isa - UK

intelligent speed adaptation

Results of Field Trial 3

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UNIVERSITY OF LEEDS

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EXECUTIVE SUMMARY

Introduction

This report documents the third 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 any carry-over effects of the ISA driving on subsequent behaviour. The results presented here should not way be construed as predicting the results of the other field trials

This trial, was the first of two trials being 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 first trial, it was carried out with a group of private motorists 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 behave 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 and the in-vehicle map used for this trial were the same as those used in Trials 1 and 2. The vehicles were refurbished between the trials.

Nine males (age range 26-–3 years) and eleven females (age range 31–57 years) were recruited from responses to newspaper advertisements. As before, participants were grouped into 'intenders' and 'non-intenders' based on their intention to exceed the speed limit.

The selected participants tended to:

- 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 five of our participants worked outside the mapped area, the majority of their day to day driving was within our boundaries. Only one driver lived outside the South-West Leicestershire area.

The characteristics of the participants are shown in Table 1.

Table 1: Characteristics of Trial 3 participants

Gender	Age	Intention to Speed	Number
Male	23–39	Intender	2
Male	23–39	Non-Intender	1
Male	40–60	Intender	4
Male	40–60	Non-Intender	2
Female	23–39	Intender	3
Female	23–39	Non-Intender	2
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 generally negative, 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, although only the change on residential roads was significant. The reduction continued into Phase 3 when the ISA was once again disabled (see Figure 5).

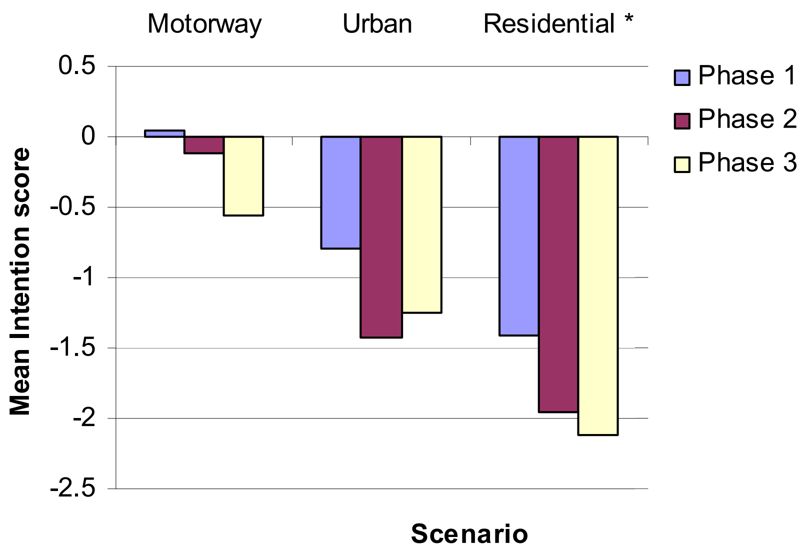

Figure 5: Intention to speed

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 6, decreased during Phase 2 on all the road categories. Self-reported speeding in Phase 3 increased but, apart from the motorway category, was still lower than that reported at Phase 1, suggesting that the effects of ISA may have been sustained even with unsupported driving.

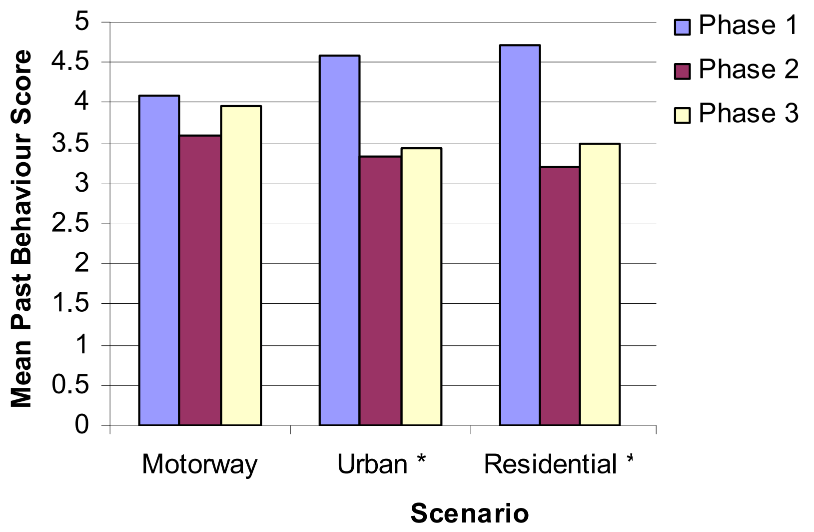

Figure 6: Self-reported speeding

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 7). 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 both to dip with initial ISA use and then recover. Ratings of the usefulness 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.

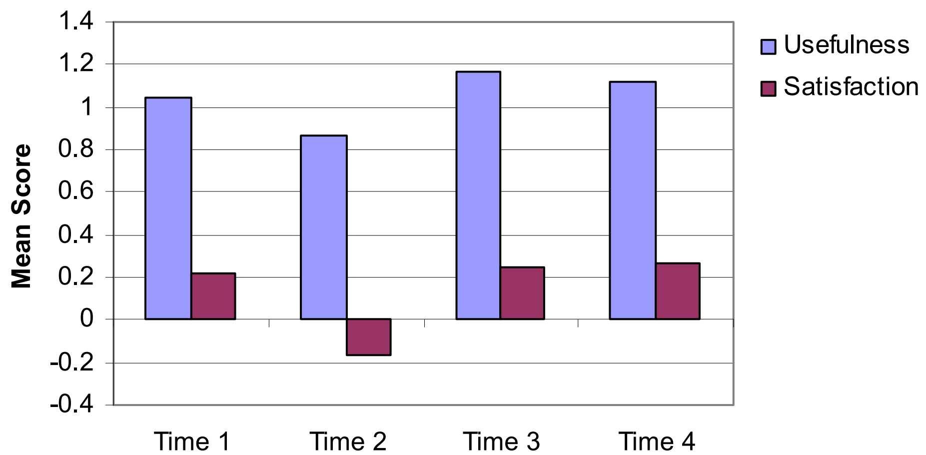

Figure 7: Acceptability of ISA

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. In this trial, a change in mean speeds could be observed in particular on roads with a speed limit of 30 mph or 40 mph. This is illustrated in Figure 8 which shows the percentage of distance travelled on 30 mph roads which 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.

This pattern of change in speed patterns 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 30 mph, 40 mph and 50 mph speed limits, i.e. on urban roads in general. Thus ISA has not only diminished excessive speeding, but also led to a reduction in speed variation with positive implications for a reduction in accident occurrence. It was also generally the case that indicators of speed were lower in the last month than in the first month, i.e. ISA had a positive carry-over effect.

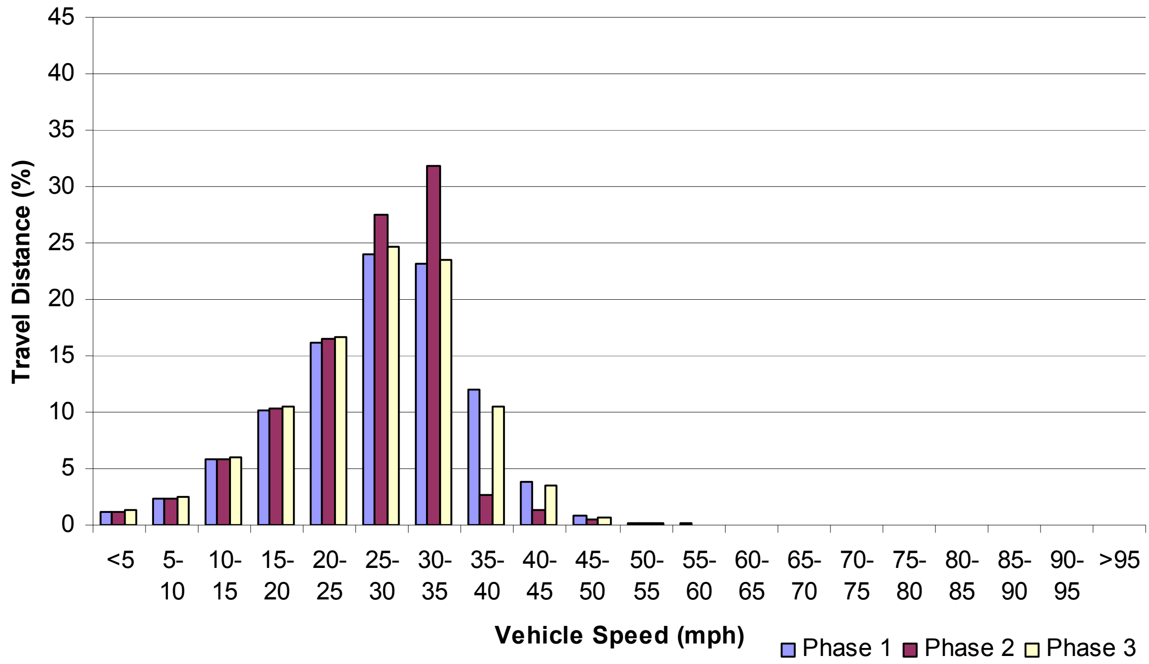

Figure 8: Speed distribution by phase on 30 mph roads

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. ISA was overridden most often on 20 mph and 70 mph roads (see Figure 9). It should be noted that driving on 20 mph roads only accounted for 0.06% of total distance travelled in phase 2. In terms of demographic groups, males tended to opt out more than females, with the contrast being the greatest on 40 mph roads (7.3% of distance travelled as compared to 3.6%).

Young drivers overrode ISA more than older drivers, particularly on 40 mph (7.8% compared to 3.9%) and 50 mph roads (7.5% compared to 2.0%). And intenders overrode the system more frequently than non-intenders across all speed zones. The differences on the 50 mph roads (7.6% compared to 1.6%) and on the 70 mph roads (25.7% compared to 4.0%) 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.

