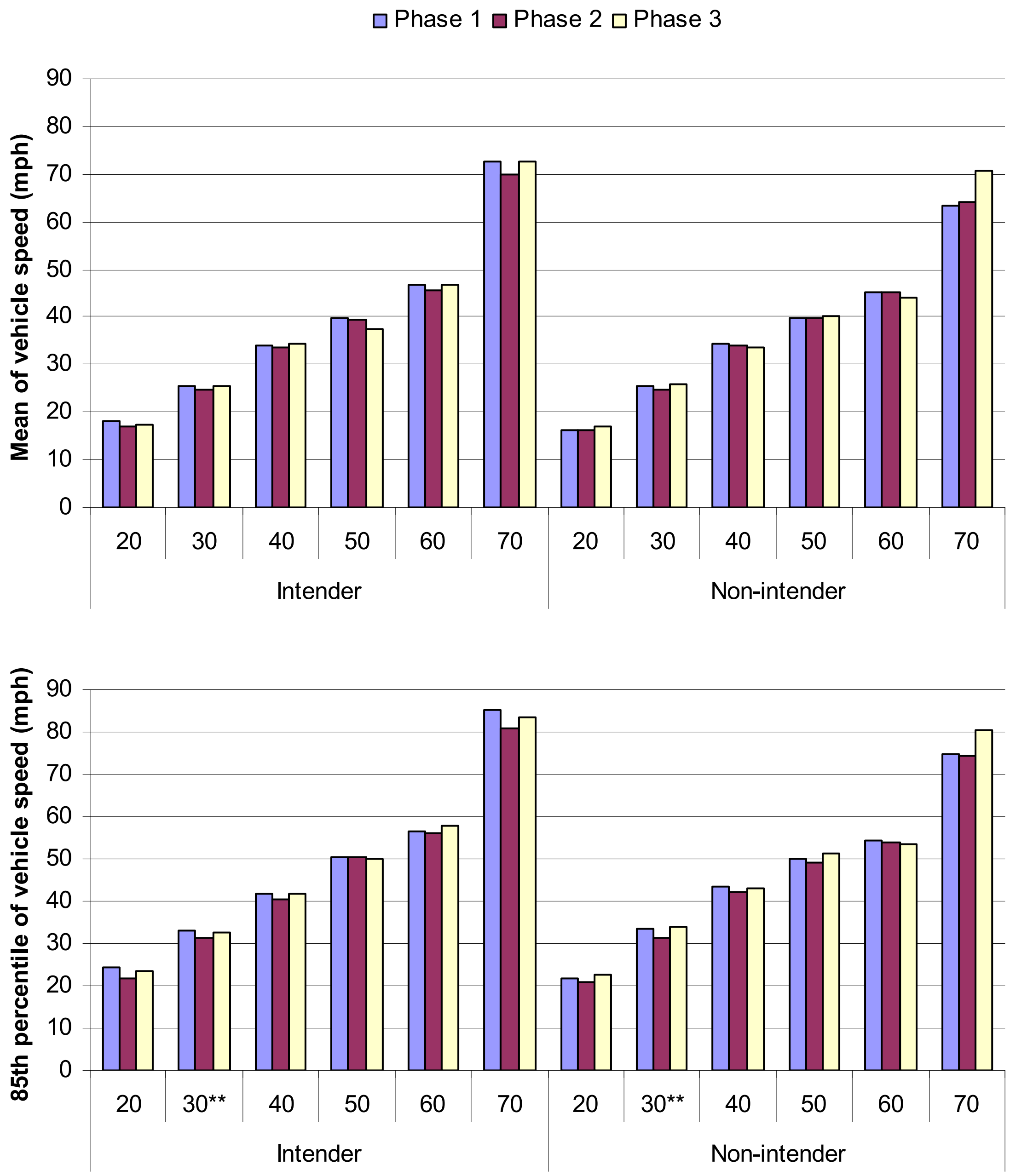


Figure 42: Comparison of key statistics of the speed distribution across trial phases between intention groups

3.4.4 The effect of ISA on demographic groups

As presented in the previous sections, ISA intervention influenced the shape of the speed distribution across demographic groups and led to a 'V' shape on comparison of key statistics across trial phases except a few distortions due to the difference in participants' reference to choice of speed across trial phases. Overriding behaviours were clearly distinguishable across speed zones with respect to each pair of demographic groups. Figure 43 compares participants' overriding behaviour in general, highlighting that younger drivers, male drivers, and intenders overrode the ISA system more often than their counterparts. Considering that these groups of drivers also demonstrated slightly higher mean and 85th percentile values of speed distribution than their counterparts, it seems that ISA was overridden by those drivers who need it most. The effectiveness of the ISA system could therefore be enhanced if compliance within the young, male and intender groups is encouraged and improved.

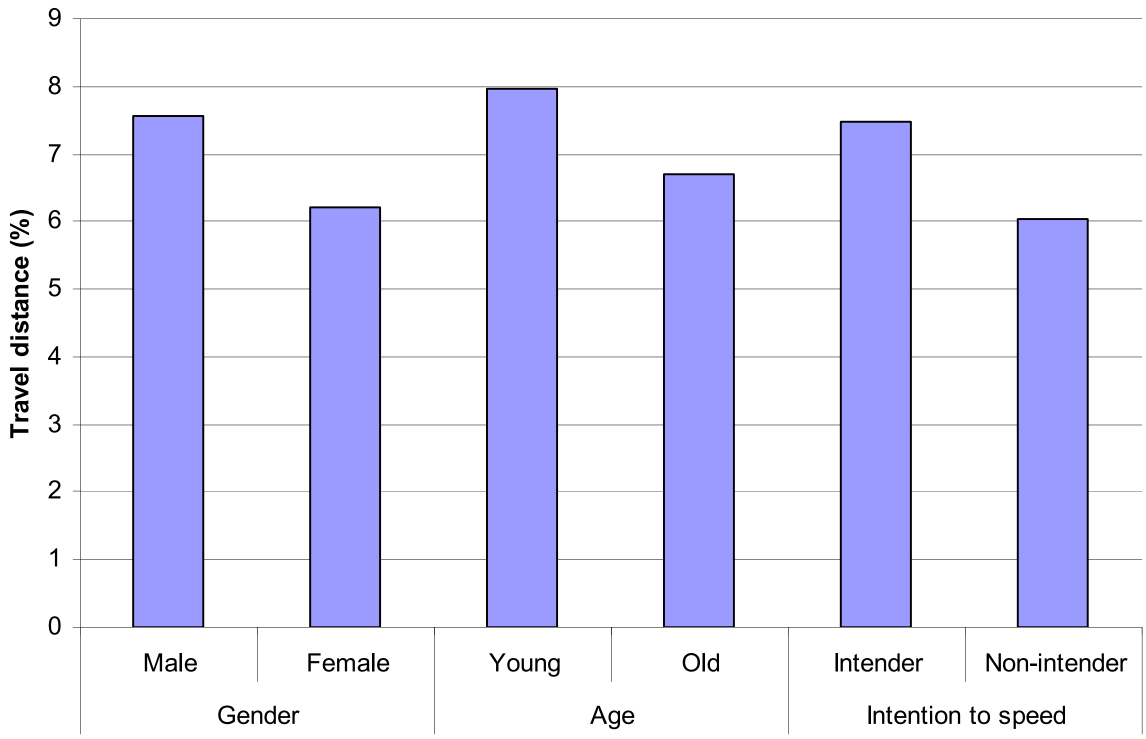


Figure 43: Comparison of overriding behaviour across demographic groups

3.5 Discussion

Based on the analyses presented in this chapter, the ISA system led to a distinctive effect in terms of transformation of the speed distribution. When ISA was switched on, a large proportion of the speed distribution initially spread over the speed limits was shifted to around or below the speed limit.

Most participants were observed to have adapted their reference for their chosen speed between trial phases. During Phase 1 and 3 when the ISA system was turned off, many participants were observed to obey the speed limits with reference to the speedometer reading. During Phase 2, most participants were observed to rely on the ISA system (i.e. throttle feedback) instead of the speedometer reading. This caused a slight distortion in Phase 2 that some data cluster within the higher speed band immediately next to the legal speed limits. Nevertheless, the trial results undoubtedly demonstrate the effectiveness of the ISA system on reshaping speed distribution.

The changes in speed distribution as a result of ISA intervention were confirmed by statistical test results. The results also indicate that ISA intervention was more effective in reducing excessive speed than mean speed, especially in lower speed zones where vulnerable road users are usually involved in road accidents. This is demonstrated by larger effect sizes derived from the 85th percentiles than from the mean speeds across speed zones (i.e. Table 16 in Section 3.3.5). Since injury severity is related to speed reduction (Nilsson, 1981), the cut-down of excessive speed delivers promising implications to road safety.

The effect of ISA intervention on reshaping of the speed distribution was less prominent in the 60 mph zones, where speeding behaviour had already rarely been observed even in the absence of ISA. This is primarily due to the constrains on driving speed imposed by road geometry, as the 60 mph speed limit is applicable to most rural roads where the layout is usually single carriageway with a mixture of geometric profiles.

The ISA system not only diminished excessive speeding, but also led to a reduction in speed variability (i.e. Table 17 in Section 3.3.6). The reduction in speed variability promises positive implications to a reduction in accident occurrence, as speed variability is related to accident rate (Taylor et al, 2000). In addition, the ISA system has reduced the probability of jerk occurrence, which implies that driving with ISA is less likely to be involved in serious traffic conflicts in comparison with driving without ISA, as it has been widely argued that braking is the most common evasion manoeuvre in traffic conflicts, ranging from 63% to 98% of traffic conflicts (van der Horst, 1984; Hyden, 1987; Garder, 1990; Hantula, 1994).

The current design of an overridable system also highlights the value of a mandatory ISA system or incentives to encourage compliance with the ISA system. Moreover, it was revealed that male drivers, younger drivers and drivers who intend to break speed limits overrode the system more often than their counterparts. Given that the three groups of participants also demonstrated a slightly higher mean and the 85th percentile speed than their counterparts, improved compliance from these groups of drivers will no doubt enhance the effect of ISA diminishing excessive speed on the roads.

4. ANALYSIS OF QUESTIONNAIRE DATA

4.1 Introduction

In both the laboratory and real-road drives in the EVSC project, participants were considerably more hostile to mandatory ISA than to voluntary ISA. This hostility was somewhat reduced after driving with the system, but was by no means eliminated (Comte, 1999).

It is unlikely that Mandatory ISA could be introduced without general public support. Currently, opinion regarding such a system is not particularly favourable. According to the 1998 Lex survey of British motorists, 27 percent of the driving public would find automatic adjustment of speed to the prevailing limit to be very useful, as compared to 54 percent finding systems warning of congestion or bad weather to be very useful (Lex, 1998). In the 1997 survey, 17 percent of the responding drivers supported the installation of speed limiters on cars. This number compares with 24 percent supporting more speed bumps and 55 percent supporting the wider use of speed cameras (Lex, 1997).

However, it should not be forgotten that, prior to the introduction of legislation for the compulsory wearing of seatbelts in front seats, there was considerable opposition to the measure. Public opinion was only won over during the consequent media debate. Traffic calming has gone through a similar change: when first introduced it was widely opposed by local residents; now it is demanded by residents and tolerated by drivers.

There are also more theoretical grounds for believing that behavioural measures may be able to change attitudes. Spanish research on drink-driving, applying the Theory of Reasoned Action (Fishbein and Ajzen, 1975), has shown that beliefs about the consequences of driving under the influence of alcohol become more favourable with the frequency of driving under the influence in the previous six months. Similarly, drinking intensity was shown to make attitudes towards driving under the influence more favourable (Tejero Gimeno et al., 1997). From this one can conclude that *habituated behaviour* influences *attitudes* rather than the other way round, i.e. people construct a set of attitudes to justify their normal behaviour.

From this, it is possible to hypothesise that, with long-term exposure to ISA; driver attitudes will become more favourable. If confirmed, this could be a very important pointer to changes in public attitudes with increasing exposure to voluntary ISA. It could also be an important contribution to the continuing debate of how best to reduce driver propensity to commit violations on the road.

The Theory of Planned Behaviour (TPB: Ajzen 1985, 1988, 1991) was therefore used as a model for evaluating changes in attitudes to speeding and ISA as result of using the system for an extended period of time.

The TPB provides a parsimonious, deliberative processing model (Conner and Sparks, 1996) which advocates that intentions and perceived behavioural control (PBC) are the proximal determinants of behaviour. Intentions reflect the cognitive representation of an individual's readiness to perform a given behaviour (Ajzen, 1991). PBC describes the individual's perception of the ease or difficulty of performing any given behaviour (Ajzen, 1991).

As intentions and PBC are held to be direct antecedents of behaviour, the model also states that intentions are influenced by three additional factors. Attitudes, subjective norms and PBC are direct determinants of intentions:

- Attitudes towards a behaviour reflect the degree of positive or negative evaluation the individual has towards performing the behaviour.
- Subjective norms refer to the perceived social pressure to engage or not engage in a behaviour. These are understood to be the sum of normative beliefs concerning what salient referents believe about the individual enacting the behaviour, weighted by the individual's motivation to comply with this group, summed across the salient referents.
- PBC again reflects the perceived ease or difficulty of undertaking a given behaviour. An individual's perception of control is assumed to be the product of the individual's evaluation of factors likely to facilitate/inhibit the performance of a behaviour and the frequency of their occurrence. These control beliefs can be both internal and external in their nature. As the relative importance of intentions and PBC in predicting behaviour can differ across behaviours and populations, so too can the importance of attitudes, subjective norms and PBC in the prediction of intentions.

Figure 44 provides a schematic representation of the TPB.

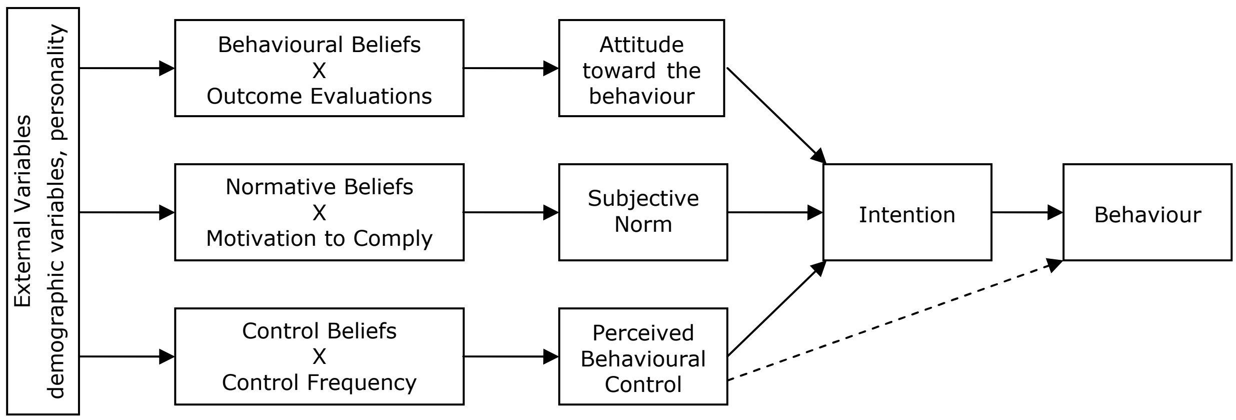


Figure 44: The Theory of Planned Behaviour (Ajzen, 1988)

Since the early 1990's research has examined the TPB and drivers propensity to speed (Lawton, Parker, Manstead and Stradling, 1997; Lawton, Parker, Stradling and Manstead, 1997; Parker et al., 1992a; Parker, Manstead, Stradling and Reason, 1992b; Parker, Stradling and Manstead, 1996), dangerously overtake (Parker et al., 1992a; Parker et al., 1992b; Parker, Manstead and Stradling, 1995), drink and drive (Parker et al., 1992a; Parker et al., 1992b), follow closely (Parker et al., 1992a; Parker et al., 1992b), recklessly weave (Parker et al., 1995), recklessly cut in (Parker et al., 1995), run red traffic lights (Manstead, Parker, Stradling and Lawton, 1996), flash at vehicles in front (Manstead et al., 1996) and engage in retaliatory/initiatory violations (Parker, Lajunen and Stradling, 1998).

Research within the driver behaviour domain has also sought to extend the TPB model, including variables such as past behaviour, moral norm and anticipated regret. Several authors have noted the impact of past behaviour upon subsequent behaviour. In a review of 12 intention related studies and five behaviour related studies, Conner and Armitage (1998) concluded that on average, past behaviour explained a further 7.2% and 13% of the variance in intentions and behaviour, respectively. Within the driver domain, habit has been reported as a strong predictor of intention to speed and reported speeding behaviour (Manstead and Parker, 1996). Elliot, Armitage and Baughan (2002) argue that habit may act as a moderator between TPB variables and behaviour, suggesting that drivers with a weak habit to comply with the speed limit base their intentions on attitudes, subjective norms and PBC to a greater extent than drivers with a strong habit to comply. Those such as Beck and Ajzen (1991) and Randall and Gibson (1991) advocate the inclusion of moral norm within the TPB model. Moral norm refers an individual's internalised moral rules or feelings of responsibility. The inclusion of anticipated regret (anticipated affective reaction to the behaviour; see van der Plight and de Vries, 1998) has also received strong support. Parker et al (1995) demonstrated that the addition of these personal norm measures improved the prediction of intention to cut in, recklessly weave and recklessly overtake by between 10.1% and 15.3%. Both moral norm and anticipated regret are believed to be especially relevant, since committing driving violations is a socially undesirable behaviour that may evoke anticipatory feelings of negative or indeed positive affect. Risk perception refers to an individual's evaluation of the risk involved in performing a given behaviour. An individual's perception of their societal role (i.e. their self-identity) has also been found to be independently predictive of individual intentions (see Conner and Armitage's review, 1998). To the best of our knowledge, the role of self-identity has not been assessed within driver behaviour research.

Speeding, unsurprisingly, has been the focus of several TPB studies. Parker et al (1992a) concluded that the performance of the TPB was reasonable, explaining 49.1% of the variance in intention to speed. PBC was identified as the single most important predictor of intentions to speed. Drivers, particularly young males, demonstrated a lesser ability to refrain from speeding, reporting significantly weaker intentions and control over not committing the violation and perceiving significant others to have weaker negative expectations compared to their counterparts (Parker et al., 1992b). Speeding appears to be a social behaviour in which risks are based upon the individuals' perceptions of control and expectations of others and rather less on personal attitudes. Intentions to speed are held to be a function of the driver's assessment of the "reasonableness of a speed limit in a particular context" (Lawton et al., 1997, p. 162). The driver deliberately takes risks.

Primarily the TPB will used as a model to monitor changes in drivers' propensity to exceed the speed limit and disengage the system as a result of experience with ISA. Following the successful completion of all four field trials however, the sample size should also be sufficient to examine the proximal determinants of speeding. Although previous work has explored the theoretical underpinnings of the motivation to speed, conclusions drawn are based upon the prediction of intention to speed. To our knowledge, no previous study has examined the relationship between intention to speed and actual speeding behaviour in an instrumented vehicle. The link between intention and behaviour is certainly well documented (see Armitage and Conner, 2001) for other behaviours but the reliance upon self-report measures within the driver behaviour domain renders their validity subject to the question of social desirability bias. Although speeding has been socially constructed as a 'non-crime' (Corbett, 2000), within the experimental situation drivers may under or over estimate their involvement in speeding violations. The present project will test the predictive utility of the TPB with respect to speeding across three classes of road (motorway, urban, and residential roads) and the addition of measures of moral norm, anticipated regret, past behaviour, risk and self identity will test the sufficiency of the central components of the TPB model.

Analysis based on this trial however was limited given the small sample size and thus concentrated on the change in key TPB constructs following experience of the ISA system.

4.2 Analysis on the Theory of Planned Behaviour

As mentioned earlier, completion of the four field trials will allow an evaluation of any changes in attitudes to speeding and ISA as a result of using the system and also test the predictive utility of the TPB. The sample size however is currently too small to attempt the latter. In order to examine changes in the TPB constructs over time and scenarios it would be most appropriate to perform a MANOVA. However given the limited sample this test would prove inappropriate. Comparisons have therefore been made across time on a construct by construct and scenario by scenario basis using a series of repeated measures ANOVAs (see Appendix B). Although this test is regarded as more resilient, the limited sample size compromises the results and makes it difficult to draw any strong conclusions. Given the number of missing responses, the sample size is reduced further in comparison to previous trials. Consequently between subject factors were not included within the analysis. Constraints here also mean that it has been impossible to include other personality measures such as sensation seeking and conscientiousness. As the sample size increases from the subsequent trials the analysis will become more sophisticated and robust.

Figure 45 highlights the change in intentions over time for each scenario. The TPB proposes that intentions predict behaviour. Across the road categories, participants' intentions to exceed the speed limit were weakest for the residential road scenario where pedestrians and potential hazards are at their greatest. There were no significant differences in intention scores over time for any scenarios. Nevertheless, the overall trend suggested that participants were less likely to intend to exceed the speed limit following early experience with the system. This trend was sustained to some extent following prolonged experience with the system and intentions remained slightly weaker than those initially expressed. With respect to the disengage scenario, intentions to disengage the ISA system were relatively low during Phase 1 when participants had no experience of the system. Although differences over time were minimal and intention scores remained negative suggesting that the desire to override the system was weak, the mean trend does suggest that experience with the system increased participants' intentions to disengage the system. Results here may reflect participants' response to a number of inaccuracies within the map.

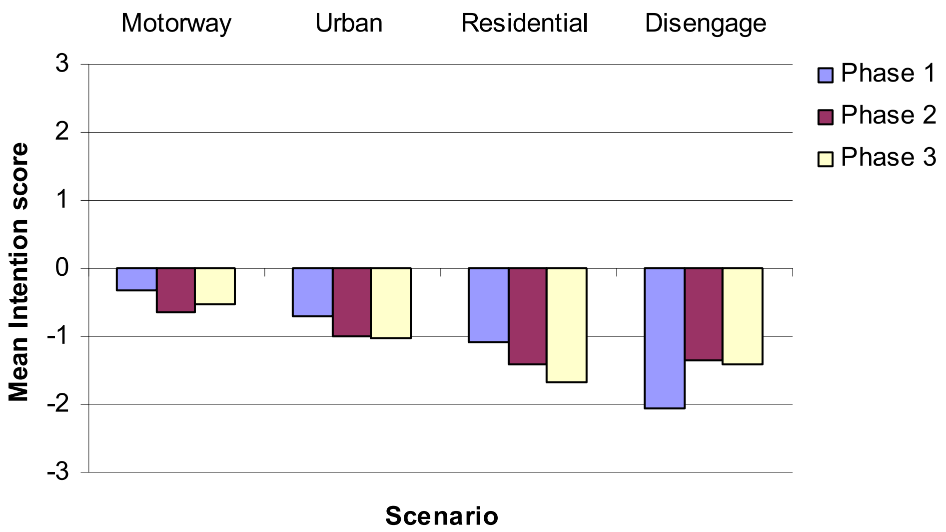


Figure 45: Mean intention scores by scenario

Participants held negative attitudes towards exceeding the limit on all road categories (see Figure 46). Attitudes towards exceeding the speed limit on a motorway and disengaging the system were the least negative. This may reflect participants' disagreement with the legal speed limit for motorways and suggest speeding is deemed most acceptable on this road category. Similarly, inaccuracies in the map may have favourably increased participants attitudes towards disengaging the system. Attitudes became less favourable towards speeding across all road categories although this was most evident for the motorway scenario. Differences across means for the scenarios were extremely small however and little meaning should be attributed to these.