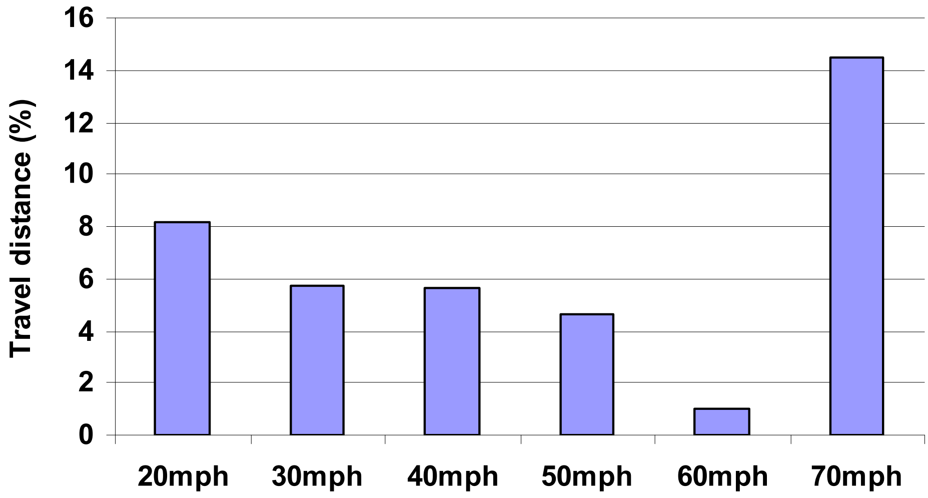

Figure 9: Proportion of distance travelled with ISA when the system was overridden

In spite these findings, ISA still had a positive impact on all groups, including young drivers and intenders to speed. 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 have been converted with the capability to provide a voluntary (overridable) ISA system and to record data on each drive. Four successive trials are planned, each of six months duration. The four field trials are:

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

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

This report presents the results of Field Trial 3 and is structured into seven chapters. The next chapter describes the design of the field trial, followed by analysis results of vehicle data, questionnaire data, the observation drives, and the cluster trial. Finally, the seventh 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 two trials (Lai et al, 2005a; Lai et al, 2005b), 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. A new version of the speed limit map was developed for Trial 3 and 4 covering South-West Leicestershire area. Table 1 shows the length of road for each road type, 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)

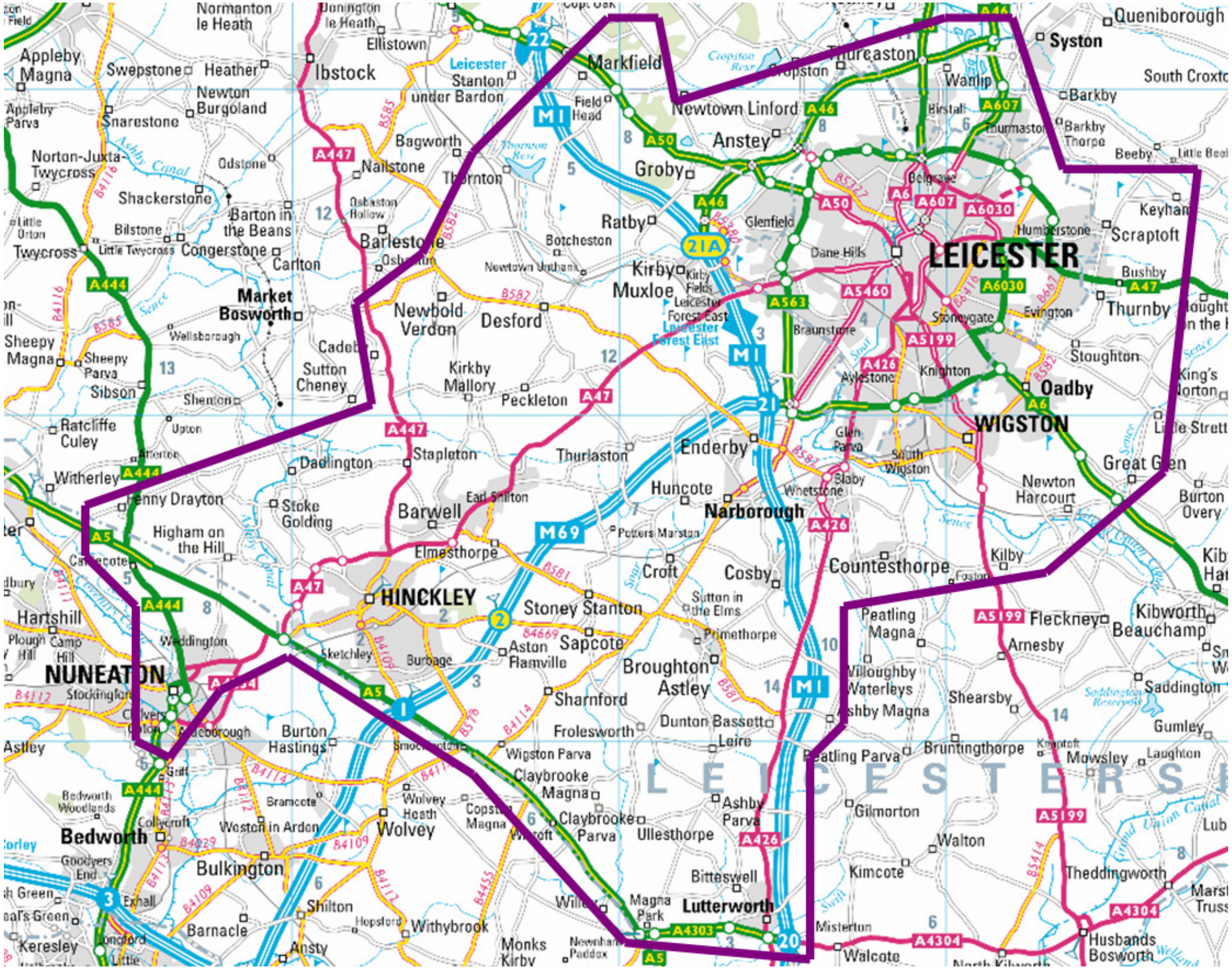


Figure 1: Boundary of the South-West Leicestershire speed limit map

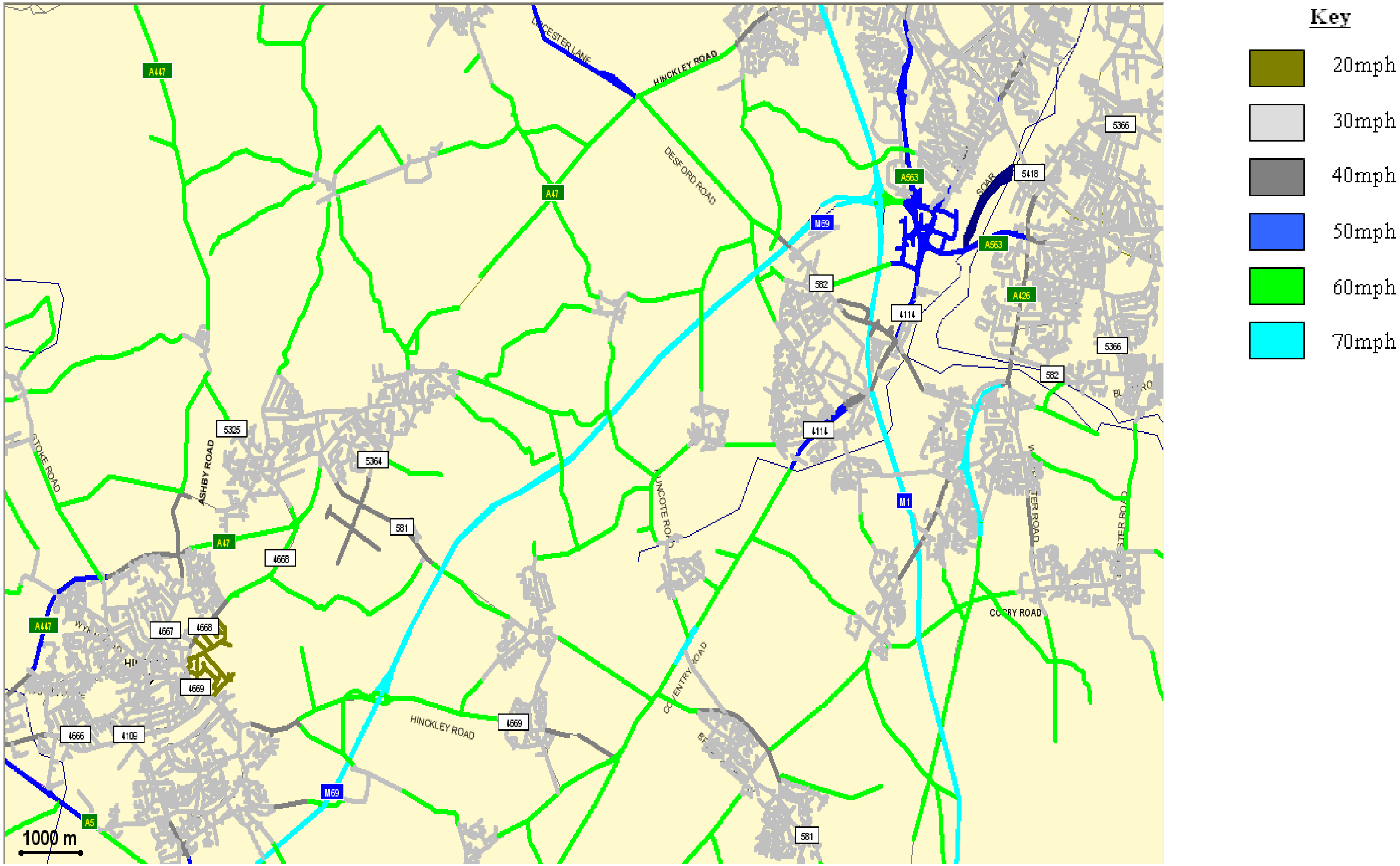


Figure 2: Illustration of speed limit distribution within the South-West Leicestershire area

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.

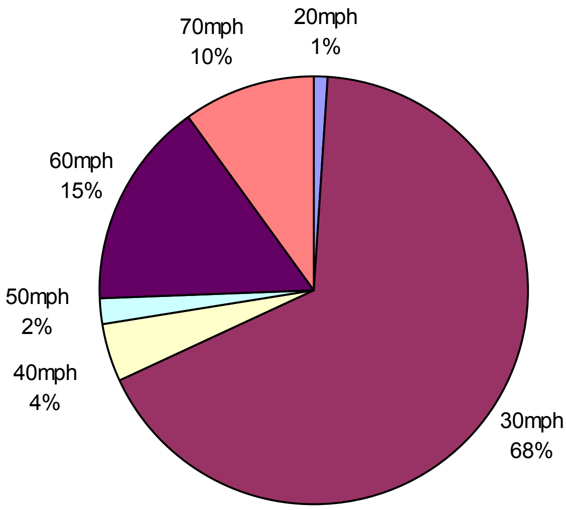


Figure 3: Distribution of speed zones in the South-West Leicestershire area

2.2.2 Hardware

Apart from updating the digital speed limits map, all vehicles were refurbished at the end of Trial 2, which included data backup, ISA function inspection (e.g. buttons and brake performance etc), and general vehicle inspection (e.g. tyre treads and fluid levels etc.). In addition, there were a few changes made to the hardware specifications prior to releasing the ISA cars to Trial 3 participants to improve the stability of system operation (e.g. power supply). These changes were:

- Soldered coin cells fitted
- Bypass wire across 5V connector fitted
- Engine speed sensor replaced

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 Trials 1 and 2.

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

↑ Observation Drive 1 (end of Phase 1) ↑ Observation Drive 2 (after first 28 days of Phase 2) ↑ Observation Drive 3 (end of Phase 2) ↑ Observation Drive 4 (end of Phase 3)

Figure 4: The structure of the ISA field trial

2.4 Participant recruitment

Nine males (age range 26-53 years, M = 41.89, SD = 10.07) and eleven females (age range 31-57 years, M = 41.18, SD = 8.94) took part in the trial. Participants were recruited from a response to an advertisement placed in the South-West Leicestershire area. A number of advertisements were placed in the Leicester Mercury in November 2004 and one in a free paper. Despite 142 responses to the advertisement, only 39 participants returned their questionnaire.

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).

Preference was given to those living and working within the South-West Leicestershire area. As can be seen in Table 2, participants were split as evenly as possible. Eight young and 12 old participants took part with an equal split of intenders and non-intenders.

Table 2: Characteristics of Trial 3 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			non-intender
4	male	old			intender
5	male	old			intender
6	male	old			intender
7	male	old			intender
8	male	old			non-intender
9	male	old			non-intender
10	female	young			intender
11	female	young			intender
12	female	young			intender
13	female	young			non-intender
14	female	young			non-intender
15	female	old			intender
16	female	old			non-intender
17	female	old			non-intender
18	female	old			non-intender
19	female	old			non-intender
20	female	old			non-intender

Although five of our participants worked outside the mapped area, the majority of their day to day driving was within our boundaries. Only one driver lived outside the South-West Leicestershire area.

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.

Table 3: Age by attitude group

	N	Mean	Standard Deviation	Minimum	Maximum
Intenders	10	36.60	9.80	24.00	50.00
Non-Intenders	10	42.40	8.03	30.00	55.00

As can be seen in Table 3, it was difficult to recruit participants at the extremes of the age group ranges with the majority aged within the 30–50yr age bracket.

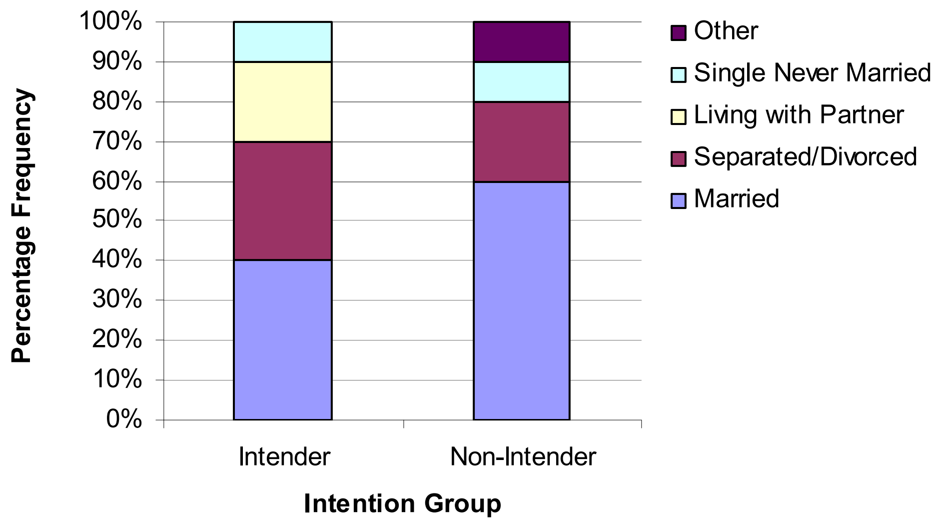


Figure 5: Marital status by intention group

Figure 5 shows little variation across the groups in terms of their marital status with 60% of the participants married or living with a partner. Fifty-three percent of the participants also had one or more children aged 18 or under living with them (see Figure 6). Non-intenders were less likely to have a child living at home.

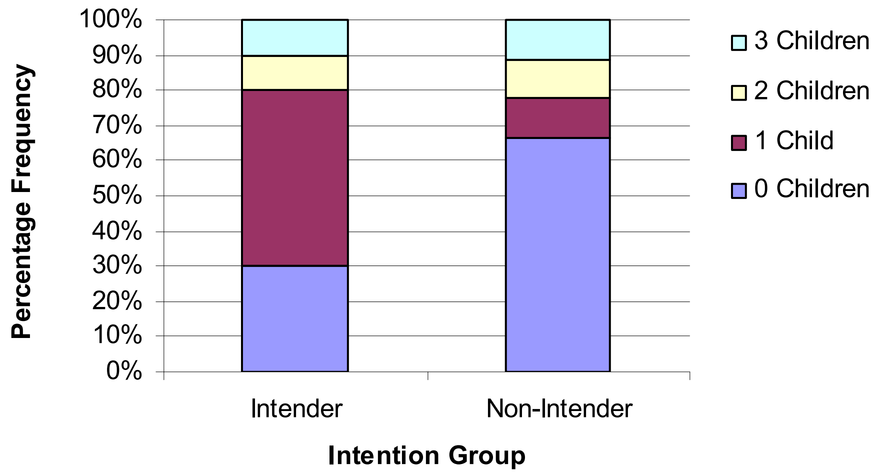


Figure 6: Number of children (18yrs and under) living at home by intention group

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

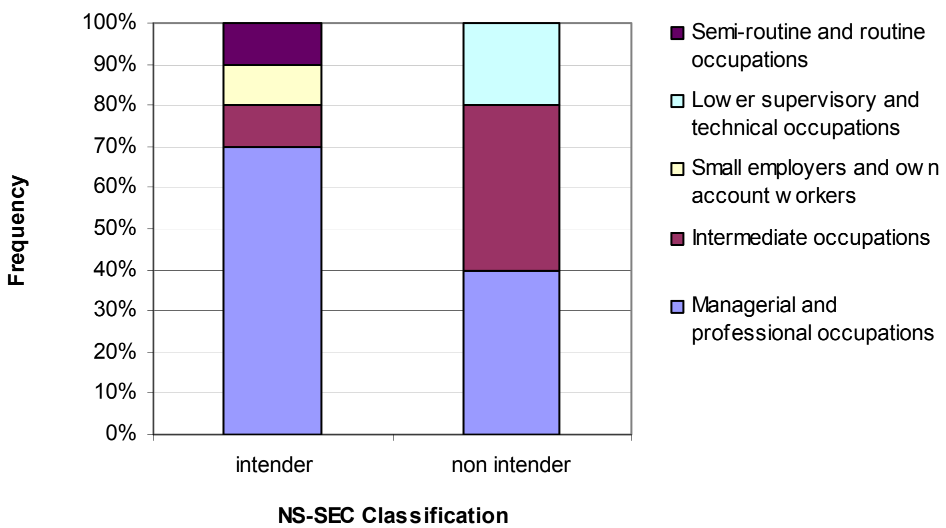


Figure 7: NS-SEC classification by intention group

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 intenders made slightly more trips and covered more miles than non-intenders.

Table 4: Participants mileage and trip statistics

	Intenders	Non-Intenders
SW Leicestershire weekday mileage	179.35	151.89
SW Leicestershire weekend mileage	58.70	55.99
SW Leicestershire total weekly mileage	238.05	207.88
SW Leicestershire monthly mileage	952.20	831.52
SW Leicestershire annual mileage	12378.60	10809.76
Total annual mileage	16611.40	13801.84
% of driving in SW Leicestershire area	84.90	84
No. weekday trips	30.50	23.9
No. of w/end trips	8.30	7.5
Total weekly trips	38.80	31.4

Eight participants (5 intenders, 3 non-intenders) had received three points for speeding within the last five years. Four of the participants (3 intenders, 1 non-intender) 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 is 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	0.86	0.94	0.92
Residential 30 mph	0.85	0.83	0.74
Urban 40 mph	0.87	0.90	0.78
Disengage ISA	0.69	0.61	0.68

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	0.63	0.84	0.67
Residential 30 mph	0.72	0.88	0.85
Urban 40 mph	0.87	0.87	0.84
Disengage ISA	0.62	0.83	0.71

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	0.76	0.95	0.95
Residential 30 mph	0.87	0.91	0.91
Urban 40 mph	0.89	0.96	0.97
Disengage ISA	0.91	0.94	0.92

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 nighttimes 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	0.95	0.97	0.83
Residential 30 mph	0.96	0.95	0.95
Urban 40 mph	0.99	0.97	0.96
Disengage ISA	0.93	0.96	0.95

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	0.98	0.86	0.96
Residential 30 mph	0.99	0.89	0.91
Urban 40 mph	0.93	0.87	0.75
Disengage ISA	-	0.86	-

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	0.60	0.88	0.91	0.95
Satisfaction	0.85	0.93	0.94	0.95

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	0.85	0.68	0.56	0.66
Error	0.78	0.67	0.72	0.84
Violation	0.55	0.64	0.59	*

* could not be calculated as the scale had less than two non-zero variance items.

2.5.2.6 Sensation seeking

The Arnett (1994) 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 $\alpha = -0.12$).

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 $\alpha = 0.40$)

Higher scores reflected a higher level of sensation seeking.

This questionnaire would 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 would 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. 72).

Orderliness 10 items measured orderliness (e.g., 'like order', very inaccurate-very accurate scored +1 to +5; Cronbach's α = 0.89).

Dutifulness 10 items measured dutifulness (e.g., 'try to follow the rules, very inaccurate-very accurate scored +1 to +5; Cronbach's α = 0.71).

Achievement Striving 10 items measured achievement striving (e.g., 'demand quality' very inaccurate-very accurate scored +1 to +5; Cronbach's α = 0.84).

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 = 0.89).

Cautiousness 10 items measured cautiousness (e.g., 'Avoid mistakes' very inaccurate-very accurate scored +1 to +5; Cronbach's α = 0.83).

Higher scores reflected a higher level of conscientiousness.