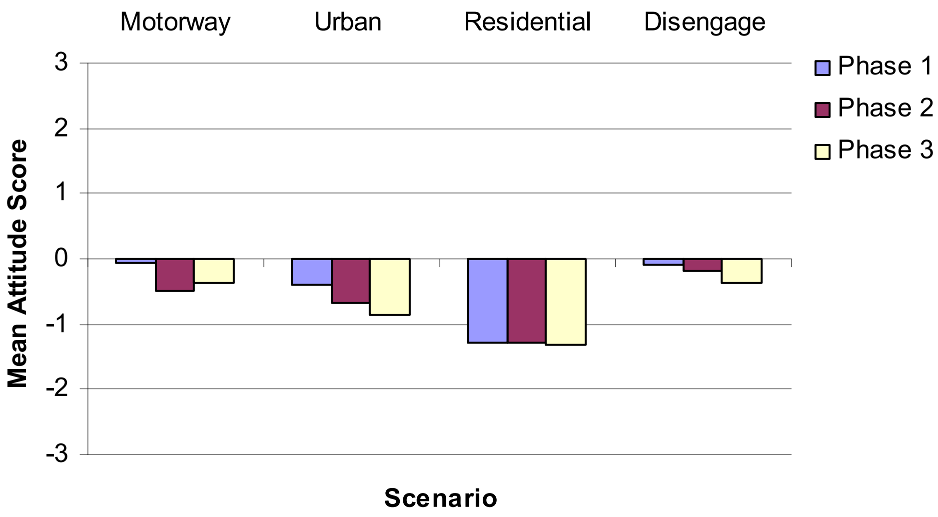


Figure 46: Mean attitude score by scenario

Behavioural belief scores provided an indirect measure of participants' attitudes towards exceeding the speed limit and disengaging the system. Repeated measures ANOVAs did not reveal any significant differences over time for the motorway, urban, residential or disengage scenario. However it is of more interest to look at the individual behavioural belief scores rather than the composite mean scores in order to gain an overview of the beliefs that may be amenable to safety campaigns. Again however differences over time are minimal and interpretation should be treated with care.

Comparisons across the three speeding scenarios suggest that participants believed they would feel anxious speeding on all roads. During Phase 2 participants were slightly less likely to believe speeding would make them feel anxious (except for motorway scenario). When the system was removed however, participants believed that speeding would make them feel more anxious than they had initially thought. Initially, participants disagreed that exceeding the speed limit would make them *feel good*, but, as the freedom to speed was withdrawn, this belief weakened (except for urban scenario). Mean scores remained negative, but became less negative over time. Participants appeared to realise that exceeding the speed limit did, in some ways make them feel good.

Figure 47, Figure 48 and Figure 49 suggest that, in general, participants tended to believe that they were less likely to be *stopped by the police* or *prosecuted and fined* following experience with the system. Similarly, participants tended to believe that speeding in all scenarios was slightly less likely to be *against the law* following experience with the ISA system. Participants' beliefs that exceeding the speed limit would *save time*, enable them to *make rapid progress* and *get them to their destination on time* generally tap into participants perception of their journey times. On the whole, participants' beliefs weakened following experience with the system. Participants experience with the ISA system educated them that driving above the legal speed limit does not necessarily reduce journey time. Having gained experience of the system participants were also less likely to believe that exceeding the speed limit would *irritate other drivers* although for the urban and residential scenario removal of the system served to reverse this belief. For the motorway scenario, experience of the ISA system strengthened the belief that speeding would risk causing an accident. Surprisingly for the urban and residential scenario this belief was weakened following experience with the system.

Overall comparisons of these behavioural beliefs provide useful societal beliefs that can be encouraged and enhanced to reduce speeding and also negative beliefs that must be tackled and corrected. Given that the behavioural belief scores for the disengage scenario range only from −0.95 to +1.38, any differences noted are minimal and beliefs are on the whole relatively neutral. The ISA intervention did not influence behavioural belief scores and trends shown below should be interpreted with caution.

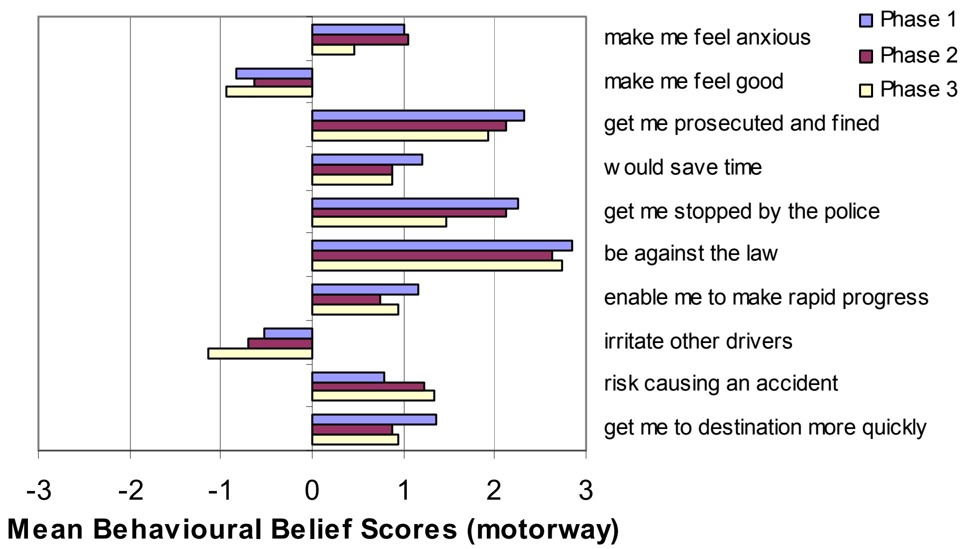


Figure 47: Mean behavioural belief scores for motorway scenario

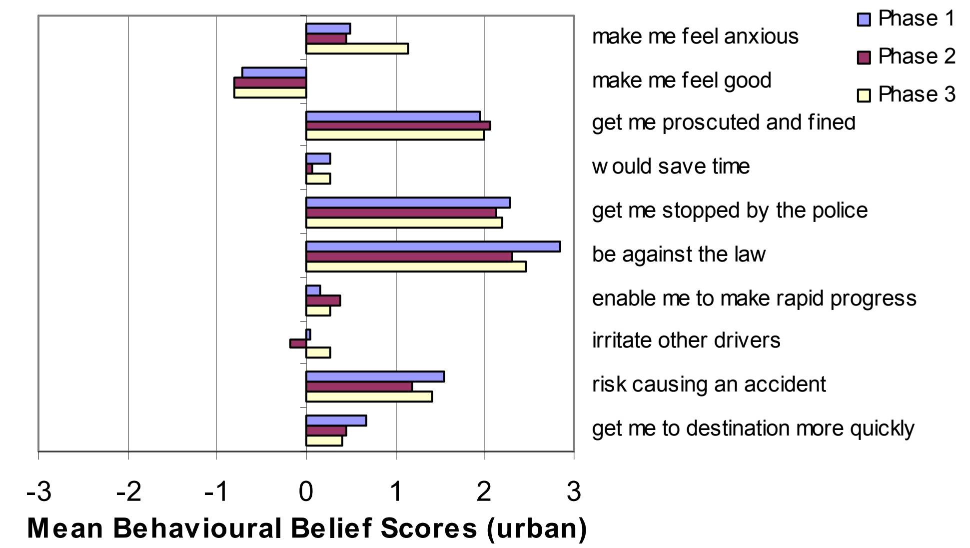


Figure 48: Mean behavioural belief scores for urban road scenario

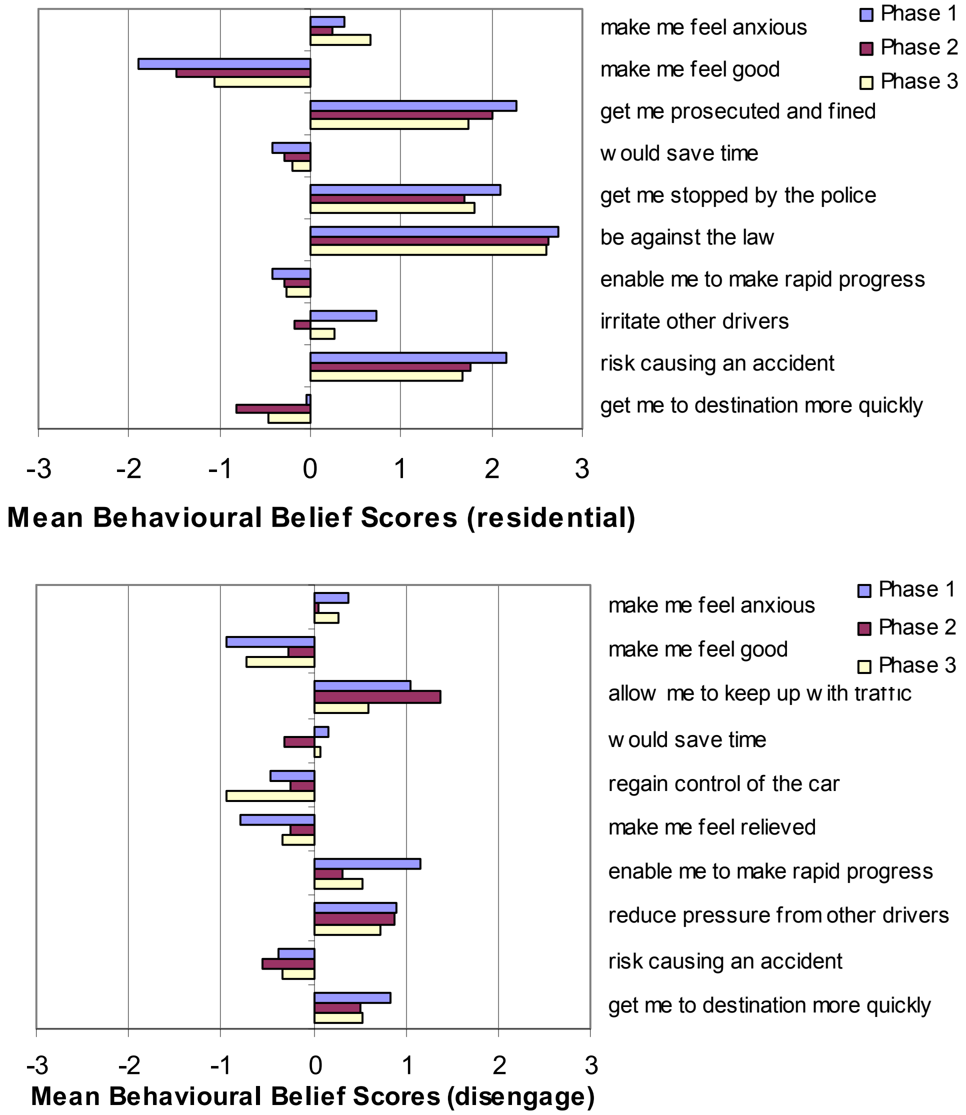


Figure 49: Mean behavioural belief scores for residential road scenario

Figure 50 highlights that participants were unlikely to believe disengaging the system would make them *feel anxious* following experience with the system. During Phase 2 participants were more likely to believe that disengaging the system would *allow them to keep up with the traffic* but unlikely to believe it would *save time* or allow them to *make rapid progress*. They were unlikely to believe that disengaging the system would *risk causing an accident*.

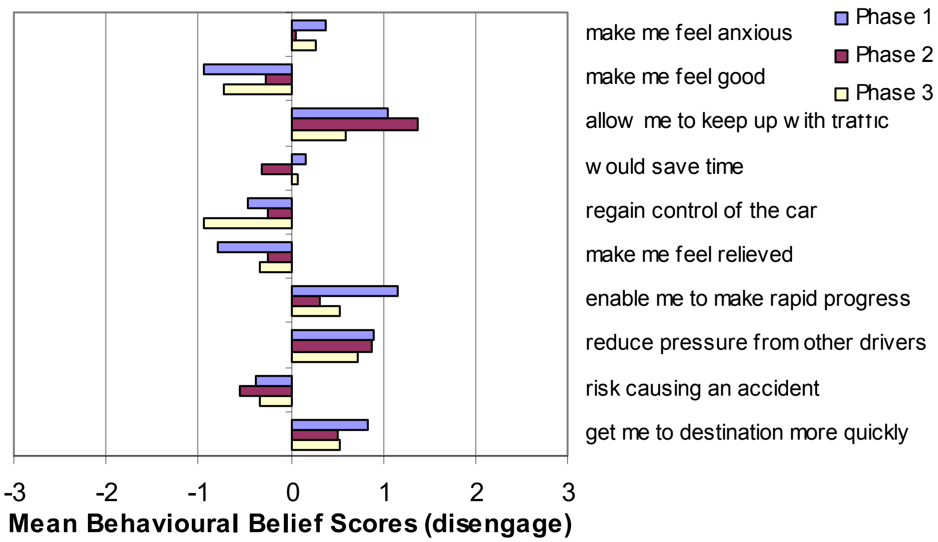


Figure 50: Mean behavioural belief scores for the disengage scenario

Perceived pressure from significant others decreased during Phase 2 across all scenarios (see Figure 51). It appears that during the ISA phase participants felt their significant other were *less* likely to disapprove of them exceeding the speed limit or disengaging the system. Differences may again be attributable to a shift in participants' definition of speeding. Participants may have felt that significant others would disapprove of excessive speeding but when limited to the speed limit they may have believed that significant others would not have disapproved of driving a certain percentage above the speed limit. During Phase 3 perceived pressure increased following the removal of ISA. Differences were again marginal however and there were no significant differences in normative pressure scores over time for any of the scenarios.

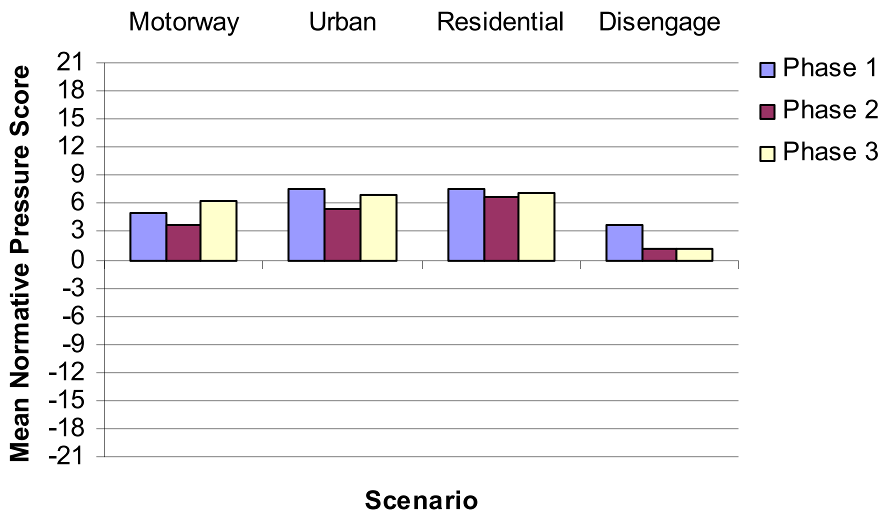


Figure 51: Mean normative pressure score by scenario

As can be seen in Table 24**,** the police were the most influential referent. It is important therefore that either a direct or indirect police presence is maintained. Implications for successful campaigns are discussed later.

Table 24: Mean motivation to comply scores over time

Referent Group	Phase 1	Phase 2	Phase 3
Police	5.84	5.53	5.47
Other road users	4.16	3.71	3.60
Family	4.79	4.47	4.67
Friends	3.68	3.65	4.33
Spouse/partner	5.22	4.65	5.07

Figure 52 shows that there were no significant differences in PBC scores over time for the road scenario. Surprisingly however the mean trend would suggest that participants' perceived control increased during phase 2 when restricted to the speed limit. A significant difference was found across participants ratings for the disengage scenario. Post hoc analysis revealed a significant increase in PBC from Phase 1 to Phase 2; participants felt they were in greater control of their ability to disengage the system during Phase 2 compared to previously driving without ISA. This is perhaps a reflection of the participants' realisation of the ease at which they could override the system. Since participants were not instructed on the functionality of the system during Phase 1 they may have believed that overriding the system would be difficult and cumbersome.

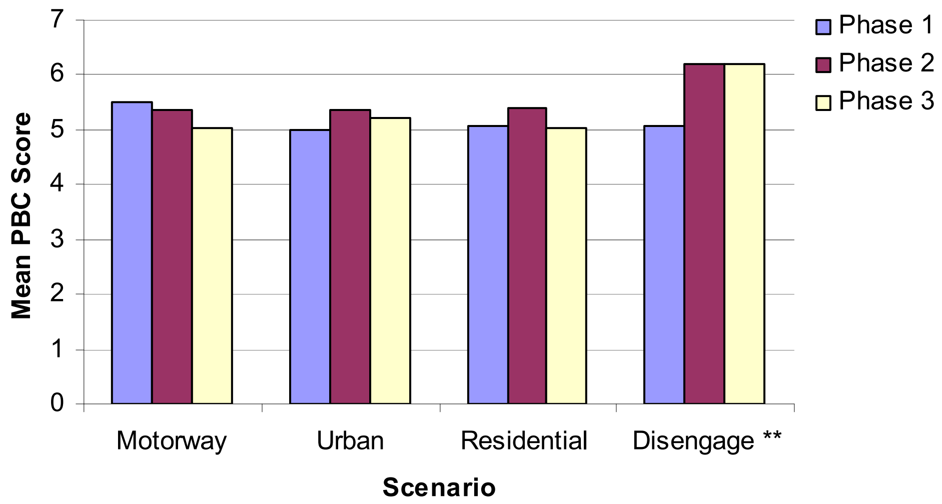


Figure 52: Mean perceived behavioural control score by scenario

Figure 53, Figure 54, Figure 55 and Figure 56 provide a comparison of the stated control factors over time and scenarios. As can be seen the majority of control factors were generally seen as inhibiting participants' propensity to speed and disengage the system, except for *being in a hurry*, where this was seen to facilitate speeding. Participants felt they were more likely to speed when they were in a hurry. They were also more likely to disengage the system when they were in a hurry or driving with a passenger.

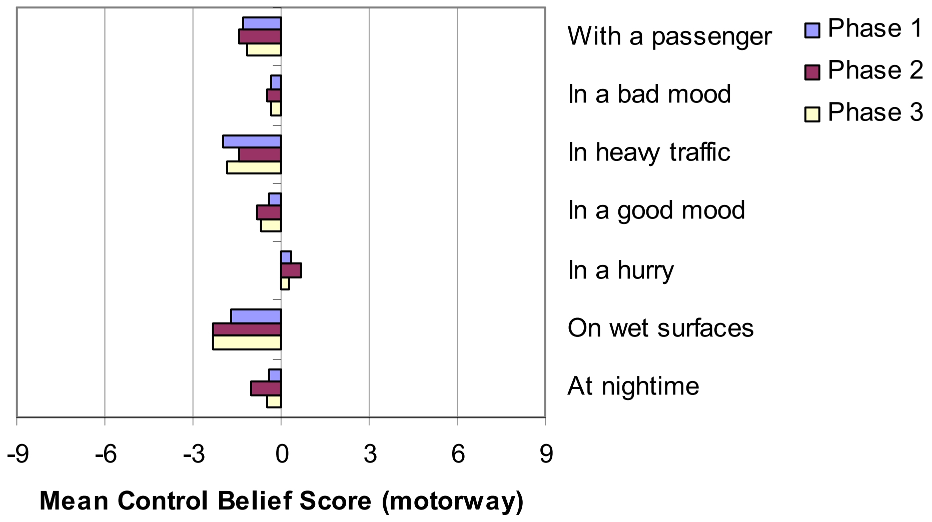


Figure 53: Mean control belief scores for motorway scenario

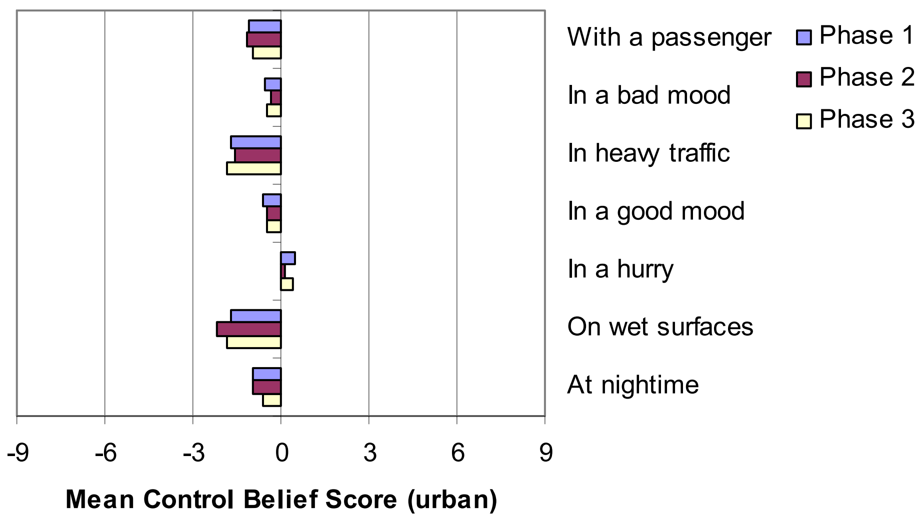


Figure 54: Mean control belief scores for urban scenario

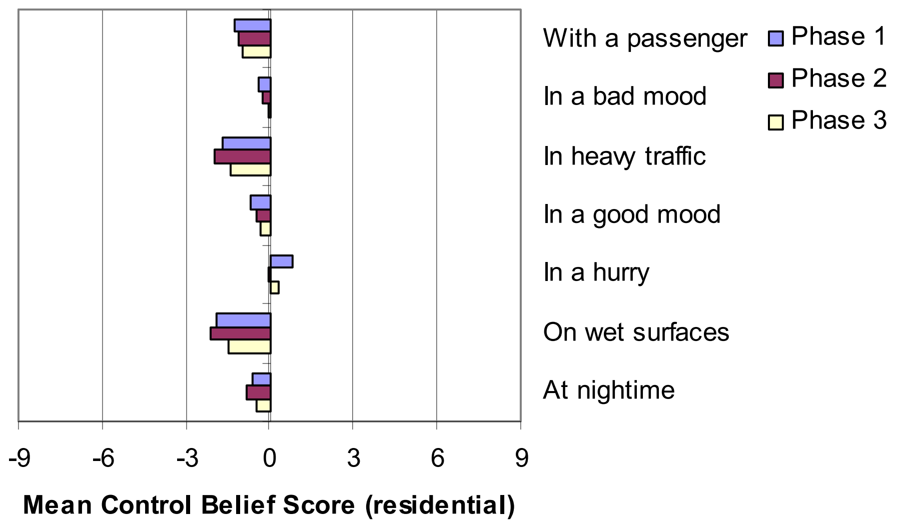


Figure 55: Mean control belief scores of residential scenario

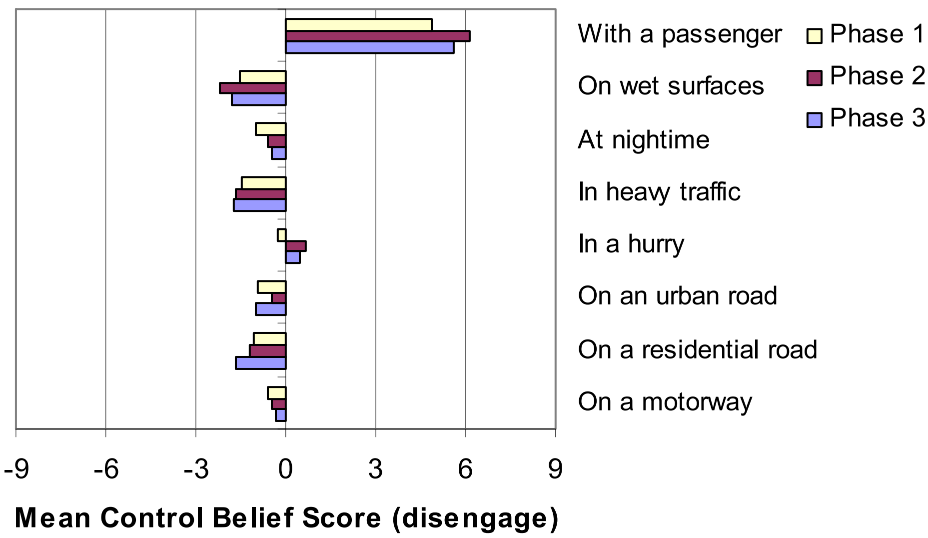


Figure 56: Mean control belief scores for disengage scenario

Generally the scores suggest that participants believed that exceeding the speed limit across all scenarios and disengaging the system was morally wrong (see Figure 57). For the road scenarios moral beliefs tended to weaken following experience with the ISA system however differences were minimal and non significant. Similarly, ratings showed minimal differences overtime for the disengage scenario.

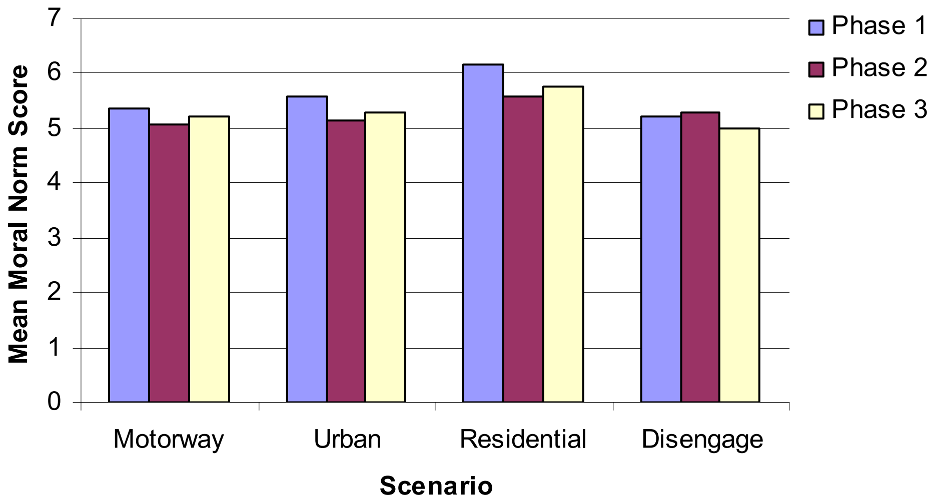


Figure 57: Mean moral norm score by scenario

Similarly, as participants tended to believe that exceeding the speed limit was morally wrong, they also tended to anticipate regretting engaging in this behaviour (see Figure 58). Participants reported anticipating least regret for exceeding the speed limit on a motorway. Following experience with the system, the mean trend suggests that participants were less likely to anticipate regretting speeding in the urban road scenario. Differences across time for all road scenarios were again non significant. For the disengage scenario the anticipate regret scores showed a significant difference overtime. Post hoc analysis however did not reveal any significant differences between time points. Nevertheless the mean trend would suggest that participants were less likely to regret overriding the system following prolonged experience. This is perhaps a consequence of the participants' experience of false or inaccurately placed speed limits.

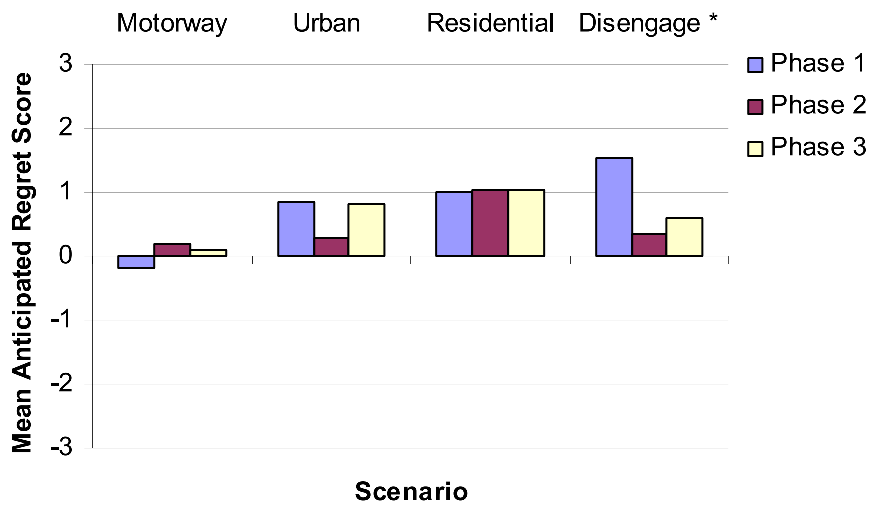


Figure 58: Mean anticipated regret score by scenario

Given the controlling nature of the system, past behaviour scores (see Figure 59) are as expected. Driver's self-reported propensity to exceed the speed in the last month decreased during Phase 2. For all the scenarios, self-reported speeding in Phase 3 decreased slightly suggesting that the effects of ISA may have been sustained throughout unsupported driving. There was a significant difference in self reported speeding for the motorway and urban scenario. However post hoc analysis did not indicate any significant differences between individual time points.

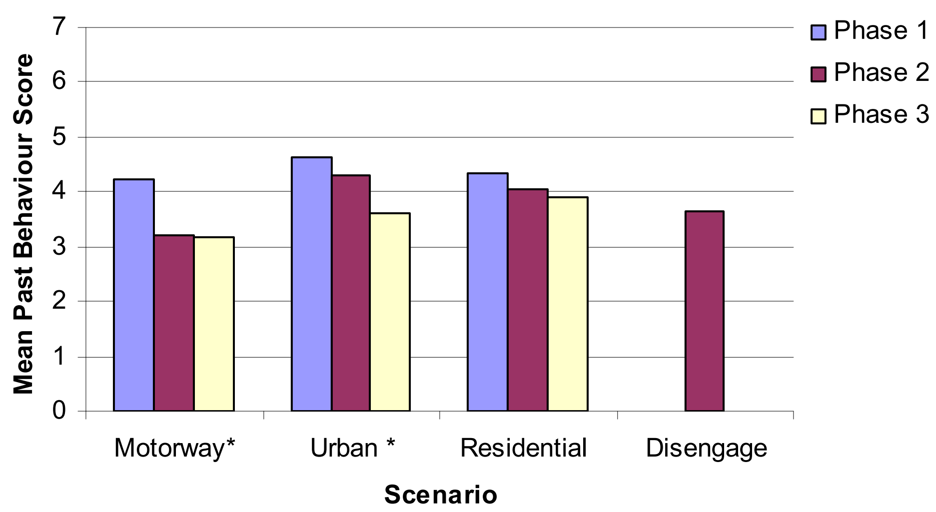


Figure 59: Mean past behaviour score by scenario

Comparisons of past behaviours can not be made with respect to disengaging the system since participants had no prior experience of this technology. However, it can be seen from Figure 59 that participants had disengaged the system relatively frequently in the past.

Figure 60 suggests that participants' perception of the risk involved in speeding on a urban and a residential road tended to decrease during phase 2(although only slightly). Perceptions of risk for the motorway and disengage scenario tended to increase following exposure to the ISA system. For all scenarios differences are minimal and non significant however.

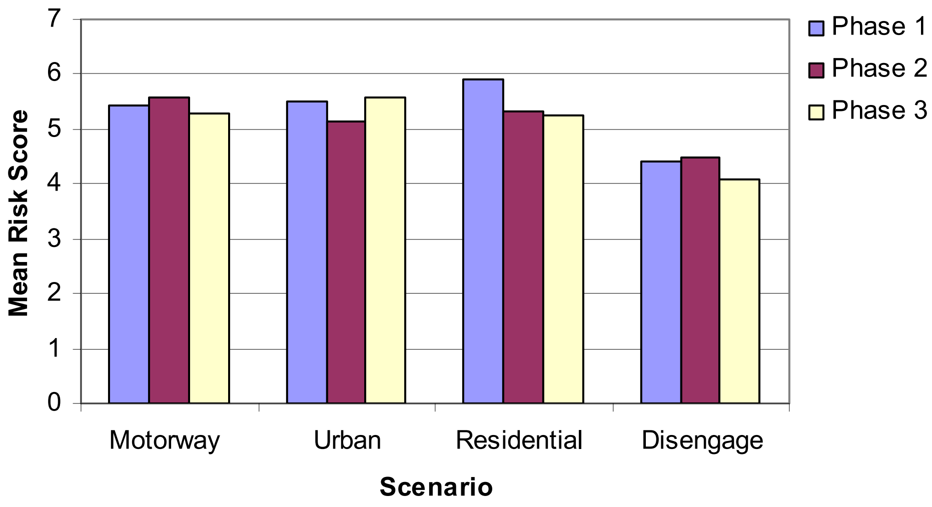


Figure 60: Mean risk score by scenario

Self identity measures were taken during each phase. Although participants were less likely to identify as a safe driver whilst driving with ISA (Table 25) differences over time were minimal and non significant.

Table 25: Mean self-identity scores over time

Phase	Mean Score
Phase 1	6.00
Phase 2	5.57
Phase 3	6.21

Table 26: Correlation between TPB constructs and behavioural intention scores across time and scenarios

Note 1: * denotes significance at the 0.05 level, ** denotes significance at the 0.01 level, *** denotes significance at the 0.001 level

Construct	Phase 1 Correlations with Intentions				Phase 2 Correlations with Intentions				Phase 3 Correlations with Intentions			
	motorway	urban	residential	disengage	motorway	urban	residential	disengage	motorway	urban	residential	disengage
ATT	0.65**	0.81***	0.62**	0.30	0.83***	0.69**	0.87***	0.64**	0.79***	0.75**	0.79***	0.58*
BE	0.64**	0.58*	0.41	0.50*	0.86***	0.68**	0.38	0.56*	0.73**	0.55*	0.54*	0.44
NBMC	-0.46*	-0.67**	-0.60*	-0.32	-0.58*	-0.56*	-0.72**	-0.42	-0.57*	-0.76**	-0.76***	-0.34
PBC	0.47*	0.60*	0.25	0.14	0.22	-0.14	-0.06	-0.11	0.70**	0.39	0.04	0.06
CBF	0.74***	0.80***	0.60*	0.56*	0.65**	0.58*	0.59*	0.72**	0.60*	0.65*	0.35	0.61*
MN	-0.60**	-0.57*	-0.34	-0.18	-0.73**	-0.30	-0.71**	-0.13	-0.67**	-0.16	-0.74**	-0.64**
AR	-0.81***	-0.81***	-0.64**	-0.61**	-0.77***	-0.64*	-0.78***	-0.57*	-0.76***	-0.68**	-0.73**	-0.74**
PB	0.78***	0.71***	0.69**		0.77***	0.53	0.51*	0.81***	0.63*	0.79***	0.76***	
RISK	-0.77***	-0.59*	-0.59*	-0.04	-0.73**	-0.31	-0.14	0.02	-0.64**	-0.41	-0.39	0.09
SI	-0.46*	-0.63**	-0.48*	-0.60**	0.07	0.12	0.05	-0.03	-0.72**	-0.58*	-0.22	-0.60*

Table 26 provides a comparison of the TPB constructs significantly correlating with behavioural intentions over time and scenarios.

Generally, comparisons across scenarios suggest that that those who intended to speed during Phase 1 tended:

- to possess more favourable attitudes towards exceeding the speed limit
- to believe that more positive than negative outcomes would result from exceeding the speed limit (except for residential roads)
- to perceive less normative pressure from significant others
- perceive greater control over exceeding the speed limit
- to believe that the stated control factors were more likely to facilitate rather than inhibit their exceeding the speed limit
- not to believe that exceeding the speed limit was morally wrong
- not anticipate regretting exceeding the speed limit
- to have exceeded the speed limit frequently in the past
- to perceive less risk in exceeding the speed limit
- to possess a weak self identity as a safe rider

Generally, comparisons across scenarios suggest that participants intending to exceed the speed limit during Phase 2 tended:

- to possess more favourable attitudes towards exceeding the speed limit
- to believe that more positive than negative outcomes would result from exceeding the speed limit (except for residential roads)
- to perceive less normative pressure from significant others
- to believe that the stated control factors were more likely to facilitate rather than inhibit their exceeding the speed limit
- to not to believe that exceeding the speed limit was morally wrong (except for urban roads)
- not anticipate regretting exceeding the speed limit
- to have exceeded the speed limit frequently in the past (except for urban roads)
- to perceive less risk in exceeding the speed limit (except for residential and urban roads)

Generally, comparisons across scenarios suggest that participants intending to exceed the speed limit during Phase 3 tended:

- to possess more favourable attitudes towards exceeding the speed limit
- to believe that more positive than negative outcomes would result from exceeding the speed limit
- to perceive less normative pressure from significant others
- perceive greater control over exceeding the speed limit (except for residential and urban roads)
- to believe that the stated control factors were more likely to facilitate rather than inhibit their exceeding the speed limit (except for residential roads)
- not to believe that exceeding the speed limit was morally wrong (except for urban roads)
- not anticipate regretting exceeding the speed limit
- to have exceeded the speed limit frequently in the past
- to perceive less risk in exceeding the speed limit (except for residential and urban roads)
- to possess a weak self identity as a safe rider (except for residential)

Comparisons over time for the disengage scenario revealed a less consistent pattern. Anticipated regret and control beliefs consistently correlated with intention across all three phases such that those who did not anticipate regretting overriding the system and those who believed that the stated control factors were more likely to facilitate rather than inhibit their overriding behaviour were more likely to disengage the system.

The TPB was most successful for predicting behavioural intentions to exceed the speed limit on the motorway. This is perhaps because this road types affords the greatest opportunity to speed. Given participants admittance to speed most frequently on this road and feel little regret or moral opposition to this, responses may have been more honest and thus more successful in predicting intentions.

The power of the individual constructs varies over time. Attitudes, anticipated regret and normative pressure appeared to be the most consistent correlate across the speeding scenarios.

4.2.1 Overview of the impact of ISA on the TPB constructs

On the whole results here should be treated with caution. Trends noted are based on very small differences in means and show little effect of the ISA system.

Participants expressed little intention to exceed the speed limit. Generally for the road scenarios participants' intentions weakened during Phase 2. Comparisons of mean trends for the road scenarios provide encouraging results that the physical enforcement of speed may be sufficient to change participants' intentions. However no significant differences were found and thus conclusions are only tentative. For the disengage scenario intention to override the system seemed to increase following experience with the ISA system however differences were minimal and remained negative suggesting the desire to override the system was weak.

Attitudes correlated positively with intentions across all phases such that those participants with more favourable attitudes towards speeding were more likely to intend to exceed the speed limit. Participants held negative attitudes towards exceeding the speed limit on all roads. Mean trends suggested that attitudes toward speeding may have become slightly less favourable following experience with the ISA system but again differences were minimal and non significant. Although attitudes towards disengaging the system became more slightly favourable during Phase 2, problems with the mapping software were discussed as possible explanations.

Behavioural beliefs correlated positively with intentions such that those who believed more positive outcomes would result from speeding or disengaging the system were more likely to intend to do such. Differences in behavioural beliefs over time are again minimal, but the direction of change in mean scores does hint at some possible target beliefs for intervention.

Subjective norms consistently correlated negatively with intentions such that those who perceived less pressure from significant others not to exceed the speed limit or disengage the system were more likely to intend to do so. Perceived pressure from significant others weakened during Phase 2, suggesting that participants felt it was less likely important others would disapprove of these behaviours. It would therefore seem appropriate to raise drivers' awareness of the impact of speeding and disengaging the system if the road seems relatively hazard free or the map is slightly inaccurate. In view of the fact that the police were the most influential referents, it is important to ensure that a police presence is directly or indirectly felt. Although direct policing may not always be appropriate, indirect measures such as speed cameras, police warning signs and information leaflets endorsed by the police might prove beneficial additions to any targeted campaign.

PBC was rarely a significant correlate with intentions. Generally participants perceived control increased during phase 2, although differences were non significant. Participants felt they were in significantly greater control of their ability to disengage an ISA system following experience with the system.

On the whole control factors positively correlated with intentions such that those who believed the stated factors were more likely to facilitate exceeding the speed limit or disengaging the system were more likely to intend to do such. Control factors were generally seen to inhibit participants' propensity to speed. Being in a hurry was deemed to facilitate participants' propensity to speed and disengage the system. Driving with a passenger was also seen to facilitate participants' propensity to disengage the ISA system. Campaigns should emphasis that driving with a passenger, in a good or bad mood, in heavy traffic, in a hurry, on wet surfaces and at night-time are not excuses to exceed the speed limit or disengage the system. Indeed the consequences of these factors should be highlighted as important reasons not to do such.

Moral norms and anticipated regret correlated negatively with intentions consistently, such that those who did not regard speeding and disengaging the system as morally wrong and those who did not anticipate regretting doing such were more likely to intend to perform these behaviours. Changes in moral norms tended to suggest that participants were less morally opposed to speeding following experience with the ISA system. Differences between mean scores were again small and non significant. For the motorway and residential scenario, participants appeared to anticipate feeling greater regret when speeding after having gained experience of the system. The opposite was true for the urban and disengage scenario however. Participants seemed less likely to regret overriding the system on a motorway following prolonged experience. Changes in personal norms here may be a reflection of inaccuracies in the speed limit map. Where the system displayed inaccurate and subsequently unsafe speed limits participants are less likely to regret overriding the system as in most cases it is safer to do so.

Past behaviour positively correlated with intentions such that those who had frequently exceeded the speed limit in the past intended to do so in the future. As expected, past measures tended to decrease following experience with the system. This decrease was significant for both the urban and motorway scenario. During Phase 3 reported speeding appeared lower than that recorded in Phase 1, suggesting experience of the ISA system had lowered participants' speeds during unrestricted driving.

In general, the correlation between perceptions of risk and intentions was inconsistent across phases. Participants' perception of the risk involved in speeding on an urban and a residential road tended to decrease over time (although only slightly). Perceptions of risk for the motorway and disengage scenario tended to increase following exposure to the ISA system. For all scenarios differences were minimal and non significant however.

Self identity scores tended to correlate negatively with intentions such that those expressing a weaker identity as a safe driver were more likely to intend to exceed the speed limit and disengage the system. Although participants were less likely to identify as a safe driver whilst driving with ISA, differences over time were minimal and non significant.

4.2.2 Relationship between TPB and Behaviour Measures

Given the limited sample size it is not possible to test the predictive utility of the Theory of Planned Behaviour with respect to speeding. Simple correlations between the TPB constructs and behaviours measures have therefore been calculated. It is important that the behaviour measure selected closely matches that described within the TPB scenarios in the questionnaires. The scenarios relate to exceeding the speed limit on a 70mph motorway, 40mph urban road and 30mph residential road. The percentage of distance spent travelling above the speed limit has therefore been chosen a key measure of behaviour. Given that participants' definition of speeding is perhaps not strictly 1mph above the speed limit, the threshold for issuing fixed penalties has also been used. The Association of Chief Police Officers (ACPO) issues guidance to police officers and advocates that the issue of fixed penalty notices is likely to be the minimum appropriate enforcement action as soon as the speeds noted in Table 27 have been reached.

Table 27: Fixed Penalty Guidelines

Limit	Fixed Penalty
30 mph	35 mph
40 mph	46 mph
70 mph	79 mph

When examining the power of the TPB constructs it is important to correlate cognitions measured at one time point with *prospective* behaviour measures. Although it is possible to correlate, for example, cognitions measured at the end of Phase 2 with behaviour recorded during Phase 2, it would be impossible to rule out that the behaviour had not driven the cognitions rather than the reverse. The analysis therefore concentrates on prospective correlations. Cognitions measured at the start of the trial, before having driven the ISA vehicle, have been correlated with behaviour throughout Phase 1, 2 and 3. Cognitions measured at the end of Phase 2 have been correlated with behaviour throughout Phase 3.