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

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 96.2%. 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 3

Participant ID	Completed days	Completion rate (%)
50	168	100.0
51	155	92.3
52	164	97.6
53	167	99.4
54	168	100.0
55	161	95.8
56	168	100.0
57	168	100.0
58	168	100.0
59	168	100.0
60	168	100.0
61	123	73.2
62	145	86.3
63	165	98.2
64	168	100.0
65	168	100.0
66	152	90.5
67	168	100.0
68	154	91.7
69	166	98.8
Overall completion rate		**96.2 %**

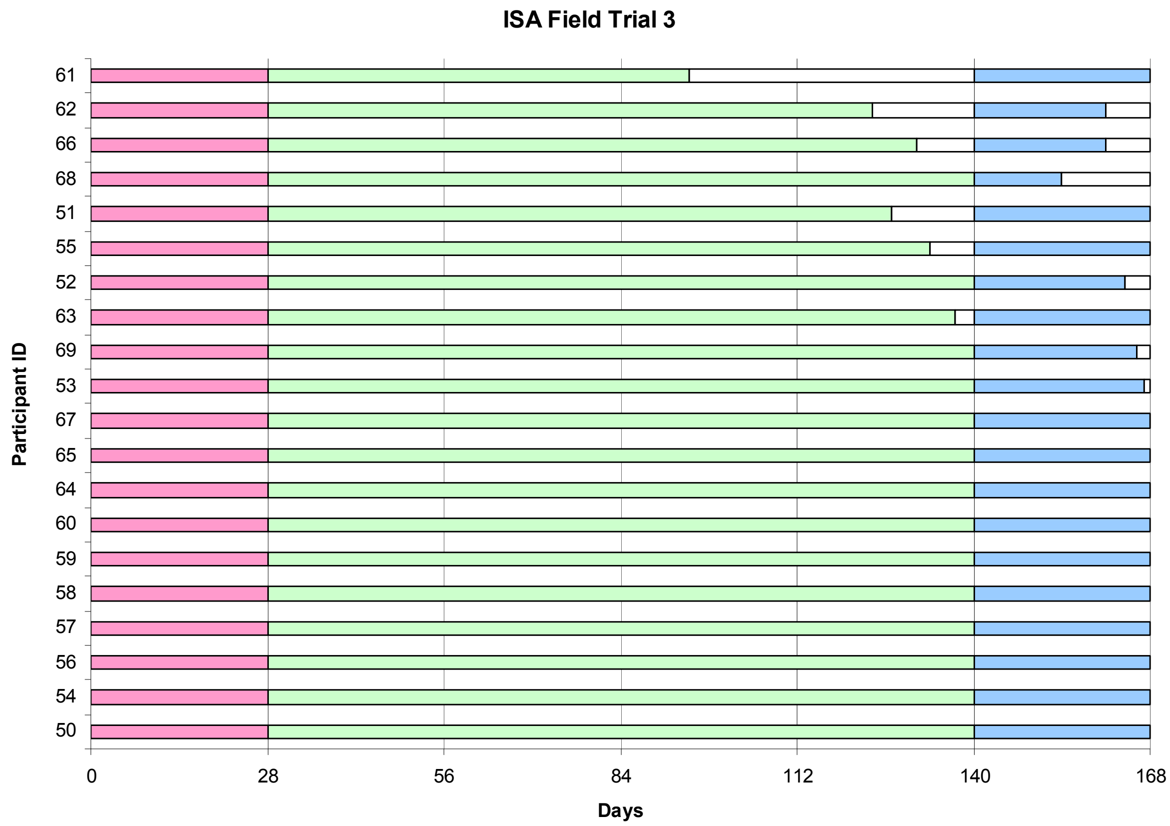


Figure 8: Completion rate in Field Trial 3

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 33,301,857 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 166,509 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 70 mph zones, followed by 30 and 60 mph zones. The majority of the travel occurred in rural areas, as the vehicle kilometres recorded in the 50, 60, and 70 mph zones accounted for 63% of the total vehicle kilometres. Even if the 50mph zone is left out, the sum of 60 and 70 mph zones is still well over 50%.

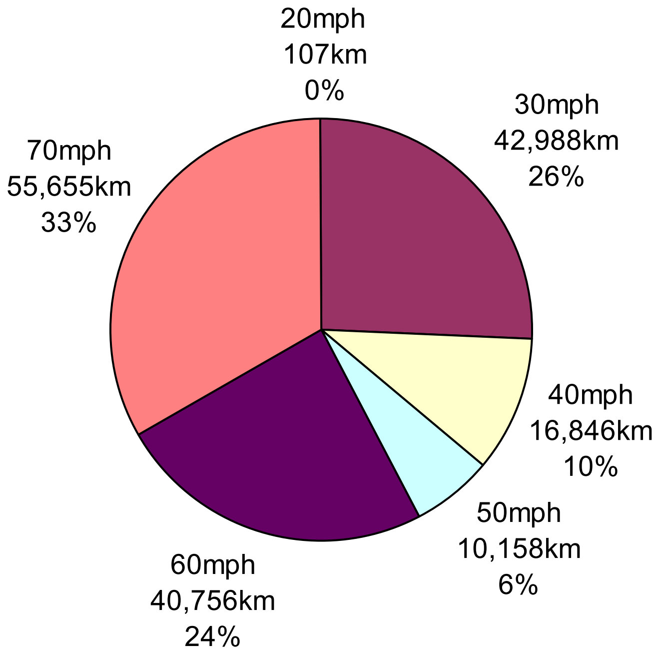


Figure 9: Distribution of total vehicle kilometres with respect to speed zones

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	28	66	14	0.1	0.1	0.0
30 mph	8,687	27,147	7,154	24.6	26.5	24.9
40 mph	3,497	10,468	2,880	9.9	10.2	10.0
50 mph	1,953	6,376	1,829	5.5	6.2	6.4
60 mph	8,586	25,812	6,358	24.3	25.2	22.2
70 mph	12,510	32,688	10,456	35.5	31.9	36.4
Sum	35,261	102,556	28,692	100	100	100

3.3.3 Speed distribution

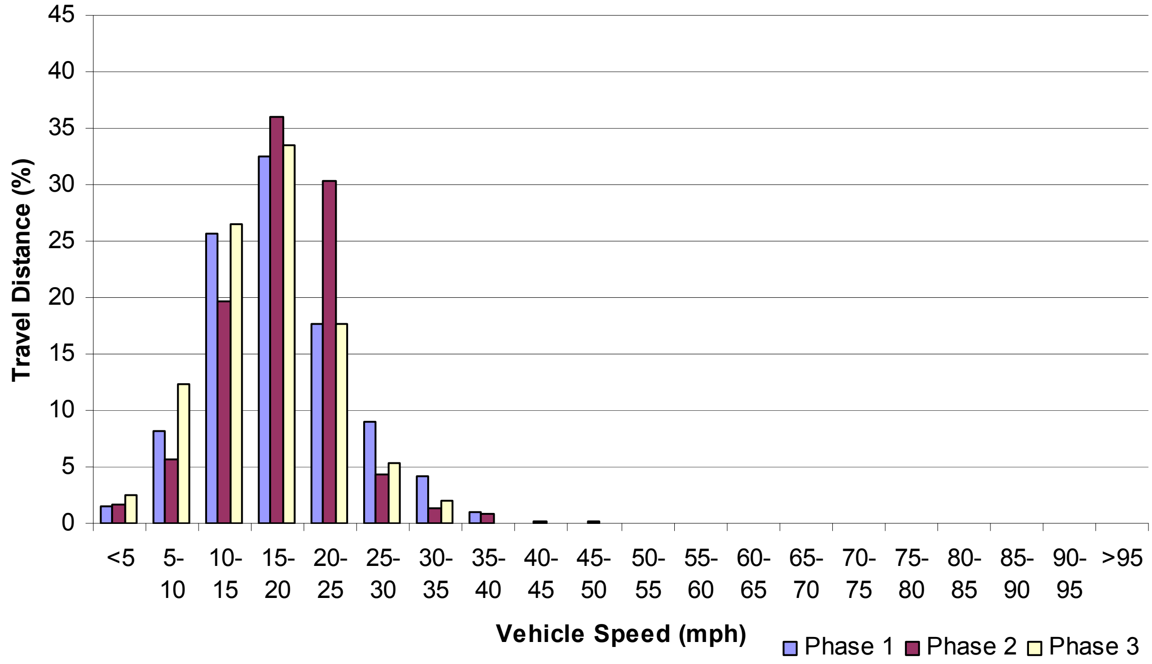
The logged vehicle data provides a comprehensive database of the speed distribution. Figure 10 through Figure 15 illustrate speed distribution across speed zones from 20 mph to 70 mph respectively. Each figure consists of two graphs; the top graph shows speed distribution across trial phases, and the 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 55-60 mph band in Figure 14, 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. This suggests that, although ISA effectively changed the speed distribution, the carry-over effect was not prominent.