Unfortunately the results of correlations highlight very few significant relationships between the TPB constructs and behaviour measures. As can be seen in Table 28, the TPB constructs measured at the start of the trial do not consistently correlate with behaviour measures during Phase 1, Phase 2 or Phase 3 across all road scenarios. As in previous trials cognitions relating to speeding on a motorway correlate most successfully with behaviour during Phase 1. Participants who tended to exceed the speed limit on a motorway were more likely:

- to believe that more positive than negative outcomes would result from exceeding the speed limit
- to perceive less normative pressure from significant others
- not to believe that exceeding the speed limit was morally unacceptable
- not anticipate regretting exceeding the speed limit
- to have exceeded the speed limit frequently in the past
- to perceive less risk in exceeding the speed limit

A number of significant correlations were also found between the TPB constructs and participants propensity to exceed the fixed penalty limit on a residential road. Here, participants who tended to exceed the speed limit on a motorway were more likely:

- to intend to exceed the speed limit
- to possess more favourable attitudes towards exceeding the speed limit
- to believe that more positive than negative outcomes would result from exceeding the speed limit
- to perceive less normative pressure from significant others
- to believe that the stated control factors were more likely to facilitate rather than inhibit their exceeding the speed limit

- not to believe that exceeding the speed limit was morally unacceptable
- to have exceeded the speed limit frequently in the past

Examination of the correlations between cognitions measured following prolonged experience with ISA and behaviour during Phase 3 did not provide any consistent significant correlations between cognitions and behaviour. Significant relationships are noted (see Table 29).

Cognitions measured during Phase 1 relating to participants intentions to disengage the system were also correlated with the percentage of distance participants drove with ISA disengaged. As can be seen in Table 30 none of the TPB constructs significantly correlated with behaviour. Correlations here offer little understanding of the relationship between cognitions and disengaging behaviour.

Table 28: Correlations between Phase 1 Cognitions and Speeding Behaviour measured in Phase 1, 2, and 3

Constructs	Phase 1 Correlations for Motorway Behaviour		Phase 2 Correlations for Motorway Behaviour		Phase 3 Correlations for Motorway Behaviour	
	> 70mph	> fixed penalty (79mph)	> 70mph	> fixed penalty (79mph)	> 70mph	> fixed penalty (79mph)
BI	0.28	0.11	-0.01	-0.01	-0.13	-0.21
ATT	0.24	0.21	0.19	0.20	0.07	0.02
BE	0.49*	0.42	0.22	0.20	0.33	0.35
NBMC	-0.65**	-0.56*	-0.41	-0.32	-0.36	-0.34
PBC	0.27	0.19	0.19	0.16	0.08	-0.07
CBF	0.35	0.26	0.25	0.13	0.20	0.15
MN	-0.80***	-0.75***	-0.54*	-0.50*	-0.47	-0.51*
AR	-0.49*	-0.40	-0.29	-0.32	-0.18	-0.07
PB	0.55*	0.51*	0.30	0.35	0.28	0.25
RISK	-0.66**	-0.54*	-0.39	-0.34	-0.31	-0.21
SI	-0.41	-0.28	-0.38	-0.22	-0.13	0.02
Constructs	**Phase 1 Correlations for Urban Behaviour**		**Phase 2 Correlations for Urban Behaviour**		**Phase 3 Correlations for Urban Behaviour**	
	> 40 mph	> fixed penalty (46mph)	> 40 mph	> fixed penalty (46mph)	> 40 mph	> fixed penalty(46mph)
BI	0.37	0.11	0.20	-0.15	0.30	0.07
ATT	0.27	-0.05	0.18	-0.29	0.32	-0.09
BE	0.36	0.29	0.25	0.10	0.28	0.20
NBMC	0.03	0.23	-0.06	0.50*	-0.19	0.14
PBC	-0.18	-0.30	-0.08	-0.55*	0.29	-0.09
CBF	0.25	-0.06	0.11	-0.36	0.35	-0.09
MN	-0.09	-0.02	-0.08	0.24	-0.20	0.09
AR	-0.27	-0.06	-0.21	0.17	-0.53*	-0.11
PB	0.28	0.08	0.24	-0.07	0.61**	0.26
RISK	0.08	0.17	0.12	0.35	0.01	0.31
SI	-0.32	-0.11	-0.43	-0.02	-0.19	0.01
Constructs	**Phase 1 Correlations for Residential Behaviour**		**Phase 2 Correlations for Residential Behaviour**		**Phase 3 Correlations for Residential Behaviour**	
	> 30 mph	> fixed penalty (35mph)	> 30 mph	> fixed penalty (35mph)	> 30 mph	> fixed penalty (35mph)
BI	0.22	0.48*	0.38	0.34	0.27	0.46
ATT	0.19	0.52*	-0.03	0.03	-0.05	0.13
BE	0.17	0.62**	0.28	0.47	0.22	0.49
NBMC	-0.62	-0.67**	-0.44	-0.16	-0.47	-0.40
PBC	0.01	-0.21	-0.06	-0.17	-0.03	-0.10
CBF	0.43	0.52*	0.22	0.17	0.25	0.30
MN	-0.63**	-0.73***	-0.40	-0.32	-0.40	-0.36
AR	-0.24	-0.40	-0.03	-0.09	0.01	-0.11
PB	0.36	0.63**	0.12	0.18	0.13	0.28
RISK	-0.33	-0.48	-0.53*	-0.54*	-0.41	-0.51
SI	-0.17	-0.24	-0.14	0.06	0.08	0.11

Table 29: Correlations between Phase 2 Cognitions and Speeding Behaviour measured in Phase 3

Constructs in Phase 2	Phase 3 Correlations for Motorway Behaviour		Phase 3 Correlations for Urban Behaviour		Phase 3 Correlations for Residential Behaviour	
	> 70 mph	> fixed penalty (79 mph)	> 40 mph	> fixed penalty (46mph)	> 30 mph	> fixed penalty (35mph)
BI	0.37	0.40	0.50	0.51	0.65**	0.68**
ATT	0.18	0.20	0.47	0.14	0.42	0.47
BE	0.24	0.40	0.56*	0.57*	0.31	0.45
NBMC	-0.18	-0.39	-0.36	-0.06	-0.36	-0.42
PBC	0.52	0.36	-0.03	-0.23	0.06	-0.07
CBF	-0.17	-0.14	0.41	-0.05	0.20	0.33
MN	-0.05	-0.09	-0.45	0.01	-0.29	-0.39
AR	-0.26	-0.29	-0.75**	-0.57*	-0.24	-0.40
PB	0.20	0.20	0.62*	0.60*	0.36	0.41
RISK	-0.32	-0.19	-0.37	-0.14	-0.08	-0.17
SI	0.19	0.00	0.33	0.08	-0.06	0.10

Table 30: Correlation between Phase 1 cognitions and Disengaging Behaviour in Phase 2

Construct s in Phase 1	Phase 2 Correlations for Disengage Behaviour
	% opt-out
BI	0.35
ATT	0.23
BE	0.43
NBMC	-0.02
PBC	0.05
CBF	0.33
MN	0.16
AR	-0.14
PB	-
RISK	0.00
SI	-0.28

4.3 Driver Behaviour Questionnaire

The Driver Behaviour Questionnaire (Parker, Reason, Manstead and Stradling, 1995) measured the frequency with which individuals committed various types of errors and violations when driving, identifying three distinct types of aberrant driving behaviours; errors, lapses and violations. This questionnaire, administered at four time points, provided a self reported measure of changes in driving behaviour over the six month trial period.

Repeated measures ANOVAs were performed to identify significant differences in participants' propensity to engage in aberrant driving behaviours as a result of the four month ISA intervention.

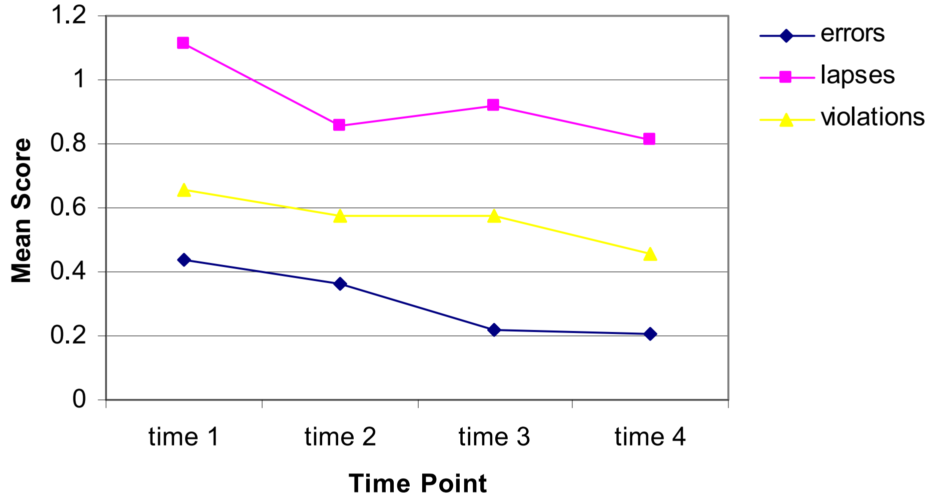


Figure 61: Mean error, lapse and violation score on DBQ over time

The analysis did not reveal any significant differences in participants' lapse, error or violation scores over time as a result of the ISA intervention. Nevertheless, the mean trends do suggest that prolonged experience with the system decreased participants' propensity to suffer errors, lapses and violations and this effect appears to be sustained when the ISA system was removed.

4.4 Acceptability

Driver acceptance of the ISA system was measured using an acceptability scale of advanced transport telematics developed by Van de Laan, Heino and De Waard (1997). This measure allows system evaluations across the dimensions of usefulness and satisfaction.

A repeated measures ANOVA did not reveal a significant change in usefulness scores over time. Figure 62 does suggest a definite trend however such that even though initial experience with the system decreased participants' appreciation of the usefulness of ISA, this increased with prolonged experience and remained at a high level when the system was removed.

Similarly a repeated measures ANOVA did not confirm any significant change in satisfaction scores over time. Nevertheless, participants' satisfaction with the ISA system steadily rose with prolonged exposure, beyond the removal of ISA support.

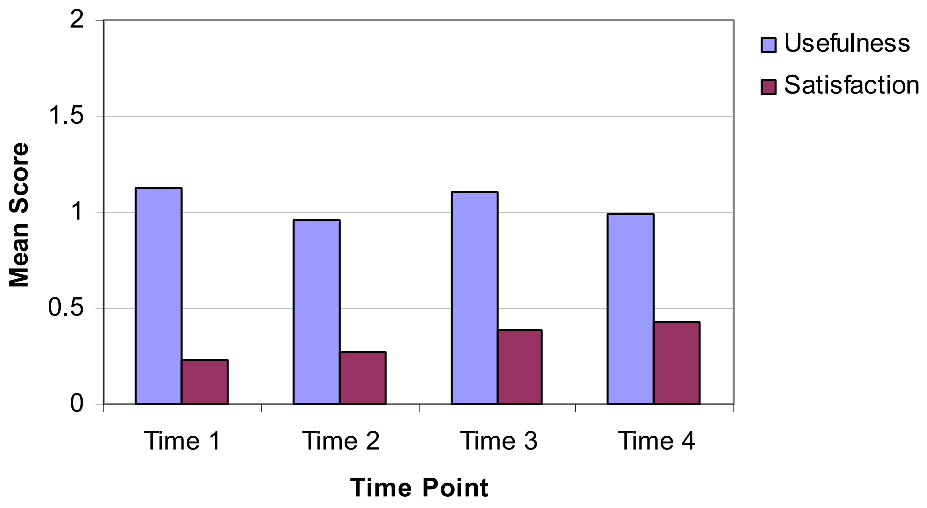


Figure 62: Acceptability ratings for the dimensions of "usefulness" and "satisfaction"

4.5 System design

Several items sought information regarding the design of the ISA system. Figure 63 and Figure 64 illustrate the most common cues within the system that participants relied upon to inform them of system state changes throughout the 4 month ISA period.

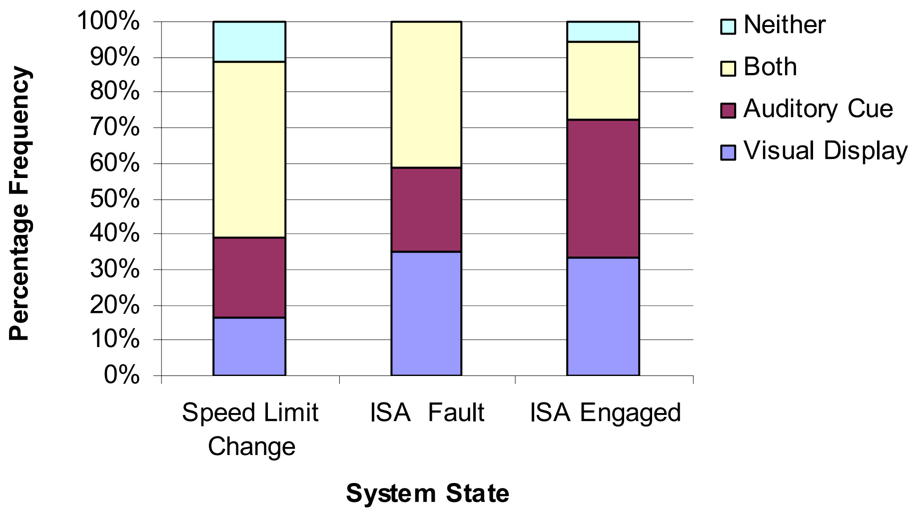


Figure 63: Most frequent cues relied upon for notification of system state changes during early exposure to ISA

There are very few differences in the way participants used the ISA system cues as their experience with the system increased.

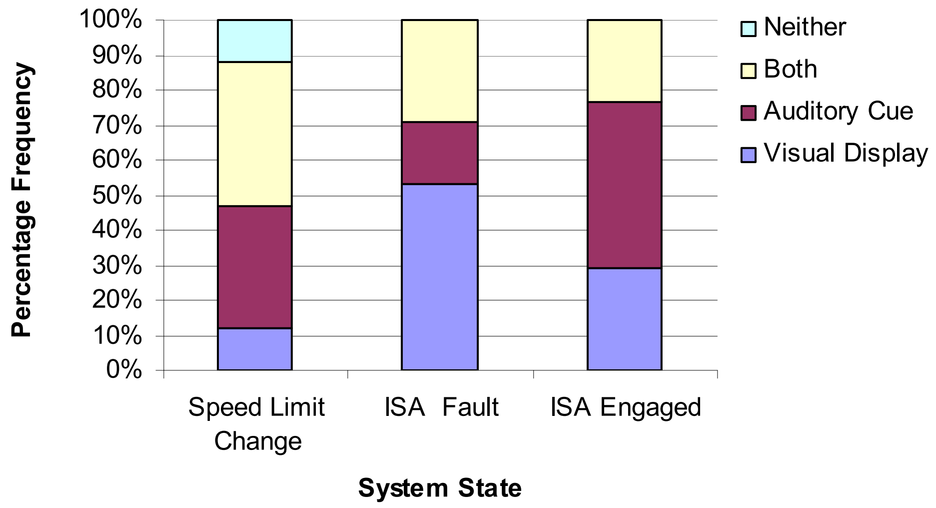


Figure 64: Most frequent cues relied upon for notification of system state changes following prolonged exposure to ISA

4.6 Driving Experience

Participants were asked several questions relating to their perceptions of driving with ISA compared to driving in a 'normal' vehicle.

4.6.1 Risk Perceptions

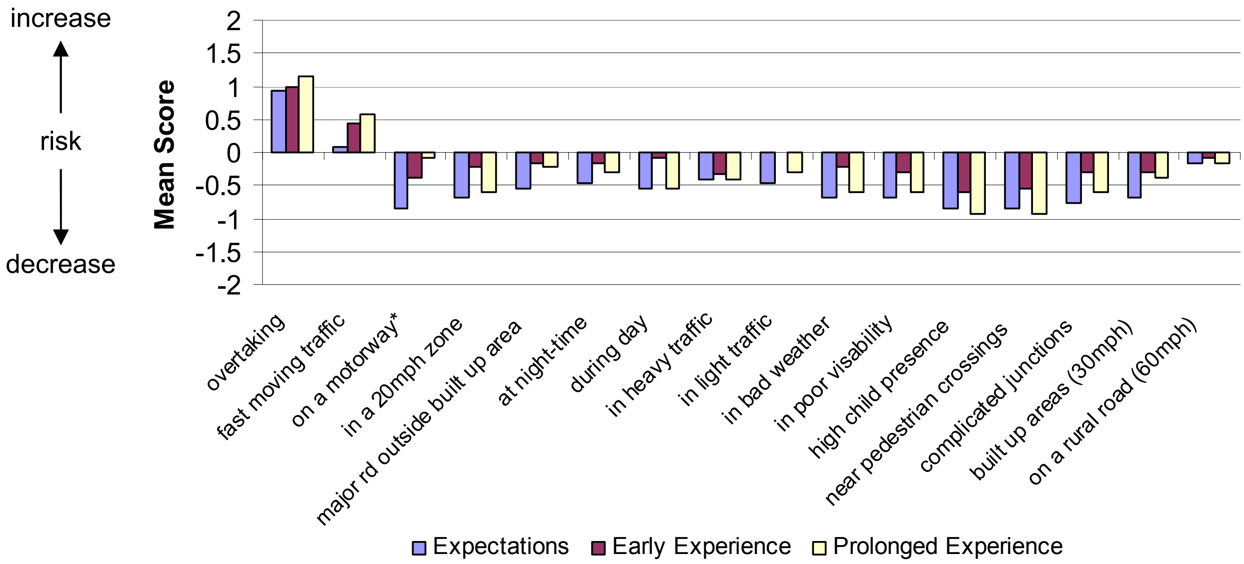


Figure 65: Perception of change in risk when driving with ISA compared to 'normal' driving

Figure 65 suggests participants felt at increased risk under ISA control when overtaking and driving in fast moving compared to normal driving. This increased perceived risk surpassed their expectations and rose with prolonged experience. For all other driving conditions, participants tended to feel at less risk when driving with ISA compared to driving in a normal vehicle. A repeated measures ANOVA confirmed that participants' perception of the risk involved in driving on motorways with ISA significantly increased. Post hoc revealed that participants believed that were at significantly more risk when driving on motorways with ISA following prolonged experience with the system than they initially expected. Although participants perceptions of the reduction in risk was not as great as expected, ratings remained negative and Figure 65 would tend to suggest that participants still considered driving with ISA in the majority of conditions safer than driving in an unsupported car.

4.6.2 Frustration

As can be seen in Figure 66, participants expected the ISA system to decrease the level of frustration experienced as the driver. ISA did not appear however to alleviate frustration levels as much as expected following initial experience with the system. The difference in these ratings over time however was non significant. Participants did believe however that their driving with ISA would prove a source of frustration to other drivers. However, following initial and prolonged experienced this perceived frustration was significantly less than they had anticipated.

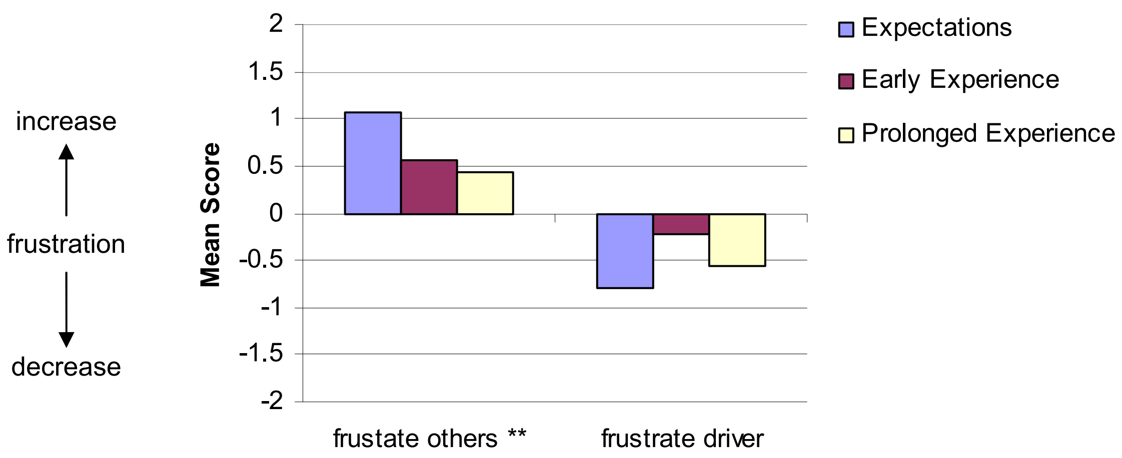


Figure 66: Influence of ISA on frustration experienced

Further questioning revealed the specific situations where participants' frustration was increased as a result of the ISA system.

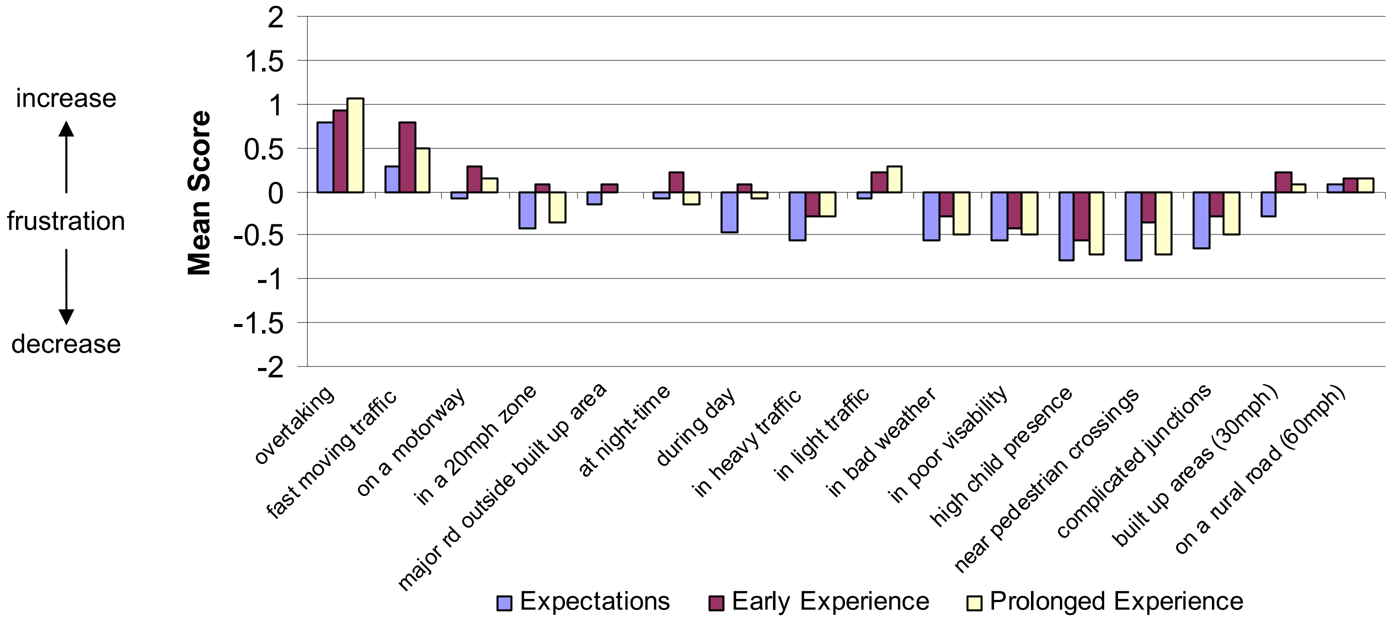


Figure 67: Perception of change in frustration experienced when driving with ISA compared to 'normal' driving

Figure 67 highlights that participants expected and generally went on to feel increased frustration when driving with ISA activated compared to a normal car whilst overtaking, driving in fast moving traffic, on a motorway, in 20mph zones, at night time, during the day, in light traffic, in built up areas and on rural roads. Frustration seemed greatest amongst those situations which afforded the opportunity to speed. For the remaining conditions participants expected to feel less frustration driving with ISA compared to driving in a normal car. Although the actual frustration experienced was greater than that expected, scores still remained negative suggesting driving with an ISA car was, on whole, less frustrating than driving in a normal car. There were no significant differences in ratings over time.

4.6.3 Concentration

It has been suggested that providing drivers with speed limit information and controlling their speed to the posted speed limit may affect drivers' concentration on the driving task and the style in which they drive. Figure 68 highlights that participants anticipation of conflicts, attention to other roads users, pedestrians and other aspects of the driving task (e.g. scanning) increased whilst driving with ISA compared to driving in a normal car. Participants' awareness and attention to speed limits also increased. Although the increase in attention was not as high as expected for some, this trend suggests ISA allowed the participants to develop more effective driving styles and search strategies when driving with the ISA system. Differences across time points were not significant.

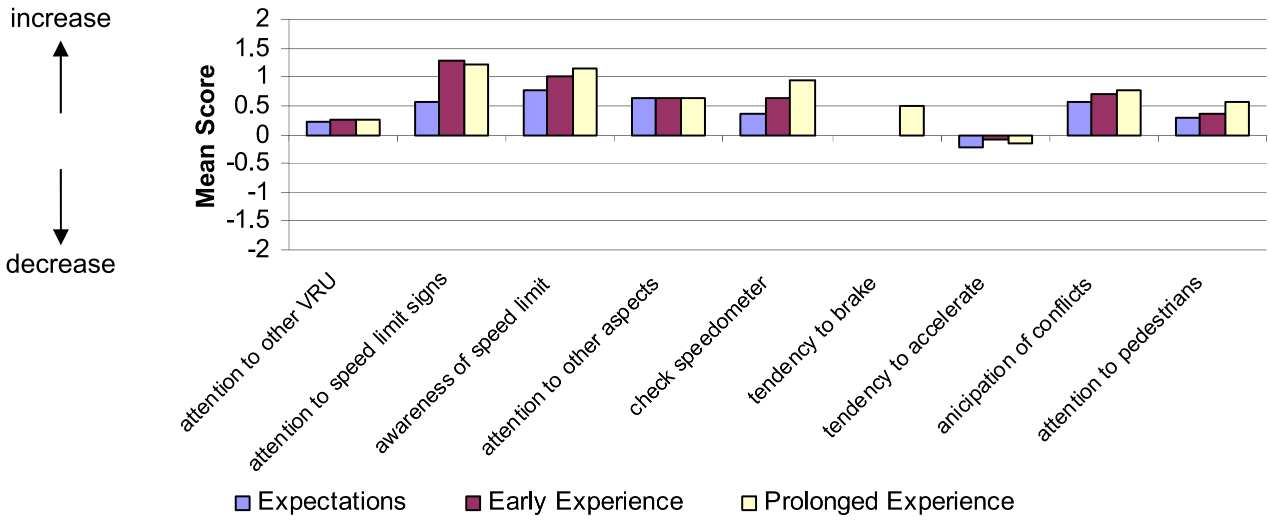


Figure 68: Perception of change in concentration when driving with ISA compared to 'normal' driving

4.6.4 Driving experience

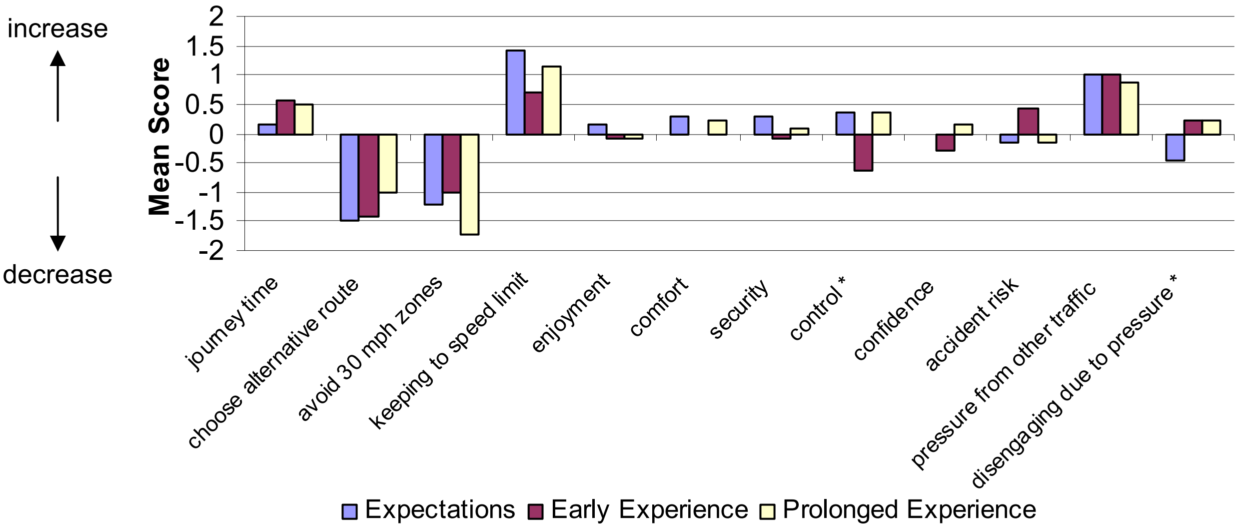


Figure 69: Perception of changes in driving experience when driving with ISA compared to 'normal' driving

Compared to 'normal' driving, participants perceived that journey times increased whilst driving with ISA (see Figure 69). This perceived increase in journey times was more than participants initially expected but lessened with prolonged experience of the ISA system. As expected, participants found that driving with ISA also made it easier to keep to the speed limits compared to driving in a normal car. Participants had rarely chosen alternative routes in order to avoid ISA warnings or avoided driving in 30mph speed zones. Enjoyment decreased slightly when driving with ISA compared to 'normal' driving during the early stages of Phase 2. During the initial month of driving with ISA, participants also felt less secure, in less control and more apprehensive. However, participants felt in significantly more control following prolonged experience of the system than during their early experience. Participants also felt under increased pressure from other drivers when driving with ISA activated. This increased pressure from other drivers also made them more likely to disengage the system than they had initially expected. Although a significant difference was found across scores here, post hoc analysis did not reveal any significant differences between time points. Participants also felt at less risk of being involved in an accident when driving with ISA but this belief weakened over time.

4.6.5 Response to common criticisms

Participants were asked for their opinion on a number of criticisms commonly made regarding the safety of driving with an ISA system. As can be seen in Figure 70, participants disagreed that ISA had made them less vigilant drivers and decreased their adopted following distances. Participants did believe however, that ISA created difficulties when overtaking and prevented the opportunity to accelerate out of danger. Although these beliefs strengthened during early experience of the system, opinions weakened considerably following prolonged experience with the system. Changes in all opinions over time were not however statistically significant.

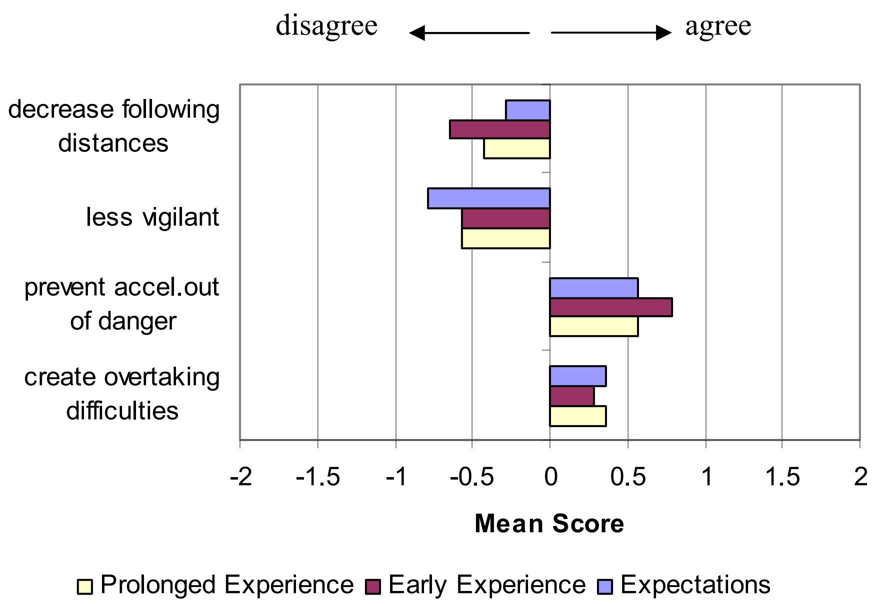


Figure 70: Participants opinions relating to common criticisms of ISA

Negative behavioural adaptations when ISA control is lost through either GPS dropout or driving on unlimited roads is also a major concern. It has been suggested that drivers may exhibit riskier driving behaviours when the opportunity for unrestricted driving is presented. Two items determined whether participants would driver faster or slower and feel relief or frustration when the ISA system temporarily dropped out. Figure 71 demonstrates that in accordance with their expectations, participants felt some slight relief when ISA was unavailable. A significant difference over time was noted in terms of whether participants would driver faster when ISA was unavailable. Post hoc analysis did not reveal any differences between time points but the mean trends suggested that participants drove faster when ISA was unavailable during their early experience with the system than they had expected. Following prolonged experience with ISA however this tendency appeared to diminish.

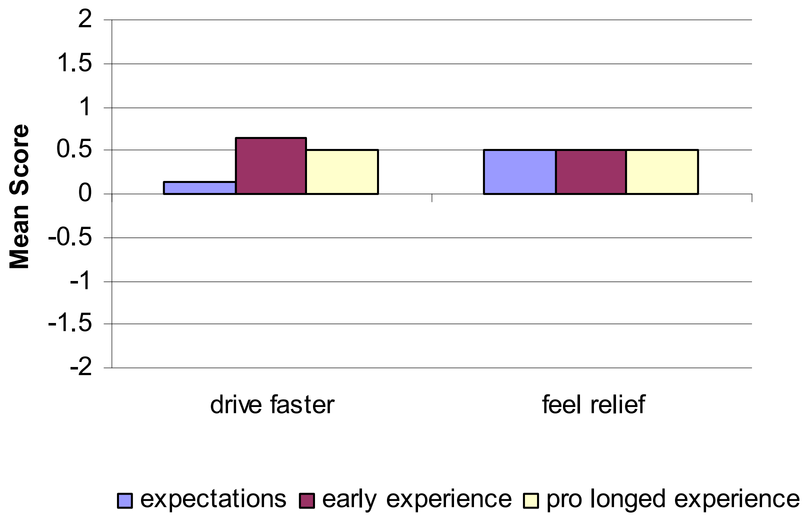


Figure 71: Participants reactions when ISA unavailable

4.7 Willingness to pay

The cost of ISA to the driver may prove a major obstacle to national roll out. The majority of ISA related studies have therefore sought to determine how much drivers are willing to pay to have an ISA system installed.

In our present study participants were asked whether they were willing to have ISA installed in their vehicle and how much they were willing to pay. Fifty seven percent of participants were willing to have ISA installed in their vehicles if its use was voluntary. Participants' willingness to pay for the system ranged from paying nothing to £500. On average participants were willing to pay £149. Seventy one percent of participants approved of the compulsory fitting of ISA to all new vehicles and 57% agreed to mandatory introduction of ISA for *all* drivers. Those who disagreed tended to approve of targeting ISA at specific high risk groups. Fifty percent approved of the mandatory introduction for novice drivers, 100% for the introduction for speed offenders and 50% for the introduction for professional drivers. Participants were unsure of the likelihood of the actual implementation of ISA throughout the UK (see Table 31). Responses were neutral but the direction of the mean suggests that participants believed a national roll out of ISA was likely and this belief strengthened with experience. Again however responses centre around the mid point reflecting relatively neutral responses and little meaning should be attributed to these trends.

Table 31: "ISA is a system that will probably never be put into operation throughout the UK: disagree-agree"

	Mean
Expectations	-0.41
Early experience	-0.28
Prolonged experience	-0.82

5. OBSERVATION DRIVES

5.1 Introduction

The primary purpose of the observation drives was to assess driver behavioural changes across the trial phases by means of indicators not available from the logged data. Participants were accompanied by two trained observers around a predetermined test route on four separate occasions. Since the four drives were carried out on an identical route, it also provided an opportunity to assess the effect of the ISA system on trip related measures. The methodology was identical to the one developed for Field Trial 1, 2 and 3 (Lai et al, 2005a; 2005b; Lai et al, 2006). The test route developed in Field Trial 3 was used again for this trial.

The Leicestershire trial route was approximately 40 miles long covering a variety of driving environments (urban, rural, and motorway), road layouts (i.e. single and dual carriageway), and speed zones (i.e. 30, 40, 50, 60, and 70 mph). It was intended to create a route with comparable geometrical features to the Yorkshire route used for Trial 1 and 2. Hence the results derived from Trial 3 and 4 would be comparable with those from Trial 1 and 2, facilitating the completion of overall analysis at a later stage. Identical to the timeframe used in the previous three trials, the drives were carried out at the end of Month 1 (OB1), Month 2 (OB2), Month 5 (OB3) and Month 6 (OB4). Driver behaviour was recorded using the Wiener Fahrprobe technique (Risser, 1985) during the drive and driver mental workload was assessed via NASA-RTLX at the end of the drive (Byers et al, 1989).

5.2 Results

5.2.1 Trip related measures

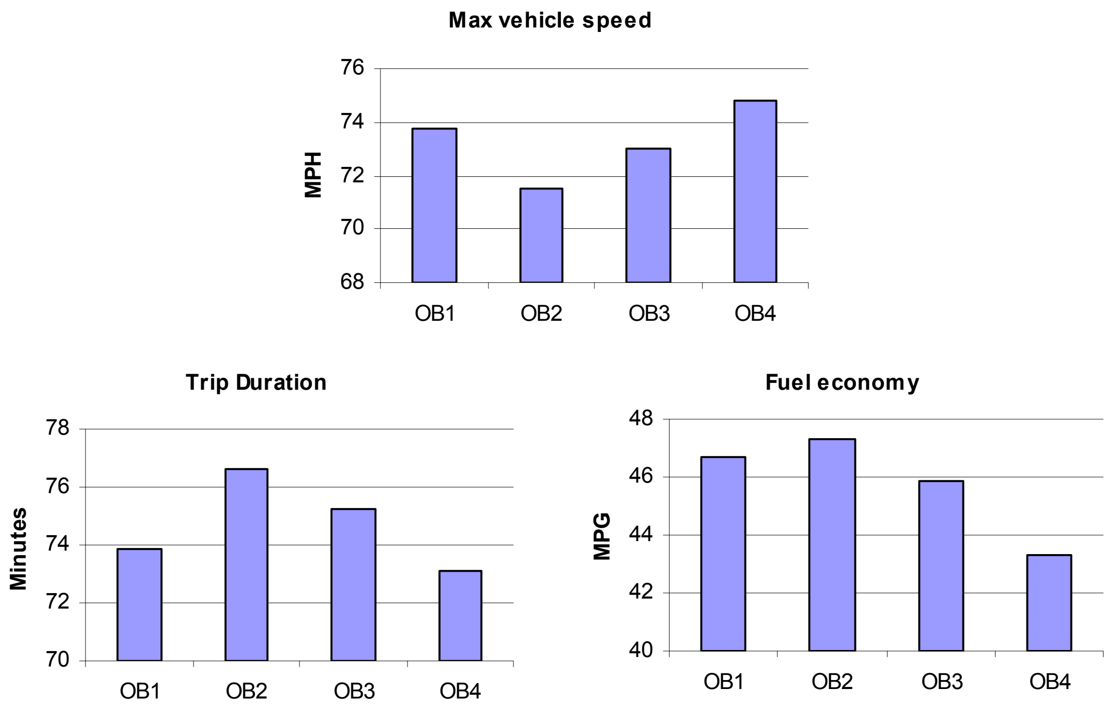


Figure 72: Comparison of trip related measures across trial phases

Figure 72 shows comparison of trip related measures across the four observation drives. Unsurprisingly, ISA led to reduced maximum speed. Presumably as a result of reduced travelling speed, ISA led to longer travel time, and, presumably as a result of a smoother acceleration profile, slightly better fuel economy (except the comparison between OB1 and OB3). Repeated measures ANOVAs were carried out to confirm the statistical significance of the differences; the results are reported in Table 32. Although the differences in these three trips related measures among the four drives were not all statistically significant, this is considered to be attributable to the small sample size (i.e. 19 participants). The same analysis will be carried out again to examine the effect of ISA on trip related measures when the data from all four trials are pooled together.

Table 32: Results of ANOVA and post-hoc t-test of trip related measures

	OB1	OB2	OB3	OB4	Repeated measures ANOVA					
					F statistic	*p* value	Post-hoc t-test			
Mean trip duration (minutes)	73.85 (4.93)	76.60 (8.83)	75.25 (8.13)	73.13 (6.77)	F (3, 48) = 0.77	0.524		OB2	OB3	OB4
							OB1	×	×	×
							OB2		×	×
							OB3			×
Max speed (MPH)	73.78 (9.20)	71.49 (5.04)	73.01 (7.14)	74.79 (7.10)	F (3, 45) = 2.02	0.112		OB2	OB3	OB4
							OB1	×	×	×
							OB2		×	*
							OB3			×
Fuel economy (MPG)	46.70 (2.64)	47.28 (2.82)	45.85 (3.61)	43.31 (4.84)	F (3, 45) = 6.14	0.001**		OB2	OB3	OB4
							OB1	×	×	*
							OB2		×	**
							OB3			*

Note:
1. * denotes the mean difference is significant at the 0.05 level.
2. ** denotes the mean difference is significant at the 0.01 level.
3. × denotes the mean difference is not significant.
4. Figures in brackets underneath mean values are standard deviations.

5.2.2 Observed driving behaviour

Figure 73 illustrates mean Wiener Fahrprobe scores across the four observation drives, which shows a dramatic drop in the number of observed negative behaviour from OB1 to OB2, a further slight drop from OB2 to OB3, then an increase from OB3 to OB4.

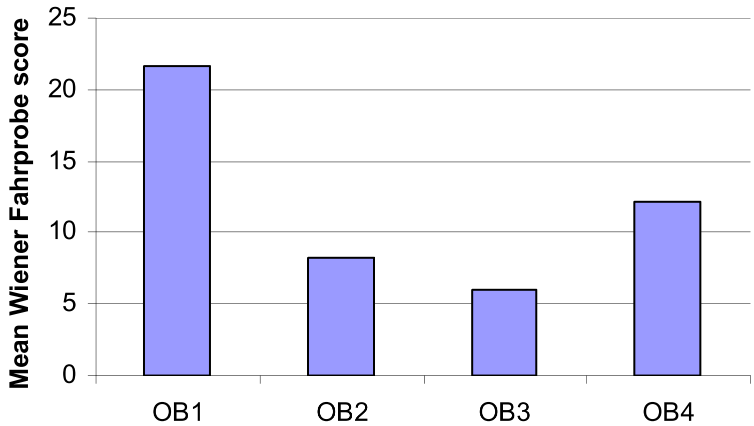


Figure 73: Mean Wiener Fahrprobe score across trial phases

The ANOVA test results presented in Table 33 reveal that the Wiener Fahrprobe scores recorded when ISA was turned on (i.e. OB2 and OB3) were statistically significantly lower than when ISA was turned off. In addition, the Wiener Fahrprobe score from OB4 was significantly lower than OB1, which indicates a carry-over effect of ISA intervention on the participants' negative driving behaviour. However, duration of the carry-over effect was not able to be fully inspected due to the trial design (i.e. only one month in Phase 3).

Table 33: Results of ANOVA and post-hoc t-test of Wiener Fahrprobe score across trial phases

	OB1	OB2	OB3	OB4	Repeated measures ANOVA					
					F statistic	*p* value	Post-hoc t-test			
								OB2	OB3	OB4
Mean Wiener Fahrprobe score	21.65	8.24	5.94	12.12	F(3,48) = 19.477	< 0.0005**	OB1	**	**	**
							OB2		×	**
							OB3			**

Note: 1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. × denotes the mean difference is not significant.

Apart from the overall score, a few individual negative behaviours recorded by the Wiener Fahrprobe sheet also reveal notable trend over the four drives as illustrated in Figure 74. It is worth noting that the significance of changes in these individual negative behaviours was not tested by repeated measures ANOVAs due to constraints in the sample size (i.e. not all participants committed these individual negative driving behaviours all the time across the four drives).

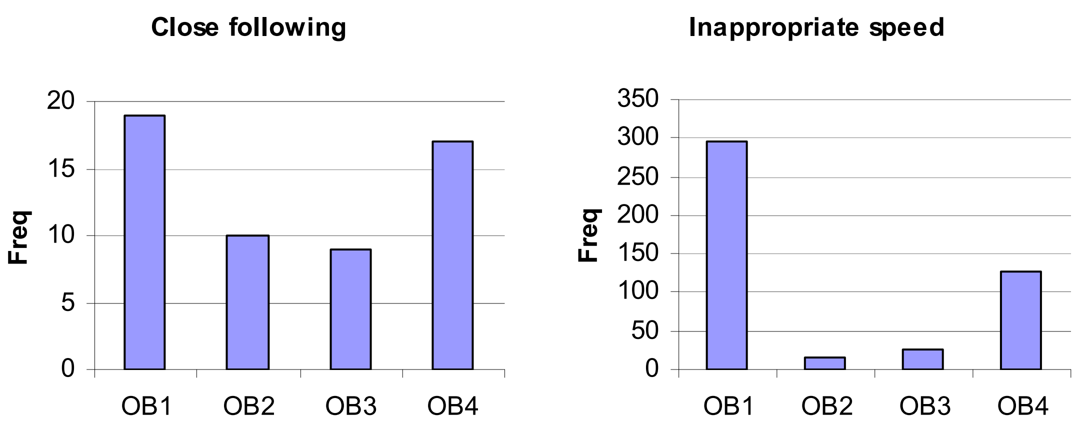


Figure 74: Observed negative driving behaviour across trial phases

Figure 75 presents comparison of mean Wiener Fahrprobe scores across the four observation drives with respect to demographic groups, which reveals similar patterns across groups, i.e. the ISA system led to fewer negative driving behaviours or reduced occurrence of negative driving behaviour regardless of a participant's demographic characteristics. The significance of the changes over time was confirmed by repeated measures ANOVA as presented in Table 34.