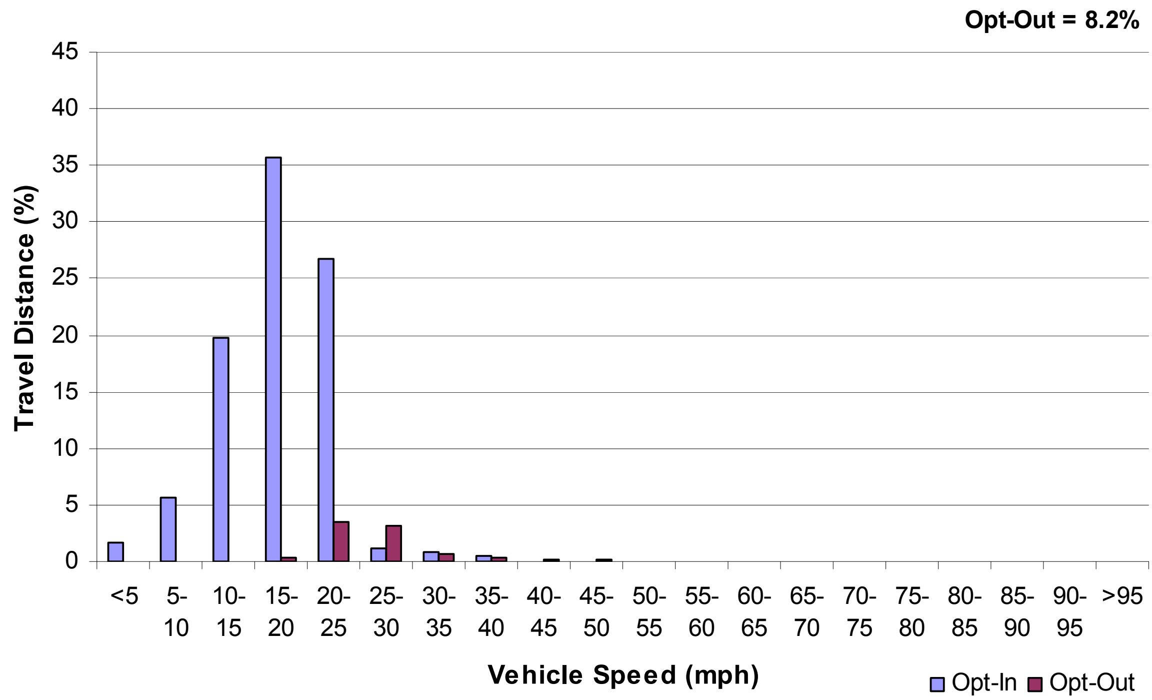
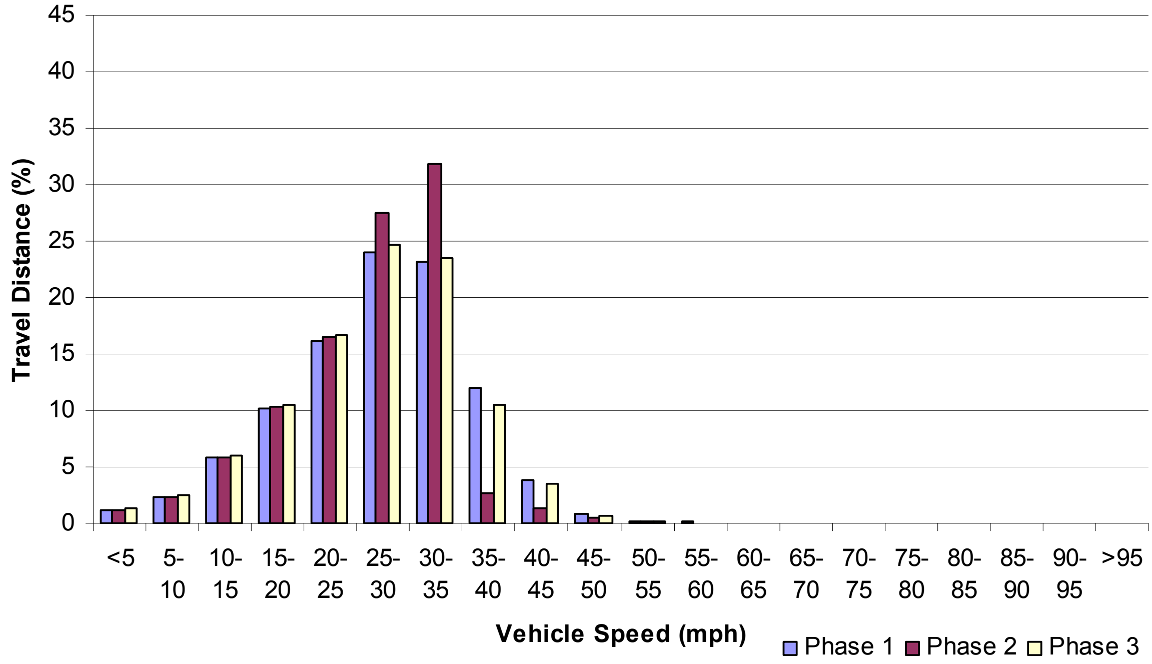


Figure 10: Overall speed distribution in 20 mph zones



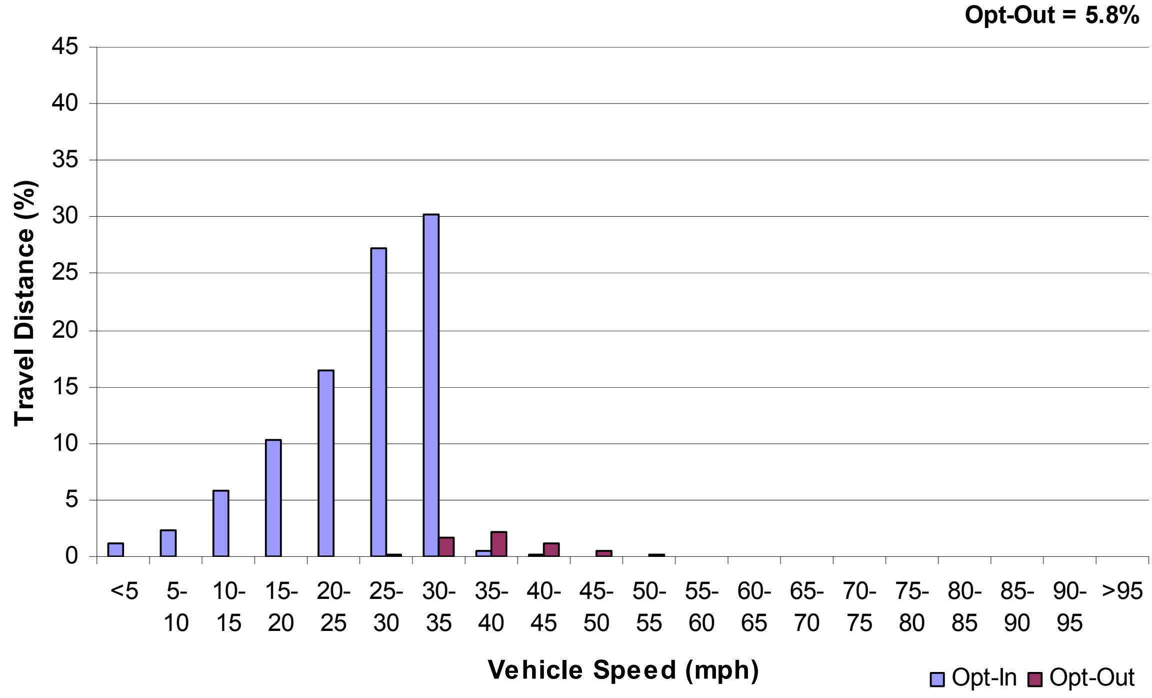
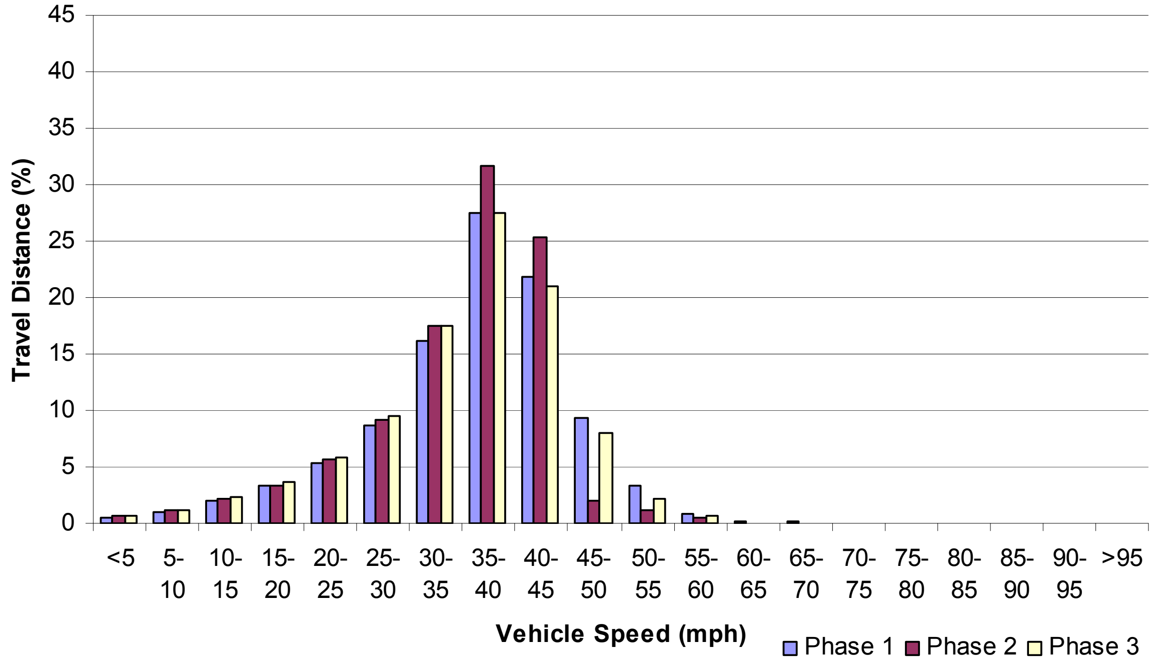


Figure 11: Overall speed distribution in 30 mph zones



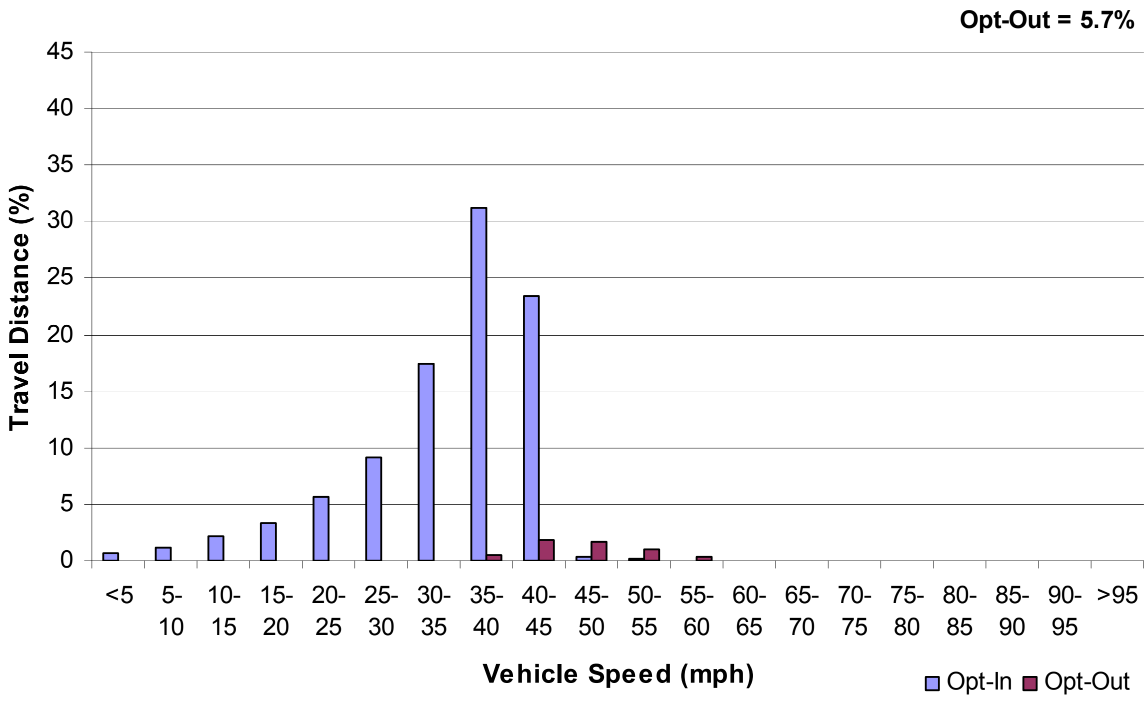
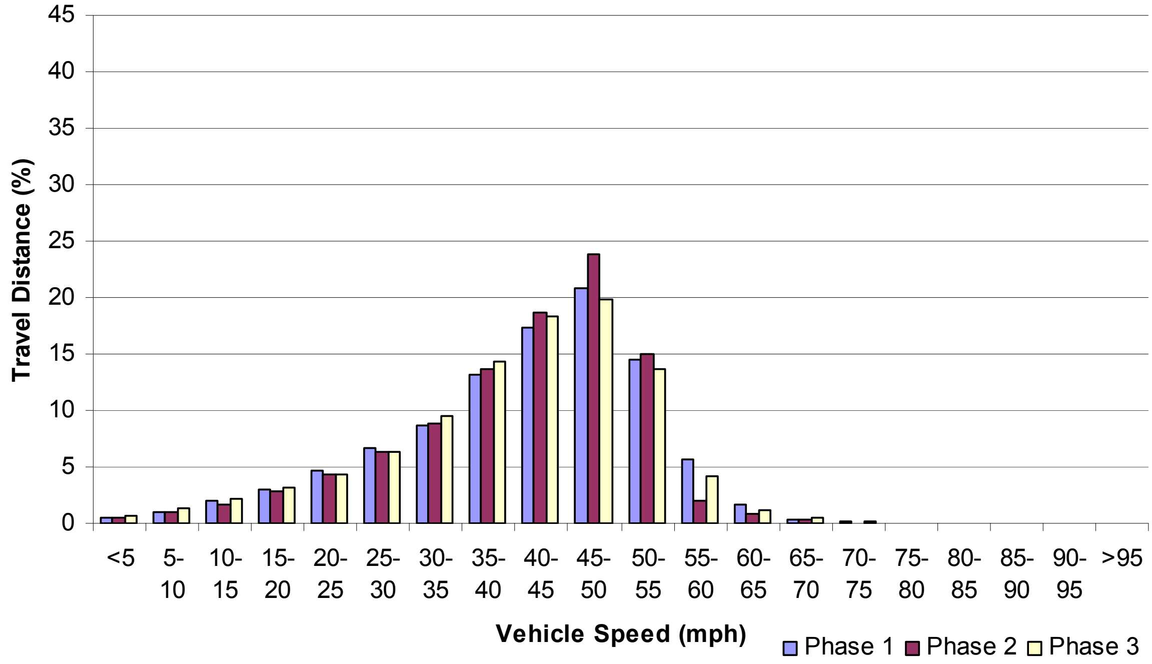