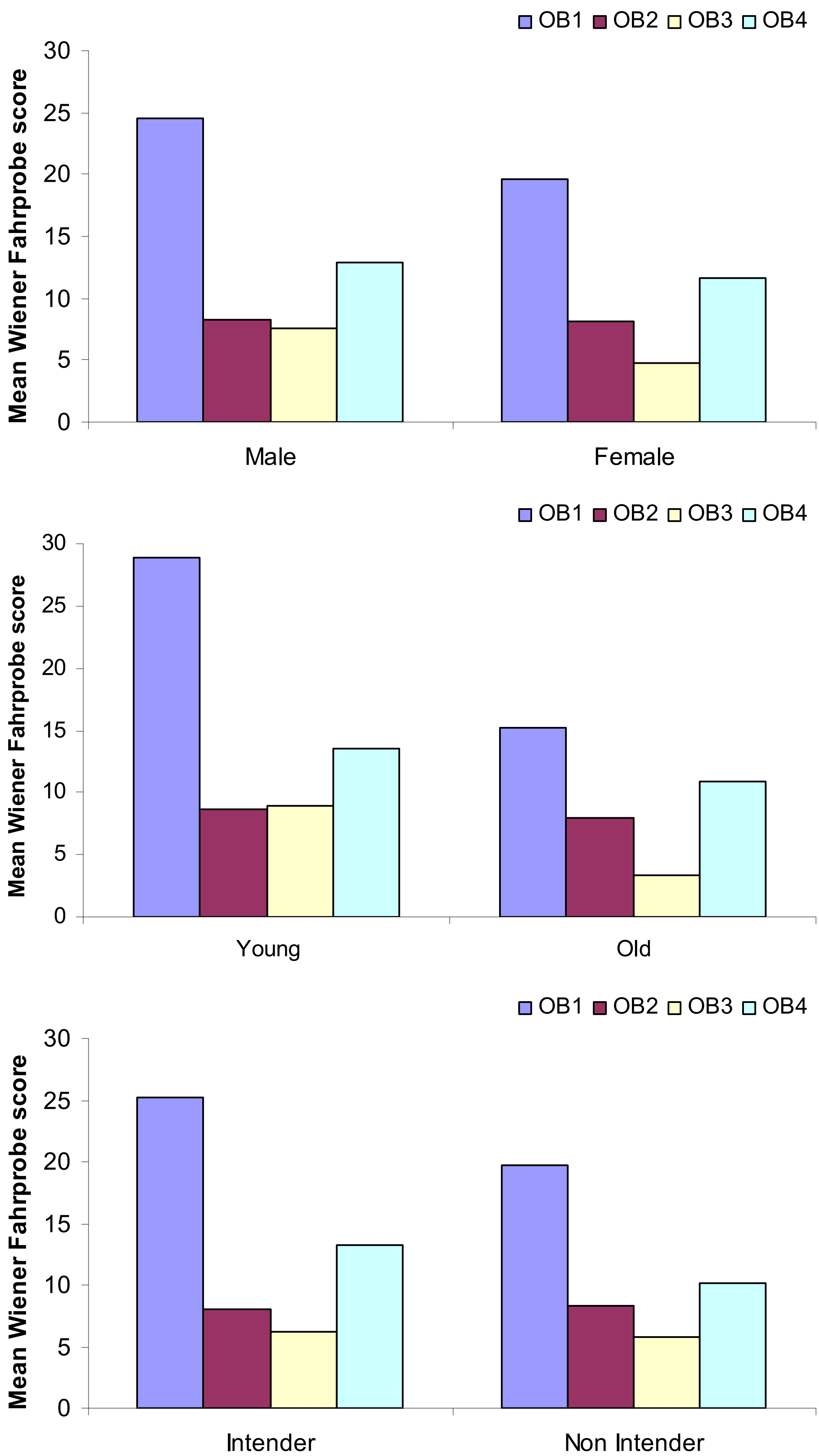


Figure 75: Mean Wiener Fahrprobe score across trial phases in terms of demographic groups

Table 34: Results of ANOVA and post-hoc t-test of Wiener Fahrprobe score across trial phases in terms of demographic groups

Demographic group		OB1	OB2	OB3	OB4	Repeated measures ANOVA: *F* statistic	significance	Effect size	Post-hoc t-tests	OB2	OB3	OB4
Gender	Male	24.57	8.29	7.57	12.86	F(3,18) = 6.89	0.003**	0.535	OB1	*	*	×
									OB2		×	×
									OB3			*
	Female	19.60	8.20	4.80	11.60	F(3,27) = 13.13	< 0.0005**	0.593	OB1	**	**	*
									OB2		×	×
									OB3			**
Age	Young	28.88	8.63	8.88	13.50	F(3,21) = 12.96	< 0.0005**	0.649	OB1	**	**	*
									OB2		×	*
									OB3			×
	Old	15.22	7.89	3.33	10.89	F(3,24) = 12.94	< 0.0005**	0.618	OB1	**	**	×
									OB2		*	×
									OB3			**
Intention to speed	Intender	25.17	8.00	6.17	10.17	F(3,15) = 6.95	0.004**	0.582	OB1	*	*	×
									OB2		×	×
									OB3			×
	Non-intender	19.73	8.36	5.82	13.18	F(3,30) = 13.90	< 0.0005**	0.582	OB1	**	**	×
									OB2		×	*
									OB3			**

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. × denotes the mean difference is not significant.

5.2.3 Subjective mental workload

As RTLX contains multiple scales, reliability analysis was carried out to confirm internal consistency among the six rating scales based on inter-item correlation; the results are presented in Table 35. The inter-item correlation between RTLX's sub scales was strong in OB1 and OB4, but was weaker in OB2 and OB3. It is worth noting that stronger inter-item correlation suggests that participants rated their perceived workload more consistently across the six workload dimensions, while weaker inter-item reliability suggests that participants showed stronger feelings on certain workload dimensions over the rest, but it does not invalidate the data.

Table 35: Reliability scores for NASA-RTLX measures

	OB1	OB2	OB3	OB4
Cronbach's Alpha (α)	0.599	0.786	0.176	0.316

Figure 76 shows the overall workload scores across trial phases. Changes in the perceived workload across trial phases suggest that participants initially felt that the driving task became more demanding in the presence of ISA. However, following prolonged experience with the system participants rated the driving task less demanding system than unsupported driving (i.e. workload score decreased from OB1 to OB3). When the ISA system was no longer present, participants' perceived workload began to rise to similar levels to the baseline (i.e. comparing OB4 against OB1). To confirm statistical significance of the changes in participants' perceived workload, repeated measures ANOVA was carried out. The results indicated that the changes over time were non significant.

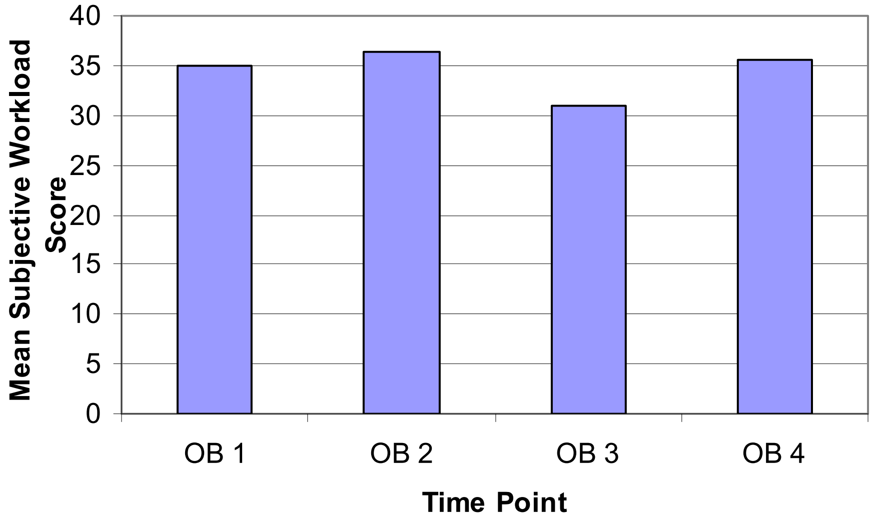


Figure 76: Mental workload scores over time

Figure 77 presents the mean scores of individual workload dimensions across the trial phases. In general, participants' perceived workload decreased when ISA was introduced and increased when ISA control was removed. In line with this drop in workload, participants also felt that their performance improved.

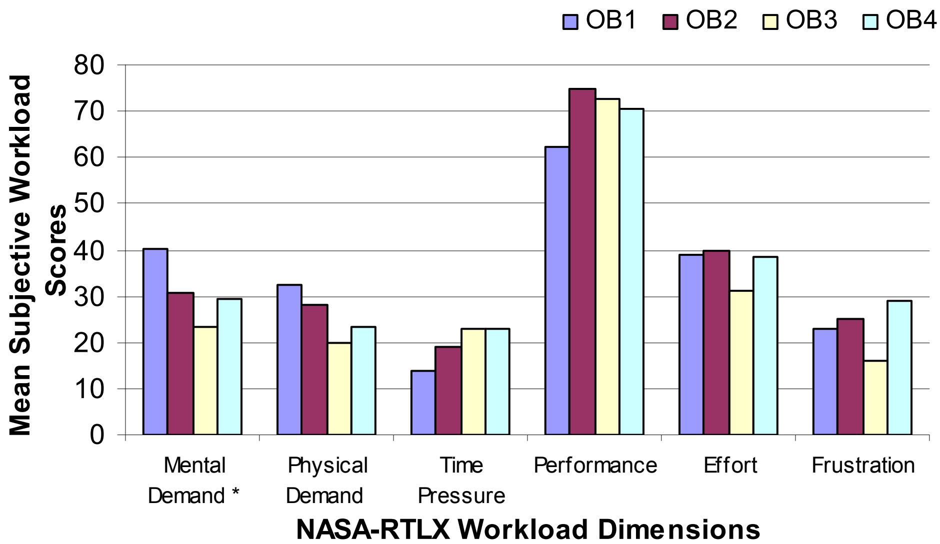


Figure 77: Individual dimension workload scores over time

Repeated measures ANOVA was employed to confirm the changes in workload scores over time. A significant difference was found across mental demand ratings. Post hoc analysis however did not reveal any significant differences between time points.

5.3 Discussion

The data collected from the observation drives have demonstrated some distinctive effect of introducing ISA on trip characteristics. ISA led to reduced max vehicle speed, increased trip duration, presumably due to diminished speed limit violations, and improved fuel economy. These trends imply that participants were adapting their driving style between trial phases as well as within the four months when ISA was activated (i.e. long-term behaviour adaptation). Carry-over effect was not evident as the measures derived from OB4 were always worse than OB1. However, the absence of carry-over effect in the observation drives corresponds to the analysis of vehicle speed presented in Section 3.3.

In addition, ISA also influenced driving behaviour as reflected on the Wiener Fahrprobe scores, either based on overall scores or individual negative driving behaviours. ISA dramatically cut down the frequency of inappropriate speed. Presumably due to reduced occurrence of speed limit violations, the recorded frequency of close following was also diminished when ISA was activated.

In terms of subjective self-assessment, participants appeared to experience less workload demand when driving with the support of ISA. Although not statistically confirmed by the data collected from this trial, further evidence may emerge when integrated analysis is carried out (i.e. pouring data from all four trials to increase the power of statistical analysis).

6. CONCLUSIONS AND IMPLICATIONS

6.1 Behavioural changes

The ISA system was observed to have a distinctive effect in terms of the transformation of the speed distribution across all speed zones except the 60 mph zones. This means that speeds over the speed limit and in particular very high exceeding of the limit were curtailed. On the 60 mph roads, speeding behaviour was already rare in the pre period (the first month), and therefore it is not surprising that there was little change with ISA. The lack of speeding on these roads is presumably due to traffic and road geometry conditions, and is in line with national data.

When ISA was switched on, a large proportion of the speed distribution initially spread over the speed limit was shifted to around or below the speed limit. Analysis of various statistics related to speed (mean, 85th percentile, etc.) revealed a 'V' shape across trial phases, i.e. the statistic goes down from Phase 1 to Phase 2, then up from Phase 2 to Phase 3. This pattern is especially prominent with respect to high percentiles of the speed distribution, which are strong indicators of speeding behaviour. ISA has not only diminished excessive speeding, but also led to a reduction in speed variation, especially in the urban area where lower speed limits apply. This delivers positive implications for a reduction in accident occurrence as a result of ISA intervention. ISA had also led to a diminished probability of jerk occurrence, which again may contribute to accident reduction on the roads.

The use of an overridable ISA system also provides an opportunity to demonstrate potential resistance from the driving population against its implementation, based on true behaviour instead of opinion. This group of drivers demonstrated a greater propensity to override the ISA system on 70 mph roads (23.3% of travel distance) than on roads with a lower speed limit. This may partially be a reflection of a common false attitude that it is safe to break the speed limits on motorways due to their smooth traffic operation and forgiving design. However, the overriding rate in lower speed zones still highlights concerns over road safety, as these are the roads where drivers are most likely to encounter conflicts with vulnerable road users such as pedestrians and cyclists.

Analysis of overriding behaviour in terms of demographic groups revealed that male participants, younger participants, and participants who intend to break speed limits overrode the system more often than their counterparts. Thus there is a tendency for ISA to be overridden more by those drivers who in safety terms stand to benefit most from using it. Thus those who need it most use it least. This suggests that there may be a role for incentives to keep ISA active and discouragement of overriding when ISA is deployed on a voluntary or fleet basis.

In addition to improved speed limit compliance, ISA also contributes to diminished negative driving behaviour, either at an aggregated level or in terms of individual driving behaviours such as inappropriate choice of speed, and close following, as revealed by the observation drives.

6.2 Attitudinal changes

Participants expressed little intention to exceed the speed limit. Generally intentions to speed weakened following experience with the ISA system. Similarly, attitudes towards speeding were negative and became slightly less favourable following exposure to the ISA system. Comparisons of behavioural beliefs showed that experience with ISA educated participants that speeding does not necessarily reduce journey times. This is especially important given that safe driving is often compromised in order to save time. The police were identified as the most influential referents however perceived pressure not to exceed the speed limit weakened following experience with the system. Although changes in moral norms tended to suggest that participants were less morally opposed to speeding following experience with the ISA system, past behaviour measures did indicate that participants had reduced their speeding behaviour. Cognitions correlated weakly with behaviour measures.

Although the effect was non significant, self-reported driving errors, lapses and violations decreased when driving with ISA and this effect was sustained following the removal of ISA. Despite an initial dip in acceptability, the rating of the ISA system in terms of usefulness and satisfaction, improved over time. Usefulness may represent a social utility construct, whereas satisfaction has more to with fulfilment of personal goals. It is encouraging that satisfaction and usefulness ratings were steadily improving with experience beyond the removal of the ISA system.

Participants tended to feel at increased risk and frustration in those situations (e.g. on a motorway, in fast moving and light traffic) which afforded the greatest opportunity to speed. Overtaking was raised also raised as a concern. Nevertheless in the majority of driving situations, participants did feel at less risk when driving with ISA compared to a normal car and experienced less frustration. Similarly participants believed that attention to the speed limits, potential hazards (e.g. other road users, pedestrians) and conflicts had increased. ISA seems to have raised participants' perceived safety and encouraged participants to develop more effective driving styles.

Support for the implementation of ISA was reasonably strong. Fifty seven percent of participants were willing to have ISA installed in their vehicles if its use was voluntary. Moreover 71% agreed with the compulsory fitting of ISA to all new vehicles and 50% agreed to the mandatory introduction of ISA for all drivers. Those who disagreed were most in favour of ISA for speed offenders.

7. REFERENCES

Ajzen, I. (1985). From intentions to action: A theory of planned behaviour. In Kuhl, J. and Beckman, J. (Eds.) Action control: From cognitions to behaviours (pp. 11-39). New York: Springer.

Ajzen, I. (1988). Attitudes, personality, and behaviour. Buckingham: Open University Press.

Ajzen, I. (1991). The theory of planned behaviour. Organizational Behaviour and Human Decision Processes, 50, 179-211.

Armitage, C.J. and Conner, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. British Journal of Social Psychology, 40, 471-499.

Arnett, J.J. (1996). Sensation seeking, aggressiveness and adolescent reckless behaviour. Personality and Individual Differences, 20, 693-702.

Beck, L. and Ajzen, I. (1991). Predicting dishonest actions using the Theory of Planned Behaviour. Journal of Research in Personality, 25, 285-301.

Byers, J.C., Bittner, A.C. Jr. and Hill, S.G. (1989). Traditional and raw task load index (TLX) correlations: Are paired comparisons necessary? Advances in Industrial Ergonomics and Safety I, 481-485.

Comte, S. (1999). On road study. Deliverable 10 of External Vehicle Speed Control Project. December 1999. Institute for Transport Studies, University of Leeds, Leeds.

Comte, S.L. (2000). New system: new behaviour? Transportation Research Part F, 3, 95-111.

Conner, M. and Armitage, C.J. (1998). Extending the theory of planned behaviour: A review and avenues for further research. Journal of Applied Social Psychology, 28, 1430-1464.

Conner, M. and Sparks, P. (1996). The theory of planned behaviour and health behaviours. In Conner, M. and Norman, P. (Eds.) Predicting health behaviour: Research and practice with social cognition models (pp. 121-162). Milton Keynes, UK: The Open University Press.

Corbett, C. (2000). The social construction of speeding as not 'real' crime. Crime Prevention and Community Safety, 2, 33-46.

de Waard, D., van der Hulst, M. and Brookhuis, K. (1999). Elderly and young drivers' reaction to an in-car enforcement and tutoring system. Applied Ergonomics, 30, 147-157.

Elliot, M.A., Armitage, C.J. and Baughan, C. (2002). Changing drivers' attitudes: is there potential for changing drivers' behaviour? Paper presented at the DTLR Behavioural Research in Road Safety: Twelfth Seminar. Dublin, Ireland.

Fishbein, M. and Ajzen, I. (1975). Belief, Attitude, Intention and Behaviour: An Introduction to Theory and Research. Reading, Mass.: Addison-Wesley.

Garder, P. (1990). Occurrence of evasive manoeuvres prior to accidents - Data from North Carolina accidents. Proceedings of the 2nd Workshop of ICTCT in Munich, November 1989, University of Lund, Lund.

Hantula, L. (1994). Accident Data Collected by Road Accident Investigation Teams in Finland. Paper presented at the OECD Workshop on Accident Data System, Jurmala, 1994.

Hyden, C. (1987). The development of a method for traffic safety evaluation: The Swedish Traffic Conflicts Technique. Bulletin 70. University of Lund, Lund, Sweden.

Jonah, B.A. (1997). Sensation seeking and risky driving: a review and synthesis of the literature. Accident Analysis and Prevention, 29(5), 651-665.

Lai, F., Chorlton, K. Carsten, O., Fowkes, M., Tjahjono, T. and Gawthorpe, S. (2005a). Results of Field Trial 1. The ISA-UK project. July, 2005. Institute for Transport Studies, University of Leeds, Leeds.

Lai, F., Chorlton, K. and Carsten, O. (2005b). Results of Field Trial 2. The ISA-UK project. November, 2005. Institute for Transport Studies, University of Leeds, Leeds.

Lai, F., Chorlton, K. and Carsten, O. (2006). Results of Field Trial 3. The ISA-UK project. June, 2006. Institute for Transport Studies, University of Leeds, Leeds.

Lawton, R., Parker, D., Stradling, S.G. and Manstead, A.S.R. (1997). Self-reported attitude towards speeding and its possible consequences in five different road contexts. Journal of Community and Applied Social Psychology, 7, 153-165.

Lawton, R., Parker, D., Manstead, A.S.R. and Stradling, S.G. (1997). The role of affect in predicting social behaviours: The case of road traffic violations. Journal of Applied Psychology, 27, 1258-1276.

Lex (1997). 1997 Lex report on motoring: driving for safety. Lex Service, London.

Lex (1998). 1998 Lex report on motoring: driving for the future. Lex Service, London.

Manstead, A.S.R. and Parker, D. (1996). Reconstructing the theory of planned behaviour. Paper presented at the Eleventh General Meeting of the European Association of Experimental Social Psychology. Gmunden, Austria.

Manstead, A.S.R., Parker, D., Stradling, S.G. and Lawton, R. (1996). Adding affect to the Theory of Planned Behaviour. Unpublished manuscript, University of Manchester, UK.

National Statistics Socio Economic Classification.
http://www.statistics.gov.uk/methods_quality/ns_sec.

Nygård, M. (1999). A method for analysis of traffic safety with the help of speed profiles. VTT Communities and Infrastructure report.

Nilsson, G. (1981). The Effect of Speed Limits on Traffic Accidents in Sweden. Proceedings of International Symposium on the Effects of Speed Limits on Traffic Accidents and Transport Energy Use. Organization for Economic Cooperation and Development.

Ordnance Survey (2001). OSCAR User Guide v4.0. Ordnance Survey. Southampton, UK

Parker, D., Manstead, A.S.R., Stradling, S.G., Reason, J. T. and Baxter, J. S. (1992a). Intention to commit driving violations: An application of the theory of planned behaviour. Journal of Applied Psychology, 77, 94-101.

Parker, D., Manstead, A.S.R., Stradling, S.G. and Reason, J.T. (1992b). Determinants of intention to commit driving violations. Accident Analysis and Prevention, 24, 117-131.

Parker, D., Manstead, A.S.R. and Stradling, S.G. (1995). Extending the theory of planned behaviour: The role of personal norm. British Journal of Social Psychology, 34, 127-137.

Parker, D., Reason, J., Manstead, A. and Stradling, S. (1995). Driving errors, driving violations and accident involvement. Ergonomics, 38(5), 1036-48.