Figure 12: Overall speed distribution in 40 mph zones



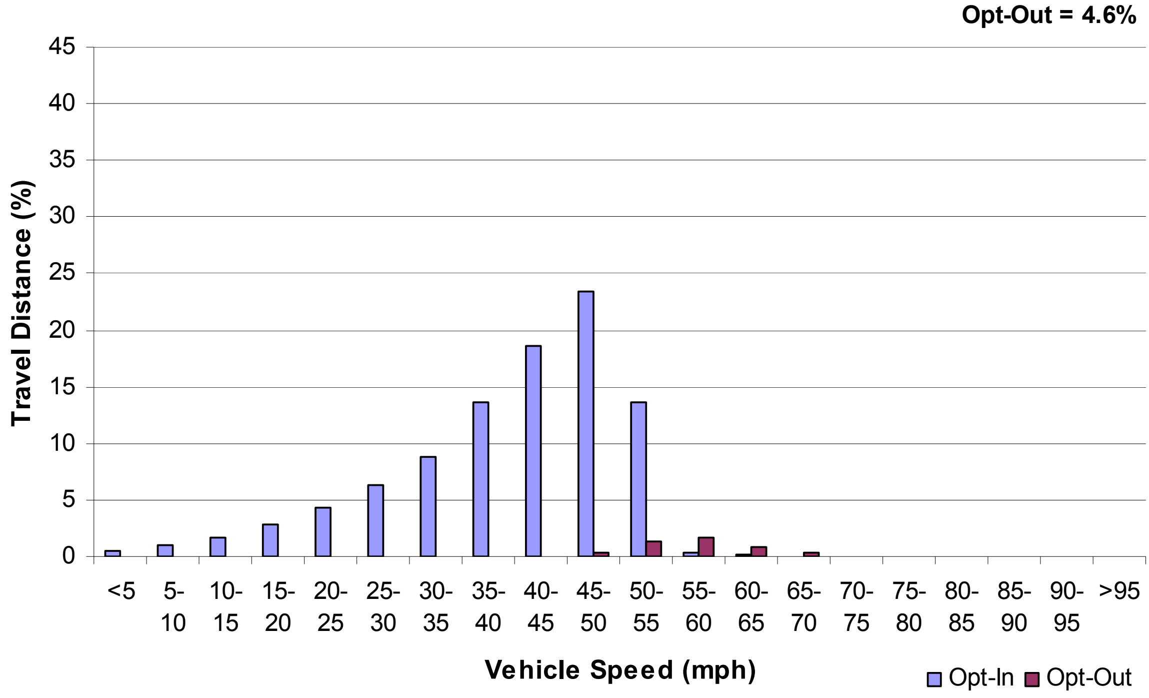
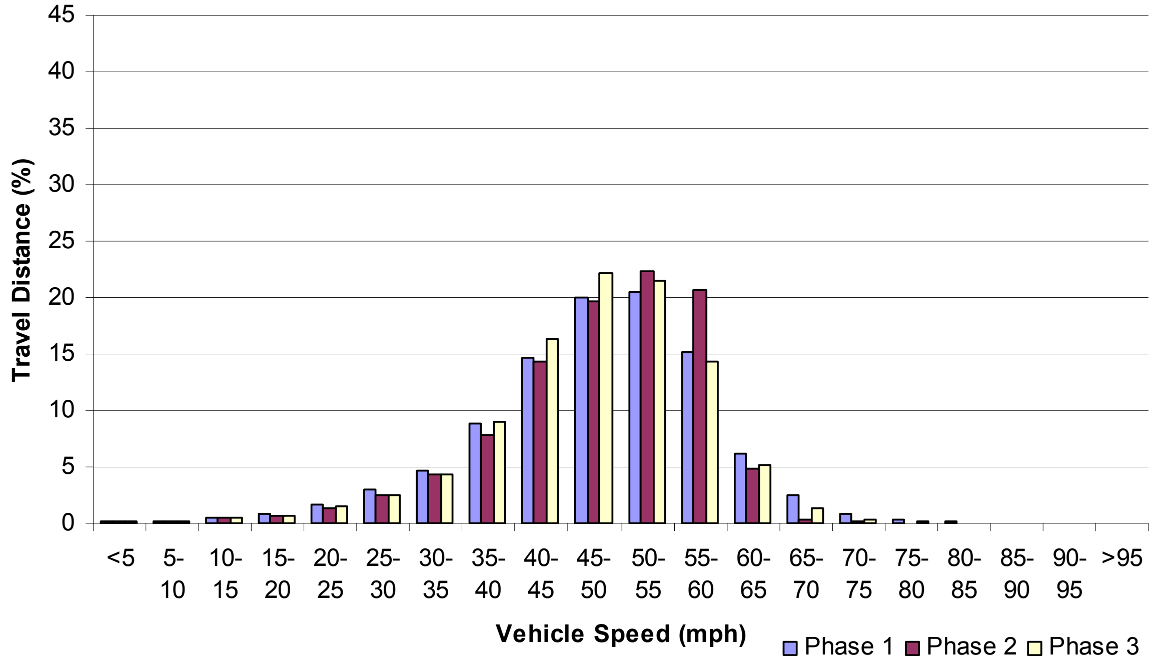