Parker, D., Stradling, S.G. and Manstead, A.S.R. (1996). Modifying beliefs and attitudes to exceeding the speed limit: an intervention study based on the theory of planned behaviour. Journal of Applied Social Psychology, 26, 1-19.

Parker, D., Lajunen, T. and Stradling, S.G. (1998). Attitudinal predictors of interpersonally aggressive violations on the road. Transportation Research Part F, 1, 11-24.

Randall, D.M. and Gibson, A.M. (1991). Ethical decision making in the medical profession: An application of the theory of planned behaviour. Journal of Business Ethics, 10, 111-112.

Reason, J.T., Manstead, A., Stradling, S. and Baxter, J. (1990). Errors and violations on the roads: A real distinction? Ergonomics, 33, 1315-1332.

Risser, R. (1985). Behaviour in traffic conflict situations. Accident Analysis and Prevention, 17(2), 179-197.

Taylor, M.C, Lynam, D.A and Baruya, A. (2000). The effects of drivers' speed on the frequency of road accidents. TRL Report 421. TRL, Crowthorne, UK.

Taylor, M.C, Baruya, A. and Kennedy, J.V. (2002). The relationship between speed and accidents on rural single-carriageway roads. TRL Report 511. Crowthorne: TRL Limited.

Tejero Gimeno, P., Carbonell Vayá, E. and Canet Centellas, F. (1997). An assessment of some causal models to explain drinking-driving intention. Paper presented at the ICTCT Conference. Department of Traffic Planning and Engineering, Lund University.

Trafimow, D., Sheeran, P., Conner, M. and Finlay, K.A. (2002). Evidence that perceived behavioural control is a multidimensional construct: Perceived control and perceived difficulty. British Journal of Social Psychology, 41, 101-121.

Van der Horst, A.R.A. (1984). The ICTCT Calibration Study at Malmo: A quantitative analysis of video recordings. TNO Institute of Perception, Soesterberg. The Netherlands.

Van der Laan, J.D., Heino, A. and De Waard, D. (1997). A simple procedure for the assessment of acceptance of Advanced Transport Telematics. Transportation Research Part C, 5(1), 1-10.

Van der Pligt, J. and de Vries, N. (1998). Belief importance in expectancy-value models of attitudes. Journal of Applied Social Psychology, 28, 1339-1354.

West R.J., Elander J. and French D.J. (1992). Decision making, personality and driving style as correlates of individual accidents risk. Contractor Report 309, Crowthorne: Transport Research Laboratory.

Zuckerman, M. (1994). Behavioural expressions and biosocial bases of sensation seeking. Cambridge: University of Cambridge Press.

APPENDIX A: ANOVA RESULTS FOR KEY STATISTICS OF THE SPEED DISTRIBUTION

Table A1: ANOVA results for mean speed by gender

<table>
<tr><th rowspan="2">Gender group</th><th rowspan="2">Speed zone</th><th colspan="3">Mean</th><th colspan="6">Repeated measures ANOVA</th></tr>
<tr><th>Phase 1</th><th>Phase 2</th><th>Phase 3</th><th>F statistic</th><th>significance</th><th>Effect size</th><th colspan="3">Post-hoc t-tests</th></tr>
<tr><td rowspan="18">Male</td><td rowspan="3">20</td><td rowspan="3">18.39</td><td rowspan="3">17.02</td><td rowspan="3">17.50</td><td rowspan="3">F(2,21) = 0.62</td><td rowspan="3">0.55</td><td rowspan="3">0.06</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">30</td><td rowspan="3">25.83</td><td rowspan="3">25.12</td><td rowspan="3">25.82</td><td rowspan="3">F(2,23) = 2.03</td><td rowspan="3">0.15</td><td rowspan="3">0.15</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">40</td><td rowspan="3">33.49</td><td rowspan="3">33.04</td><td rowspan="3">33.74</td><td rowspan="3">F(2,23) = 0.27</td><td rowspan="3">0.76</td><td rowspan="3">0.02</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">50</td><td rowspan="3">40.33</td><td rowspan="3">39.72</td><td rowspan="3">39.15</td><td rowspan="3">F(2,22) = 0.07</td><td rowspan="3">0.94</td><td rowspan="3">0.01</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">60</td><td rowspan="3">45.79</td><td rowspan="3">45.28</td><td rowspan="3">46.55</td><td rowspan="3">F(2,23) = 0.44</td><td rowspan="3">0.65</td><td rowspan="3">0.04</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">70</td><td rowspan="3">74.32</td><td rowspan="3">69.61</td><td rowspan="3">75.53</td><td rowspan="3">F(2,21) = 2.68</td><td rowspan="3">0.09</td><td rowspan="3">0.20</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="18">Female</td><td rowspan="3">20</td><td rowspan="3">15.53</td><td rowspan="3">16.11</td><td rowspan="3">17.02</td><td rowspan="3">F(2,25) = 0.39</td><td rowspan="3">0.68</td><td rowspan="3">0.03</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">30</td><td rowspan="3">24.86</td><td rowspan="3">24.36</td><td rowspan="3">25.45</td><td rowspan="3">F(2,29) = 1.26</td><td rowspan="3">0.30</td><td rowspan="3">0.08</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">40</td><td rowspan="3">34.79</td><td rowspan="3">34.47</td><td rowspan="3">34.19</td><td rowspan="3">F(2,29) = 0.20</td><td rowspan="3">0.82</td><td rowspan="3">0.01</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">50</td><td rowspan="3">39.70</td><td rowspan="3">39.33</td><td rowspan="3">39.25</td><td rowspan="3">F(2,29) = 0.26</td><td rowspan="3">0.77</td><td rowspan="3">0.02</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">60</td><td rowspan="3">45.53</td><td rowspan="3">45.32</td><td rowspan="3">44.29</td><td rowspan="3">F(2,29) = 0.54</td><td rowspan="3">0.59</td><td rowspan="3">0.04</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">70</td><td rowspan="3">63.68</td><td rowspan="3">64.59</td><td rowspan="3">69.15</td><td rowspan="3">F(2,29) = 1.33</td><td rowspan="3">0.28</td><td rowspan="3">0.08</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
</table>

Note: × denotes the mean difference is not significant

Table A2: ANOVA results for the 85th percentile of the speed distribution by gender

<table>
<tr><th rowspan="2">Gender group</th><th rowspan="2">Speed zone</th><th colspan="3">Mean</th><th colspan="6">Repeated measures ANOVA</th></tr>
<tr><th>Phase 1</th><th>Phase 2</th><th>Phase 3</th><th>F statistic</th><th>significance</th><th>Effect size</th><th colspan="3">Post-hoc t-tests</th></tr>
<tr><td rowspan="18">Male</td><td rowspan="3">20</td><td rowspan="3">24.52</td><td rowspan="3">21.83</td><td rowspan="3">23.43</td><td rowspan="3">F(2,21) = 1.95</td><td rowspan="3">0.168</td><td rowspan="3">0.16</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>✗</td><td>✗</td></tr>
<tr><td>PH2</td><td></td><td>✗</td></tr>
<tr><td rowspan="3">30</td><td rowspan="3">33.97</td><td rowspan="3">31.37</td><td rowspan="3">33.57</td><td rowspan="3">F(2,23) = 13.14</td><td rowspan="3">< 0.0005**</td><td rowspan="3">0.53</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>**</td><td>✗</td></tr>
<tr><td>PH2</td><td></td><td>**</td></tr>
<tr><td rowspan="3">40</td><td rowspan="3">42.75</td><td rowspan="3">40.52</td><td rowspan="3">42.66</td><td rowspan="3">F(2,23) = 2.85</td><td rowspan="3">0.078</td><td rowspan="3">0.20</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>✗</td><td>✗</td></tr>
<tr><td>PH2</td><td></td><td>✗</td></tr>
<tr><td rowspan="3">50</td><td rowspan="3">50.99</td><td rowspan="3">50.48</td><td rowspan="3">51.45</td><td rowspan="3">F(2,22) = 0.24</td><td rowspan="3">0.791</td><td rowspan="3">0.02</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>✗</td><td>✗</td></tr>
<tr><td>PH2</td><td></td><td>✗</td></tr>
<tr><td rowspan="3">60</td><td rowspan="3">56.64</td><td rowspan="3">56.27</td><td rowspan="3">57.37</td><td rowspan="3">F(2,23) = 0.20</td><td rowspan="3">0.820</td><td rowspan="3">0.02</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>✗</td><td>✗</td></tr>
<tr><td>PH2</td><td></td><td>✗</td></tr>
<tr><td rowspan="3">70</td><td rowspan="3">87.58</td><td rowspan="3">80.78</td><td rowspan="3">88.35</td><td rowspan="3">F(2,21) = 2.93</td><td rowspan="3">0.076</td><td rowspan="3">0.22</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>✗</td><td>✗</td></tr>
<tr><td>PH2</td><td></td><td>✗</td></tr>
<tr><td rowspan="18">Female</td><td rowspan="3">20</td><td rowspan="3">20.70</td><td rowspan="3">20.45</td><td rowspan="3">22.69</td><td rowspan="3">F(2,25) = 1.80</td><td rowspan="3">0.185</td><td rowspan="3">0.13</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>✗</td><td>✗</td></tr>
<tr><td>PH2</td><td></td><td>✗</td></tr>
<tr><td rowspan="3">30</td><td rowspan="3">32.82</td><td rowspan="3">31.11</td><td rowspan="3">33.38</td><td rowspan="3">F(2,29) = 11.14</td><td rowspan="3">< 0.0005**</td><td rowspan="3">0.43</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>**</td><td>✗</td></tr>
<tr><td>PH2</td><td></td><td>**</td></tr>
<tr><td rowspan="3">40</td><td rowspan="3">43.80</td><td rowspan="3">43.03</td><td rowspan="3">42.67</td><td rowspan="3">F(2,29) = 0.08</td><td rowspan="3">0.924</td><td rowspan="3">0.01</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>✗</td><td>✗</td></tr>
<tr><td>PH2</td><td></td><td>✗</td></tr>
<tr><td rowspan="3">50</td><td rowspan="3">49.56</td><td rowspan="3">49.24</td><td rowspan="3">50.55</td><td rowspan="3">F(2,29) = 0.83</td><td rowspan="3">0.445</td><td rowspan="3">0.05</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>✗</td><td>✗</td></tr>
<tr><td>PH2</td><td></td><td>✗</td></tr>
<tr><td rowspan="3">60</td><td rowspan="3">54.55</td><td rowspan="3">53.93</td><td rowspan="3">54.27</td><td rowspan="3">F(2,29) = 0.22</td><td rowspan="3">0.807</td><td rowspan="3">0.01</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>✗</td><td>✗</td></tr>
<tr><td>PH2</td><td></td><td>✗</td></tr>
<tr><td rowspan="3">70</td><td rowspan="3">75.03</td><td rowspan="3">74.37</td><td rowspan="3">78.08</td><td rowspan="3">F(2,29) = 1.07</td><td rowspan="3">0.358</td><td rowspan="3">0.07</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>✗</td><td>✗</td></tr>
<tr><td>PH2</td><td></td><td>✗</td></tr>
</table>

Note:
1. ** denotes the mean difference is significant at the 0.01 level
2. ✗ denotes the mean difference is not significant

Table A3: ANOVA results for mean speed between age groups

Age group	Speed zone	Phase 1	Phase 2	Phase 3	Repeated measures ANOVA			Post-hoc t-tests		
					F statistic	significance	Effect size	PH1 vs PH2	PH1 vs PH3	PH2 vs PH3
Young	20	17.34	16.63	16.35	F(2,20) = 1.01	0.382	0.09	×	×	×
	30	25.12	24.32	25.18	F(2,26) = 2.55	0.098	0.16	×	×	×
	40	34.88	34.44	34.95	F(2,26) = 0.21	0.815	0.02	×	×	×
	50	39.77	38.31	37.74	F(2,25) = 0.59	0.560	0.05	×	×	×
	60	47.58	46.54	44.40	F(2,26) = 1.88	0.172	0.13	×	×	×
	70	73.09	68.44	74.46	F(2,24) = 1.56	0.231	0.12	×	×	×
Old	20	18.57	17.26	19.93	F(2,26) = 1.05	0.364	0.07	×	×	×
	30	25.62	25.14	25.96	F(2,26) = 1.07	0.358	0.08	×	×	×
	40	33.72	33.31	33.45	F(2,26) = 0.25	0.779	0.02	×	×	×
	50	40.06	40.76	40.50	F(2,26) = 0.28	0.758	0.02	×	×	×
	60	44.74	44.64	45.53	F(2,26) = 0.46	0.636	0.03	×	×	×
	70	63.93	65.90	69.32	F(2,26) = 1.66	0.210	0.11	×	×	×

Note: × denotes the mean difference is not significant

Table A4: ANOVA results for the 85th percentile of the speed distribution between age groups

Age group	Speed zone	Phase 1	Phase 2	Phase 3	Repeated measures ANOVA			Post-hoc t-tests		
					F statistic	significance	Effect size			
Young	20	23.41	21.46	22.13	F(2,20) = 4.06	0.033*	0.29		PH2	PH3
								PH1	*	×
								PH2		×
	30	33.80	31.27	33.66	F(2,26) = 21.63	< 0.0005**	0.62		PH2	PH3
								PH1	**	×
								PH2		**
	40	46.30	43.85	45.49	F(2,26) = 0.60	0.556	0.04		PH2	PH3
								PH1	×	×
								PH2		×
	50	51.62	49.42	50.99	F(2,25) = 2.33	0.118	0.16		PH2	PH3
								PH1	×	×
								PH2		×
	60	58.05	56.05	54.72	F(2,26) = 2.14	0.138	0.14		PH2	PH3
								PH1	×	×
								PH2		×
	70	85.82	80.67	86.35	F(2,24) = 1.59	0.224	0.12		PH2	PH3
								PH1	×	×
								PH2		×
Old	20	24.18	21.58	26.06	F(2,26) = 2.55	0.098	0.16		PH2	PH3
								PH1	×	×
								PH2		*
	30	33.18	31.24	33.41	F(2,26) = 9.29	0.001**	0.42		PH2	PH3
								PH1	**	×
								PH2		**
	40	41.28	40.30	41.35	F(2,26) = 2.37	0.113	0.15		PH2	PH3
								PH1	×	×
								PH2		×
	50	48.92	50.13	50.96	F(2,26) = 1.61	0.220	0.11		PH2	PH3
								PH1	×	×
								PH2		×
	60	53.86	53.76	55.88	F(2,26) = 1.73	0.197	0.12		PH2	PH3
								PH1	×	×
								PH2		×
	70	75.60	74.46	78.59	F(2,26) = 0.93	0.407	0.07		PH2	PH3
								PH1	×	×
								PH2		×

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. × denotes the mean difference is not significant

Table A5: ANOVA results for mean speed between intention groups

Intention group	Speed zone	Phase 1	Phase 2	Phase 3	Repeated measures ANOVA			Post-hoc t-tests		
					F statistic	significance	Effect size			
Intender	20	18.33	16.98	17.50	F(2,15) = 0.43	0.656	0.05		PH2	PH3
								PH1	×	×
								PH2		×
	30	25.55	24.87	25.43	F(2,17) = 0.93	0.412	0.10		PH2	PH3
								PH1	×	×
								PH2		×
	40	34.11	33.66	34.45	F(2,17) = 0.42	0.666	0.05		PH2	PH3
								PH1	×	×
								PH2		×
	50	39.96	39.28	37.56	F(2,16) = 0.15	0.860	0.02		PH2	PH3
								PH1	×	×
								PH2		×
	60	46.63	45.70	46.60	F(2,17) = 0.43	0.658	0.05		PH2	PH3
								PH1	×	×
								PH2		×
	70	72.51	69.98	72.56	F(2,15) = 0.33	0.724	0.04		PH2	PH3
								PH1	×	×
								PH2		×
Non-intender	20	16.30	16.36	17.14	F(2,31) = 0.20	0.821	0.01		PH2	PH3
								PH1	×	×
								PH2		×
	30	25.33	24.75	25.81	F(2,35) = 2.18	0.129	0.11		PH2	PH3
								PH1	×	×
								PH2		×
	40	34.21	33.85	33.74	F(2,35) = 0.12	0.887	0.01		PH2	PH3
								PH1	×	×
								PH2		×
	50	39.92	39.60	40.17	F(2,35) = 0.19	0.825	0.01		PH2	PH3
								PH1	×	×
								PH2		×
	60	45.04	45.12	44.06	F(2,35) = 0.39	0.681	0.02		PH2	PH3
								PH1	×	×
								PH2		×
	70	63.49	64.25	70.72	F(2,35) = 2.16	0.131	0.11		PH2	PH3
								PH1	×	×
								PH2		×

Note: × denotes the mean difference is not significant

Table A6: ANOVA results for the 85th percentile of the speed distribution between intention groups

Intention group	Speed zone	Phase 1	Phase 2	Phase 3	Repeated measures ANOVA			Post-hoc t-tests		
					F statistic	significance	Effect size	PH1 vs PH2	PH1 vs PH3	PH2 vs PH3
Intender	20	24.50	21.83	23.48	F(2,15) = 1.35	0.289	0.15	×	×	×
	30	33.19	31.20	32.68	F(2,17) = 6.25	0.009**	0.42	**	×	*
	40	41.92	40.42	41.91	F(2,17) = 2.14	0.148	0.20	×	×	×
	50	50.42	50.59	50.19	F(2,16) = 0.02	0.979	0.00	×	×	×
	60	56.73	55.98	57.88	F(2,17) = 1.11	0.353	0.12	×	×	×
	70	85.41	80.92	83.65	F(2,15) = 0.39	0.681	0.05	×	×	×
Non-intender	20	21.60	20.72	22.75	F(2,31) = 1.71	0.197	0.10	×	×	×
	30	33.57	31.28	33.90	F(2,35) = 20.89	< 0.0005**	0.54	**	×	**
	40	43.67	42.27	42.94	F(2,35) = 0.33	0.724	0.02	×	×	×
	50	49.91	49.34	51.45	F(2,35) = 2.00	0.150	0.10	×	×	×
	60	54.25	53.86	53.55	F(2,35) = 0.12	0.884	0.01	×	×	×
	70	74.83	74.31	80.52	F(2,35) = 2.19	0.127	0.11	×	×	*

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. × denotes the mean difference is not significant

APPENDIX B: ANOVA RESULTS FOR KEY STATISTICS OF QUESTIONNAIRE DATA

Table B1: ANOVA results for cognitions relating to speeding on a motorway

	TPB	Phase 1	Phase 2	Phase 3	Repeated measures ANOVA *F* statistic	Repeated measures ANOVA significance	Repeated measures ANOVA Effect size	Post-hoc t-tests		
MOTORWAY SCENARIO	BI	0.144	0.023	-0.509	F (2,28) = 3.030	0.064	0.178		PH2	PH3
								PH1	×	×
								PH2		×
	ATT	0.020	0.372	0.274	F (2,24) = 0.982	0.389	0.076		PH2	PH3
								PH1	×	×
								PH2		×
	BE	-1.279	-0.527	-1.232	F (2,28) = 2.344	0.115	0.143		PH2	PH3
								PH1	×	×
								PH2		×
	NBMC	1.915	0.748	1.028	F (2,28) = 0.560	0.577	0.038		PH2	PH3
								PH1	×	×
								PH2		×
	PBC	5.912	5.888	5.966	F (2,28) = 0.067	0.936	0.005		PH2	PH3
								PH1	×	×
								PH2		×
	CBF	-2.711	-2.042	-1.924	F(2,28) = 0.399	0.675	0.028		PH2	PH3
								PH1	×	×
								PH2		×
	MN	4.129	4.418	4.408	F (2,28) = 0.306	0.738	0.021		PH2	PH3
								PH1	×	×
								PH2		×
	AR	-0.784	-0.728	-1.110	F (2,28) = 1.768	0.189	0.112		PH2	PH3
								PH1	×	×
								PH2		×
	PB	4.375	3.734	4.091	F (2,28) = 0.862	0.433	0.058		PH2	PH3
								PH1	×	×
								PH2		×
	RISK	5.429	5.184	5.150	F (1,28) = 1.049	0.364	0.070		PH2	PH3
								PH1	×	×
								PH2		×

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. × denotes the mean difference is not significant

Table B2: ANOVA results for cognitions relating to speeding on an urban road

	TPB	Phase 1	Phase 2	Phase 3	Repeated measures ANOVA			Post-hoc t-tests		
					F statistic	significance	Effect size	PH1 vs PH2	PH1 vs PH3	PH2 vs PH3
URBAN SCENARIO	BI	-0.810	-1.363	-1.267	F (2,28) = 2.055	0.174	0.128	×	×	×
	ATT	-0.257	-0.494	-0.873	F (2,26) = 3.417	0.048	0.208	×	×	×
	BE	-2.093	-2.189	-2.237	F (2,28) = 0.062	0.940	0.004	×	×	×
	NBM C	4.241	5.274	3.736	F (2,26) = 1.773	0.190	0.120	×	×	×
	PBC	5.520	5.540	5.638	F (2,26) = 0.163	0.850	0.012	×	×	×
	CBF	-2.651	-1.864	-2.689	F (2,28) = 0.467	0.632	0.032	×	×	×
	MN	5.408	5.062	5.046	F (2,26) = 1.605	0.220	0.110	×	×	×
	AR	-0.016	0.440	0.539	F (2,26) = 3.744	0.040	0.224	×	×	×
	PB	4.572	3.508	3.473	F (2,26) = 4.506	0.021	0.257	×	*	×
	RISK	4.821	5.098	5.068	F (2,26) = 0.796	0.462	0.058	×	×	×

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. × denotes the mean difference is not significant

Table B3: ANOVA results for cognitions relating to speeding on a residential road