Figure 13: Overall speed distribution in 50 mph zones



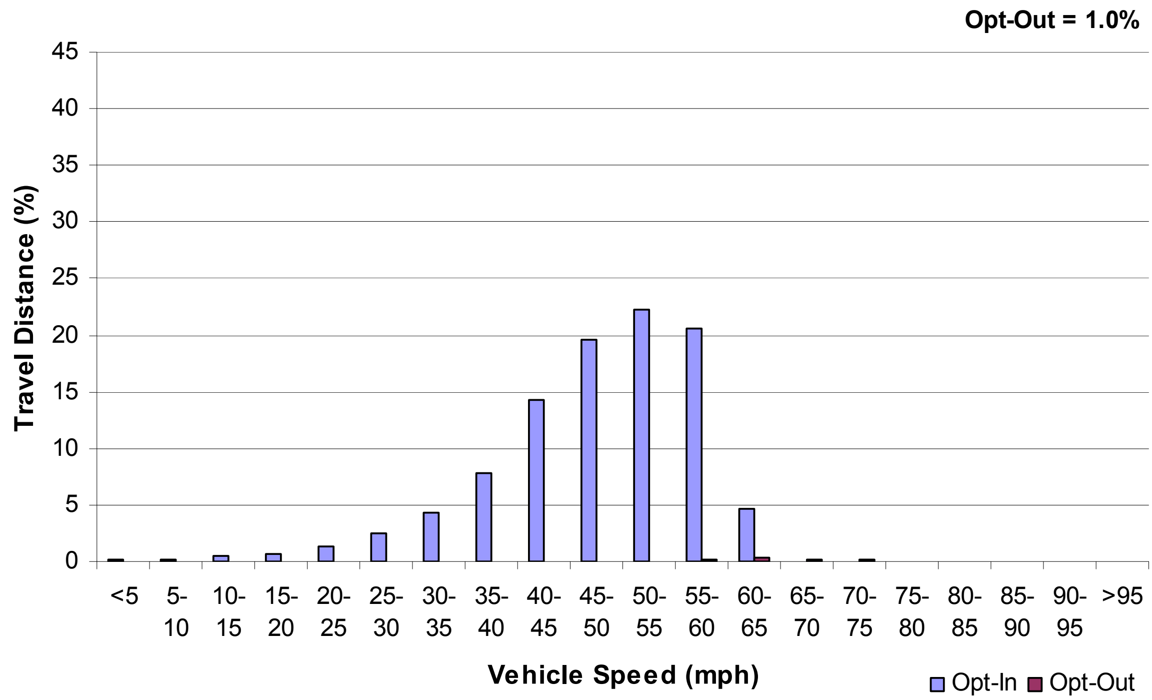


Figure 14: Overall speed distribution in 60 mph zones

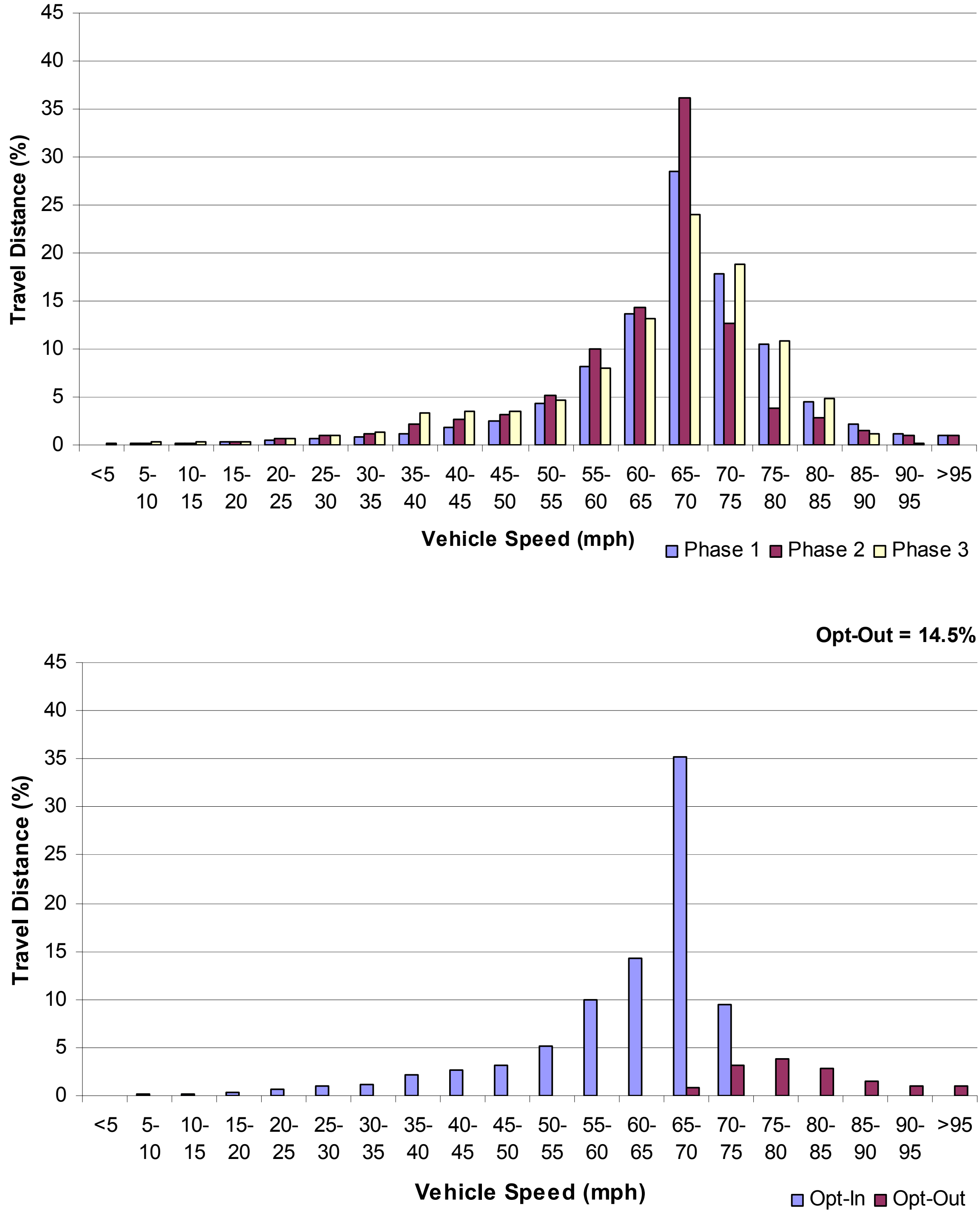


Figure 15: Overall speed distribution in 70 mph zones

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. This may be partially due to the increased exposure (i.e. one third of total vehicle kilometre was contributed by the 70 mph zones). The participants may also have felt that speeding on 70 mph roads (mainly motorways) was acceptable whereas speeding on urban roads was not. However, rates of override on urban roads are still of concern: on 20 mph roads ISA was overridden for 8.2% of distance travelled, on 30 mph roads for 5.8% and on 40 mph roads for 5.7%. 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.

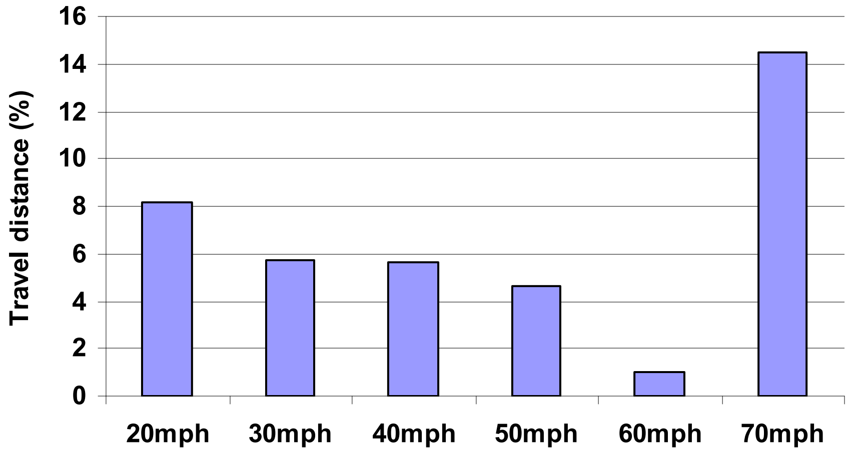


Figure 16: Comparison of overriding behaviour across speed zones

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 one fourth of overriding behaviour occurred in the urban environment (27%, 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).

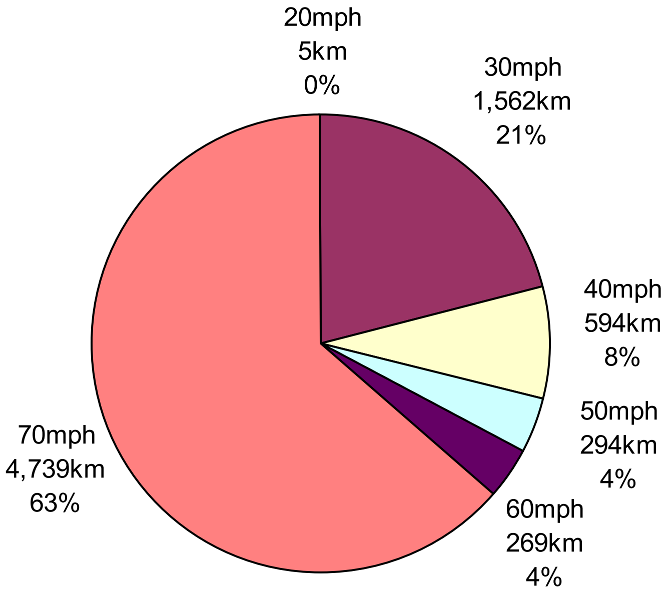


Figure 17: Distribution of travel distance with ISA overridden

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.

The data were integrated on the basis of individual participants with respect to trial phases and speed zones allowing repeated measures ANOVAs to be carried out against key statistics of the speed distribution in each speed zone across trial phases. 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 the 30, 40, and 50 mph 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 20 mph zones is believed to be a result of lack of data representativeness (i.e. only 28, 66, and 14 kilometre of logged data collected from Phase 1, 2, and 3 respectively, as reported in Table 14) and excessively small sample size (i.e. only 3 participants travelled in the 20 mph zones across all three trial phases). Nevertheless, the absence of the 'V' shape in the 60 and 70 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.

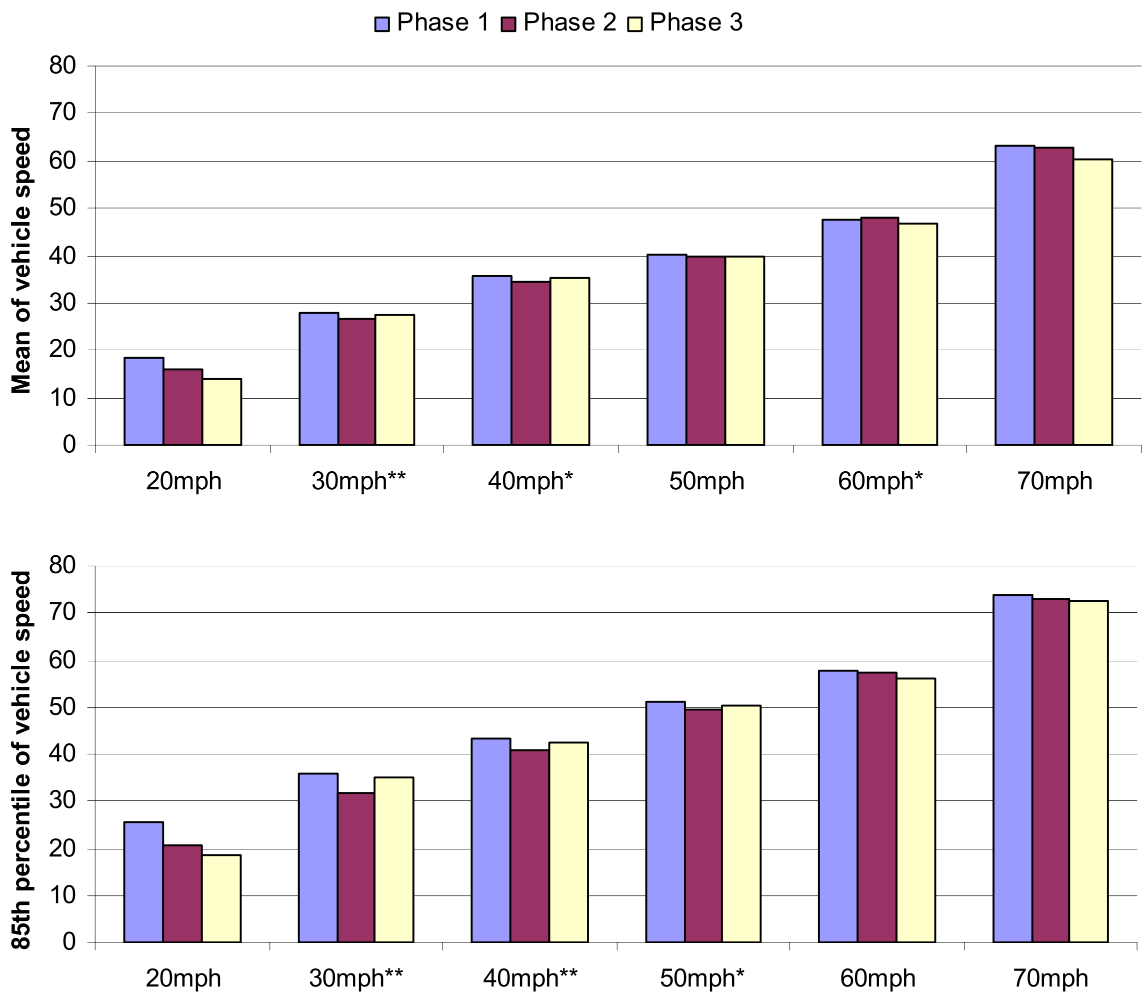


Figure 18: Comparison of key statistics of the speed distribution across trial phases