<table>
<tr><th rowspan="2"></th><th rowspan="2">TPB</th><th rowspan="2">Phase 1</th><th rowspan="2">Phase 2</th><th rowspan="2">Phase 3</th><th colspan="3">Repeated measures ANOVA</th><th colspan="3" rowspan="2">Post-hoc t-tests</th></tr>
<tr><th>F statistic</th><th>significance</th><th>Effect size</th></tr>
<tr><td rowspan="30">RESIDENTIAL SCENARIO</td><td rowspan="3">BI</td><td rowspan="3">-1.512</td><td rowspan="3">-1.936</td><td rowspan="3">-2.187</td><td rowspan="3">F (2,28) = 4.107</td><td rowspan="3">0.027</td><td rowspan="3">0.227</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">ATT</td><td rowspan="3">-1.636</td><td rowspan="3">-1.547</td><td rowspan="3">-1.633</td><td rowspan="3">F (2,28) = 0.082</td><td rowspan="3">0.921</td><td rowspan="3">0.006</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">BE</td><td rowspan="3">-3.232</td><td rowspan="3">-3.590</td><td rowspan="3">-3.090</td><td rowspan="3">F (2,28) = 1.129</td><td rowspan="3">0.338</td><td rowspan="3">0.075</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">NBMC</td><td rowspan="3">6.645</td><td rowspan="3">5.998</td><td rowspan="3">5.248</td><td rowspan="3">F (2,28) = 1.209</td><td rowspan="3">0.314</td><td rowspan="3">0.079</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">PBC</td><td rowspan="3">5.183</td><td rowspan="3">5.516</td><td rowspan="3">5.114</td><td rowspan="3">F (2,28) = 3.354</td><td rowspan="3">0.049</td><td rowspan="3">0.193</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">CBF</td><td rowspan="3">-4.623</td><td rowspan="3">-3.995</td><td rowspan="3">-3.505</td><td rowspan="3">F (2,28) = 0.726</td><td rowspan="3">0.493</td><td rowspan="3">0.049</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">MN</td><td rowspan="3">6.141</td><td rowspan="3">5.897</td><td rowspan="3">5.608</td><td rowspan="3">F (2,26) = 1.138</td><td rowspan="3">0.336</td><td rowspan="3">0.080</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">AR</td><td rowspan="3">0.509</td><td rowspan="3">0.751</td><td rowspan="3">0.463</td><td rowspan="3">F (2,26) = 0.453</td><td rowspan="3">0.578</td><td rowspan="3">0.034</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">PB</td><td rowspan="3">4.598</td><td rowspan="3">3.376</td><td rowspan="3">3.492</td><td rowspan="3">F (2,26) = 3.967</td><td rowspan="3">0.031</td><td rowspan="3">0.234</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
<tr><td rowspan="3">RISK</td><td rowspan="3">5.699</td><td rowspan="3">5.139</td><td rowspan="3">5.098</td><td rowspan="3">F (2,26) = 2.720</td><td rowspan="3">0.085</td><td rowspan="3">0.173</td><td></td><td>PH2</td><td>PH3</td></tr>
<tr><td>PH1</td><td>×</td><td>×</td></tr>
<tr><td>PH2</td><td></td><td>×</td></tr>
</table>

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. × denotes the mean difference is not significant

Table B4: ANOVA results for cognitions relating to disengaging the ISA system

	TPB	Phase 1	Phase 2	Phase 3	Repeated measures ANOVA			Post-hoc t-tests		
					F statistic	significance	Effect size			
DISENGAGE SCENARIO	BI	-1.263	-1.362	-1.318	F (2,28) = 0.044	0.894	0.003		PH2	PH3
								PH1	×	×
								PH2		×
	ATT	0.281	0.526	0.159	F (2,28) = 0.772	0.409	0.052		PH2	PH3
								PH1	×	×
								PH2		*
	BE	1.081	1.114	1.644	F (2,28) = 0.492	0.511	0.034		PH2	PH3
								PH1	×	×
								PH2		×
	NBMC	1.524	0.577	1.418	F (2,28) = 0.181	0.731	0.013		PH2	PH3
								PH1	×	×
								PH2		×
	PBC	5.862	6.035	6.374	F (2,28) = 5.754	0.008	0.291		PH2	PH3
								PH1	×	*
								PH2		*
	CBF	-5.905	-3.373	-3.592	F (2,28) = 1.681	0.214	0.107		PH2	PH3
								PH1	×	×
								PH2		×
	MN	4.488	3.797	4.203	F (2,28) = 0.939	0.370	0.063		PH2	PH3
								PH1	×	×
								PH2		×
	AR	0.685	0.015	-0.408	F (2,28) = 4.602	0.019	0.247		PH2	PH3
								PH1	×	*
								PH2		×
	RISK	3.680	3.989	3.694	F (2,28) = 0.775	0.432	0.052		PH2	PH3
								PH1	×	×
								PH2		×

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. *** denotes the mean difference is significant at the 0.001 level
4. × denotes the mean difference is not significant

Table B5: ANOVA results for participants' self identity scores

TPB	Phase 1	Phase 2	Phase 3	Repeated measures ANOVA			Post-hoc t-tests		
				F statistic	significance	Effect size			
SI	5.802	5.55	5.516	F (2,28) = 0.712	0.499	0.048		PH2	PH3
							PH1	×	×
							PH2		×

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. *** denotes the mean difference is significant at the 0.001 level
4. × denotes the mean difference is not significant

Table B6: ANOVA results for participants' acceptability ratings of ISA

		Time 1	Time 2	Time 3	Time 4	Repeated measures ANOVA			Post-hoc t-tests			
						F statistic	significance	Effect size				
ACCEPTABILITY	USE	1.047	0.867	1.165	1.116	F (3,30) = 0.413	0.588	0.040		T2	T3	T4
									T1	×	×	×
									T2		×	×
									T3			×
	SAT	0.221	-0.167	0.250	0.263	F (3,30) = 0.729	0.543	0.068		T2	T3	T4
									T1	×	×	×
									T2		×	×
									T3			×

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. *** denotes the mean difference is significant at the 0.001 level
4. × denotes the mean difference is not significant

Table B7: ANOVA results for participants' propensity to commit lapses, errors and violations

		Time 1	Time 2	Time 3	Time 4	Repeated measures ANOVA			Post-hoc t-tests			
						F statistic	significance	Effect size				
DRIVER BEHAVIOUR QUESTIONNAIRE	LAPSE	0.729	0.711	0.645	0.606	F (3,39) = 0.510	0.678	0.038		T2	T3	T4
									T1	×	×	×
									T2		×	×
									T3			×
	ERROR	0.362	0.298	0.343	0.274	F (3,39) = 0.325	0.808	0.024		T2	T3	T4
									T1	×	×	×
									T2		×	×
									T3			×
	VIOL	0.594	0.515	0.523	0.414	F (3,39) = 1.651	0.193	0.113		T2	T3	T4
									T1	×	×	×
									T2		×	×
									T3			×
	TOTAL	0.562	0.508	0.505	0.431	F (3,39) = 0.762	0.522	0.055		T2	T3	T4
									T1	×	×	×
									T2		×	×
									T3			×

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. *** denotes the mean difference is significant at the 0.001 level
4. × denotes the mean difference is not significant

Table B8: ANOVA results for participants' perceptions of change in risk when driving with ISA

		Expect	Early Use	Prolonged Use	Repeated measures ANOVA: *F* statistic	significance	Effect size	Post-hoc t-tests: EXP–EAR	EXP–PRO	EAR–PRO
RISK	overtaking	0.890	1.025	0.852	F (2,26) = 0.360	0.617	0.027	×	×	×
	fast moving	0.245	0.861	0.568	F (2,26) = 4.467	0.022	0.256	×	×	×
	motorway	0.100	0.661	0.584	F (2,26) = 2.692	0.108	0.172	×	×	×
	20mph	-0.953	-0.767	-0.460	F (2,26) = 2.602	0.093	0.167	×	×	×
	major road (40-60mph)	-0.385	-0.227	-0.042	F (2,26) = 0.934	0.406	0.067	×	×	×
	night-time	-0.330	-0.352	-0.080	F (2,26) =1.601	0.221	0.110	×	×	×
	day time	-0.296	-0.135	-0.202	F (2,26) = 0.229	0.797	0.017	×	×	×
	heavy traffic	-0.290	-0.401	-0.237	F (2,26) = 0.268	0.662	0.020	×	×	×
	light traffic	-0.150	0.231	0.074	F (2,26) = 1.586	0.224	0.109	×	×	×
	bad weather	-0.752	-0.478	-0.346	F (2,26) = 1.151	0.332	0.081	×	×	×
	poor visibility	-0.848	-0.417	-0.346	F (2,26) = 2.443	0.107	0.158	×	×	×
	child presence	-1.085	-0.889	-0.353	F (2,26) = 4.060	0.029	0.238	×	×	×
	ped. crossing	-1.012	-0.774	-0.443	F (2,26) = 3.450	0.047	0.210	×	×	×
	compl. junction	-0.703	-0.693	-0.195	F (2,26) = 4.322	0.024	0.250	×	×	*
	built up (30mph)	-0.976	-0.514	-0.173	F (2,26) = 6.309	0.006	0.327	×	*	×
	rural road (60mph)	0.038	-0.296	0.081	F (2,26) = 2.325	0.118	0.152	×	×	×

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. *** denotes the mean difference is significant at the 0.001 level
3. × denotes the mean difference is not significant

Table B9: ANOVA results for participants' perceptions of change in frustration for others and themselves when driving with ISA

		Expect	Early Use	Prolonged Use	Repeated measures ANOVA			Post-hoc t-tests		
					F statistic	significance	Effect size			
FRUSTRATION	frustrate myself	-0.070	0.253	0.159	F (2,26) = 0.653	0.529	0.048		EAR	PRO
								EXP	×	×
								EAR		×
	frustrate others	0.701	0.881	0.859	F (2,26) = 0.213	0.809	0.016		EAR	PRO
								EXP	×	×
								EAR		×

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. *** denotes the mean difference is significant at the 0.001 level
4. × denotes the mean difference is not significant

Table B10: ANOVA results for participants' perceptions of change in frustration across several conditions when driving with ISA

		Expect	Early Use	Prolonged Use	Repeated measures ANOVA			Post-hoc t-tests
					F statistic	significance	Effect size	
FRUSTRATION	overtaking	0.198	0.245	0.204	F (2,26) = 0.009	0.991	0.001	EAR PRO EXP × × EAR ×
	fast moving	0.887	1.089	0.893	F (2,26) = 0.413	0.666	0.031	EAR PRO EXP × × EAR ×
	motorway	0.461	0.797	0.912	F (2,26) = 1.552	0.231	0.107	EAR PRO EXP × × EAR ×
	20mph	-0.454	-0.303	-0.200	F (2,26) = 0.424	0.579	0.032	EAR PRO EXP × × EAR ×
	major road (40-60mph)	0.132	0.048	0.151	F (2,26) = 0121	0.887	0.009	EAR PRO EXP × × EAR ×
	night-time	-0.256	-0.132	-0.147	F (2,26) = 0.399	0.675	0.030	EAR PRO EXP × × EAR ×
	day time	0.167	0.312	0.299	F (2,26) = 0.347	0.710	0.026	EAR PRO EXP × × EAR ×
	heavy traffic	-0.542	-0.346	-0.255	F (2,26) = 0.649	0.531	0.048	EAR PRO EXP × × EAR ×
	light traffic	0.357	0.182	0.373	F (2,26) = 0.423	0.659	0.032	EAR PRO EXP × × EAR ×
	bad weather	-0.598	-0.360	-0.391	F (2,26) = 0.461	0.636	0.034	EAR PRO EXP × × EAR ×
	poor visibility	-0.605	-0.376	-0.391	F (2,26) = 0.546	0.586	0.040	EAR PRO EXP × × EAR ×
	child presence	-1.013	-0.445	-0.716	F (2,26) = 2.291	0.121	0.150	EAR PRO EXP × × EAR ×
	ped. crossing	-0.781	-0.502	-0.594	F (2,26) = 0.568	0.573	0.042	EAR PRO EXP × × EAR ×
	compl. junction	-0.559	-0.371	-0.500	F (2,26) = 0.318	0.731	0.024	EAR PRO EXP × × EAR ×
	built up (30mph)	-0.455	-0.132	-0.365	F (2,26) = 0.727	0.493	0.053	EAR PRO EXP × × EAR ×
	rural road (60mph)	0.342	0.162	0.014	F (2,26) = 0.694	0.508	0.051	EAR PRO EXP × × EAR ×

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. *** denotes the mean difference is significant at the 0.001 level

Table B11: ANOVA results for participants' perceptions of change in concentration across several conditions when driving with ISA

		Expect	Early Use	Prolonged Use	Repeated measures ANOVA			Post-hoc t-tests		
					F statistic	significance	Effect size	EXP vs EAR	EXP vs PRO	EAR vs PRO
CONCENTRATION	atten. to other road users	0.636	1.161	1.006	F (2,26) = 3.134	0.060	0.194	×	×	×
	atten. to speed limit signs	0.075	1.232	0.896	F(2,26) =13.816	0.000	0.515	***	*	×
	awareness of limit	0.769	1.397	1.346	F (2,26) = 6.803	0.005	0.362	*	*	×
	atten. to aspects of driving	0.525	0.543	0.819	F (2,26) = 0.952	0.399	0.068	×	×	×
	check speedo	-0.359	0.610	0.428	F (2,26) = 3.424	0.048	0.208	×	×	×
	tendency to brake	-0.027	-0.283	-0.224	F (2,26) = 0.443	0.647	0.033	×	×	×
	tendency to accel	-0.158	-0.289	-0.316	F (2,26) = 0.250	0.781	0.020	×	×	×
	anticip. of conflicts	0.652	0.717	0.584	F (2,26) = 0.148	0.863	0.011	×	×	×
	attent. to pedestrian	0.375	0.231	0.151	F (2,26) = 0.955	0.370	0.068	×	×	×

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. *** denotes the mean difference is significant at the 0.001 level
4. × denotes the mean difference is not significant

Table B12: ANOVA results for participants' perceptions of change in driving experience when driving with ISA

		Expect	Early Use	Prolonged Use	Repeated measures ANOVA			Post-hoc t-tests		
					F statistic	significance	Effect size			
DRIVING EXPERIENCE	journey time	1.025	0.624	0.755	F (2,26) = 1.657	0.219	0.113		EAR	PRO
								EXP	✗	✗
								EAR		✗
	Alternative route	-0.930	-1.883	-1.014	F (2,26) = 8.548	0.001	0.397		EAR	PRO
								EXP	**	✗
								EAR		**
	Avoid 30mph	-0.879	-1.857	-1.726	F(2,26)= 10.348	0.003	0.443		EAR	PRO
								EXP	**	*
								EAR		✗
	Keep to limit	1.818	1.329	1.088	F (2,26) = 3.341	0.052	0.218		EAR	PRO
								EXP	✗	✗
								EAR		✗
	enjoyment	-0.144	-0.555	-0.600	F (2,26) = 1.569	0.234	0.108		EAR	PRO
								EXP	✗	✗
								EAR		✗
	security	0.196	0.164	-0.059	F (2,26) = 0.694	0.509	0.051		EAR	PRO
								EXP	✗	✗
								EAR		✗
	control	-0.479	-0.783	-0.383	F (2,26) = 1.341	0.279	0.093		EAR	PRO
								EXP	✗	✗
								EAR		✗
	confidence	0.025	-0.090	-0.223	F (2,26) = 0.515	0.604	0.038		EAR	PRO
								EXP	✗	✗
								EAR		✗
	accident risk	-0.460	-0.096	0.288	F (2,26) = 4.611	0.019	0.262		EAR	PRO
								EXP	✗	*
								EAR		✗
	comfort	0.279	0.077	-0.144	F (2,26) = 0.896	0.389	0.064		EAR	PRO
								EXP	✗	✗
								EAR		✗
	pressure from traffic	1.467	1.341	1.379	F (2,26) = 0.342	0.713	0.026		EAR	PRO
								EXP	✗	✗
								EAR		✗
	opt out	0.195	0.090	0.100	F (2,26) = 0.080	0.923	0.007		EAR	PRO
								EXP	✗	✗
								EAR		✗

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. *** denotes the mean difference is significant at the 0.001 level
4. ✗ denotes the mean difference is not significant

Table B13: ANOVA results for participants' response to common criticisms across time.

		Expect	Early Use	Prolonged Use	Repeated measures ANOVA			Post-hoc t-tests		
					F statistic	significance	Effect size			
COMMON CRITICISMS	Overtaking difficulties	0.447	0.875	0.522	F (2,26) = 0.773	0.433	0.056		EAR	PRO
								EXP	×	×
								EAR		×
	Accel out of danger	0.495	0.167	0.464	F (2,26) = 0.402	0.673	0.030		EAR	PRO
								EXP	×	×
								EAR		×
	less vigilant	-0.359	-0.785	-0.493	F (2,26) = 0.952	0.399	0.068		EAR	PRO
								EXP	×	×
								EAR		×
	decrease following distances	-0.088	-0.361	-0.092	F (2,26) = 0.419	0.662	0.031		EAR	PRO
								EXP	×	×
								EAR		×

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. *** denotes the mean difference is significant at the 0.001 level
4. × denotes the mean difference is not significant

Table B14: ANOVA results for participants' reactions to ISA 'drop-out' across time

		Expect	Early Use	Prolonged Use	Repeated measures ANOVA			Post-hoc t-tests		
					F statistic	significance	Effect size			
DROP OUT	drive faster	0.570	0.524	0.441	F (2,26) = 0.573	0.490	0.042		EAR	PRO
								EXP	×	×
								EAR		×
	feel relief	0.522	0.669	0.508	F (2,26) = 0.322	0.645	0.024		EAR	PRO
								EXP	×	×
								EAR		×

Note:
1. * denotes the mean difference is significant at the 0.05 level
2. ** denotes the mean difference is significant at the 0.01 level
3. *** denotes the mean difference is significant at the 0.001 level
4. × denotes the mean difference is not significant

Table B15: ANOVA results for participants' NASA-RLTX scores

<table>
<tr><th rowspan="2"></th><th rowspan="2"></th><th rowspan="2">Time 1</th><th rowspan="2">Time 2</th><th rowspan="2">Time 3</th><th rowspan="2">Time 4</th><th colspan="3">Repeated measures ANOVA</th><th colspan="4" rowspan="2">Post-hoc t-tests</th></tr>
<tr><th>F statistic</th><th>significance</th><th>Effect size</th></tr>
<tr><td rowspan="28">NASA-RTLX</td><td rowspan="4">TOTAL</td><td rowspan="4">30.521</td><td rowspan="4">24.814</td><td rowspan="4">24.798</td><td rowspan="4">25.710</td><td rowspan="4">F (3,45) = 2.376</td><td rowspan="4">0.083</td><td rowspan="4">0.137</td><td></td><td>T2</td><td>T3</td><td>T4</td></tr>
<tr><td>T1</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>T2</td><td></td><td>×</td><td>×</td></tr>
<tr><td>T3</td><td></td><td></td><td>×</td></tr>
<tr><td rowspan="4">MENTAL</td><td rowspan="4">31.465</td><td rowspan="4">16.504</td><td rowspan="4">17.965</td><td rowspan="4">19.037</td><td rowspan="4">F (3,45) = 5.996</td><td rowspan="4">0.003</td><td rowspan="4">0.286</td><td></td><td>T2</td><td>T3</td><td>T4</td></tr>
<tr><td>T1</td><td>*</td><td>×</td><td>×</td></tr>
<tr><td>T2</td><td></td><td>×</td><td>×</td></tr>
<tr><td>T3</td><td></td><td></td><td>×</td></tr>
<tr><td rowspan="4">PHYSICA L</td><td rowspan="4">27.186</td><td rowspan="4">14.390</td><td rowspan="4">15.213</td><td rowspan="4">16.649</td><td rowspan="4">F (3,45) = 5.103</td><td rowspan="4">0.007</td><td rowspan="4">0.254</td><td></td><td>T2</td><td>T3</td><td>T4</td></tr>
<tr><td>T1</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>T2</td><td></td><td>×</td><td>×</td></tr>
<tr><td>T3</td><td></td><td></td><td>×</td></tr>
<tr><td rowspan="4">TIME</td><td rowspan="4">10.278</td><td rowspan="4">16.863</td><td rowspan="4">12.268</td><td rowspan="4">17.934</td><td rowspan="4">F (3,45) = 1.732</td><td rowspan="4">0.174</td><td rowspan="4">0.104</td><td></td><td>T2</td><td>T3</td><td>T4</td></tr>
<tr><td>T1</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>T2</td><td></td><td>×</td><td>×</td></tr>
<tr><td>T3</td><td></td><td></td><td>×</td></tr>
<tr><td rowspan="4">PERFORM</td><td rowspan="4">72.684</td><td rowspan="4">66.137</td><td rowspan="4">64.417</td><td rowspan="4">62.695</td><td rowspan="4">F (3,45) = 1.789</td><td rowspan="4">0.163</td><td rowspan="4">0.107</td><td></td><td>T2</td><td>T3</td><td>T4</td></tr>
<tr><td>T1</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>T2</td><td></td><td>×</td><td>×</td></tr>
<tr><td>T3</td><td></td><td></td><td>×</td></tr>
<tr><td rowspan="4">EFFORT</td><td rowspan="4">28.300</td><td rowspan="4">21.518</td><td rowspan="4">21.941</td><td rowspan="4">22.282</td><td rowspan="4">F (3,45) = 1.377</td><td rowspan="4">0.262</td><td rowspan="4">0.084</td><td></td><td>T2</td><td>T3</td><td>T4</td></tr>
<tr><td>T1</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>T2</td><td></td><td>×</td><td>×</td></tr>
<tr><td>T3</td><td></td><td></td><td>×</td></tr>
<tr><td rowspan="4">FRUST.</td><td rowspan="4">13.213</td><td rowspan="4">13.472</td><td rowspan="4">16.988</td><td rowspan="4">15.663</td><td rowspan="4">F (3,45) = 4.54</td><td rowspan="4">0.716</td><td rowspan="4">0.029</td><td></td><td>T2</td><td>T3</td><td>T4</td></tr>
<tr><td>T1</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>T2</td><td></td><td>×</td><td>×</td></tr>
<tr><td>T3</td><td></td><td></td><td>×</td></tr>
</table>

Table B16: ANOVA results for participants' NASA-RLTX scores during the cluster trial

		Medium	High	Repeated measures ANOVA		
				F statistic	significance	Effect size
NASA-RTLX	TOTAL	22.280	20.122	F (1,9) = 1.948	0.196	0.178
	MENTAL	14.970	14.939	F (1,9) = 0.000	0.991	0.000
	PHYSICAL	12.079	11.139	F (1,9) = 0.685	0.429	0.071
	TIME	13.221	6.715	F (1,9) = 6.065	0.036	0.403
	PERFORM	72.005	72.446	F (1,9) = 0.049	0.829	0.005
	EFFORT	13.905	12.793	F (1,9) = 0.439	0.524	0.047
	FRUST.	19.018	13.715	F (1,9) = 3.838	0.082	0.299
	TRAFFIC	10.762	9.107	F (1,9) = 0.159	0.699	0.017

Table B17: ANOVA results for participants' acceptability scores during the cluster trial

		Medium	High	Repeated measures ANOVA		
				F statistic	significance	Effect size
ACCEPTABILITY	USE	0.583	0.595	F (1,9) = 0.018	0.896	0.002
	SAT	0.286	0.339	F (1,9) = 0.737	0.413	0.076