Table 15 presents the test results of a series of repeated measures ANOVAs, which confirm that ISA effectively changed the speed distribution, especially in urban areas where lower speed limits normally apply. The results of the ANOVA also indicate 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 60 and 70 mph zones in which slight data distortion was observed, as explained earlier in the section). 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 speeding behaviour 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 15: 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 vs PH2	PH1 vs PH3	PH2 vs PH3
Mean speed	20	18.29	15.91	13.97	F(2,4) = 2.21	0.226	0.525	×	×	×
	30	27.98	26.56	27.38	F(2,38) = 9.84	< 0.0005**	0.341	**	×	**
	40	35.64	34.59	35.09	F(2,38) = 4.30	0.021*	0.185	**	×	×
	50	40.32	39.93	39.69	F(2,38) = 0.58	0.564	0.030	×	×	×
	60	47.71	48.20	46.74	F(2,38) = 3.63	0.036*	0.160	×	×	*
	70	63.02	62.86	60.51	F(2,38) = 1.83	0.173	0.088	×	×	×
85th percentile	20	25.53	20.80	18.61	F(2,4) = 3.85	0.117	0.658	*	×	×
	30	35.95	31.86	35.09	F(2,38) = 32.37	< 0.0005**	0.630	**	×	**
	40	43.15	40.81	42.67	F(2,38) = 12.15	< 0.0005**	0.390	**	×	**
	50	51.00	49.49	50.22	F(2,38) = 3.72	0.033*	0.164	**	×	×
	60	57.81	57.51	56.21	F(2,38) = 2.06	0.141	0.098	×	×	*
	70	73.80	72.81	72.47	F(2,38) = 0.41	0.667	0.021	×	×	×

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 16 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 1 and 2 in the 70 mph zones. 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 et al, 2000; Taylor et al, 2002).

Table 16: Coefficient of variation of vehicle speed across trial phases

Speed zone	Phase 1	Phase 2	Phase 3
20 mph	0.369	0.311	0.368
30 mph	0.322	0.286	0.316
40 mph	0.261	0.246	0.268
50 mph	0.291	0.273	0.299
60 mph	0.225	0.203	0.207
70 mph	0.184	0.199	0.214
Overall	0.398	0.400	0.401

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 17. 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, as presented in Table 18.

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 17: Analysis of jerk based on trial phases

Participant id	Trial phase		
	Phase 1	Phase 2	Phase 3
50	1		
51			1
52		1	
53		1	
54			
55	1		
56			
57		1	
58			
59			
60			
61			1
62			
63		3	
64			
65			
66			
67			
68			
69			1
sum	2	6	3
Veh-km	35,261	102,556	28,691
Prob of jerk occurrence (per veh-km)	**0.006 %**	**0.006 %**	**0.010 %**

Table 18: Analysis of jerk based on dichotomy

	ISA	No ISA
Frequency of jerk	6	5
Veh-km	102,556	63,953
Prob of jerk occurrence (per veh-km)	**0.006 %**	**0.008 %**

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 19.

Table 19: Number of participants by demographic categories

	Male		Female		Total
	Intender	Non-Intender	Intender	Non-Intender	
Young	2	1	3	2	8
Old	4	2	1	5	12
Total	6	3	4	7	20

3.4.1 Gender

Table 20 depicts a breakdown of vehicle kilometres across trial phases, speed zones and participants' gender groups, which shows that female participants contributed to a larger amount of data than male participants; this however was not completely out of expectation due to the imbalanced number of participants across the gender groups. Figure 19 further compares the distribution of travel distance between the two gender groups, which reveals that male participants travelled in rural area (i.e. the 70 mph zones) more than female participants, and female participants travelled in urban area (i.e. the 30 mph zones) more than male participants.

Table 20: 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	4	17	3	24	49	11
30 mph	2,781	8,947	2,065	5,906	18,200	5,089
40 mph	1,433	4,032	959	2,064	6,437	1,921
50 mph	687	2,095	514	1,266	4,280	1,316
60 mph	4,921	14,050	2,974	3,665	11,762	3,384
70 mph	7,141	18,709	6,286	5,370	13,979	4,170
Sum	77,616			88,893		

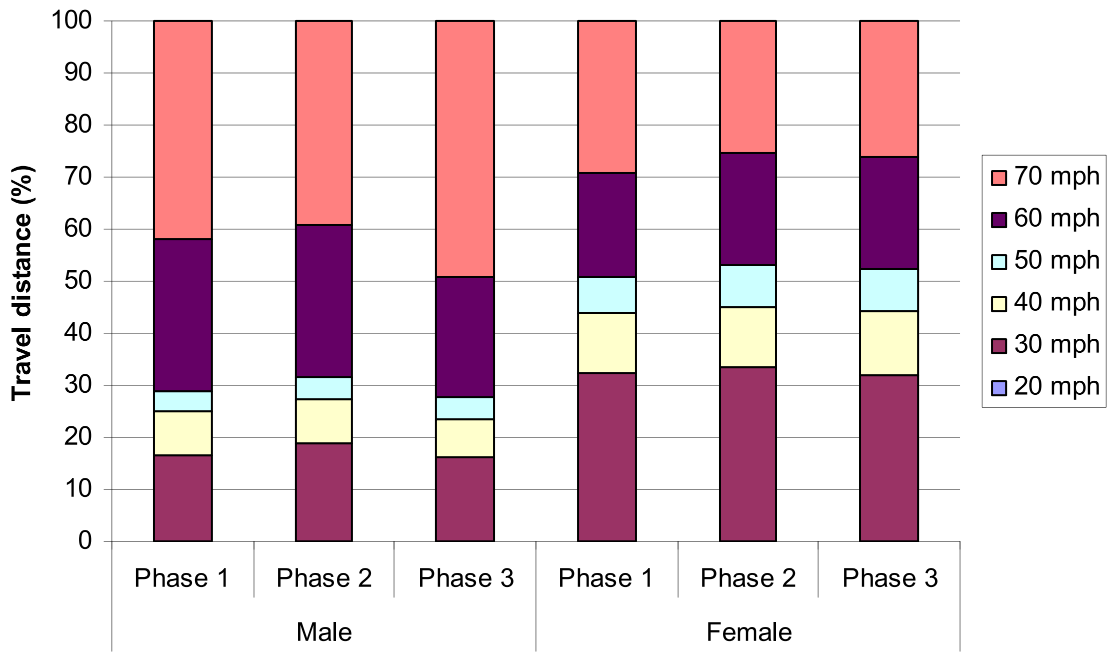


Figure 19: Comparison of patterns of travel distance between gender groups

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.

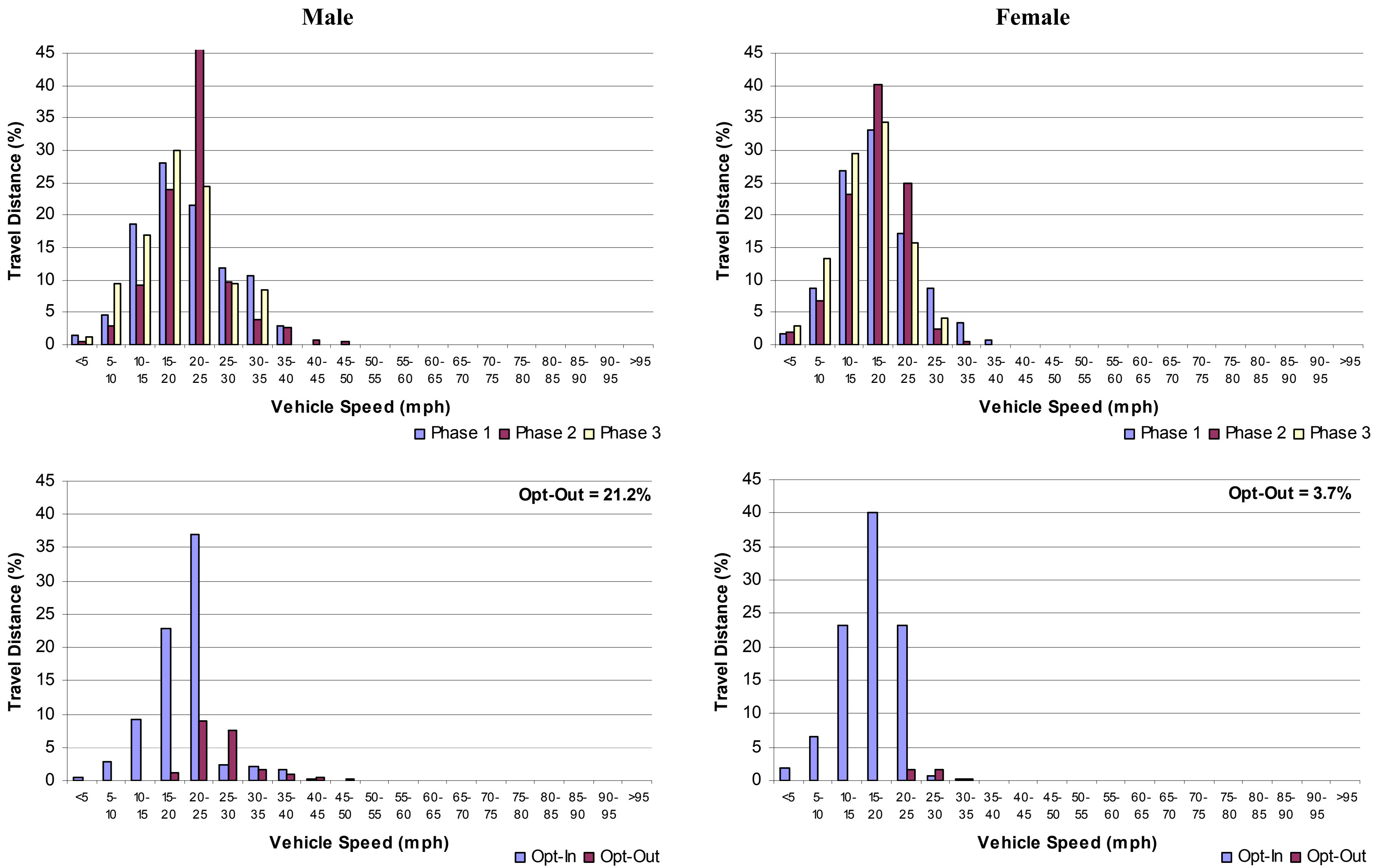


Figure 20: Comparison of the speed distribution in 20 mph zones between gender groups

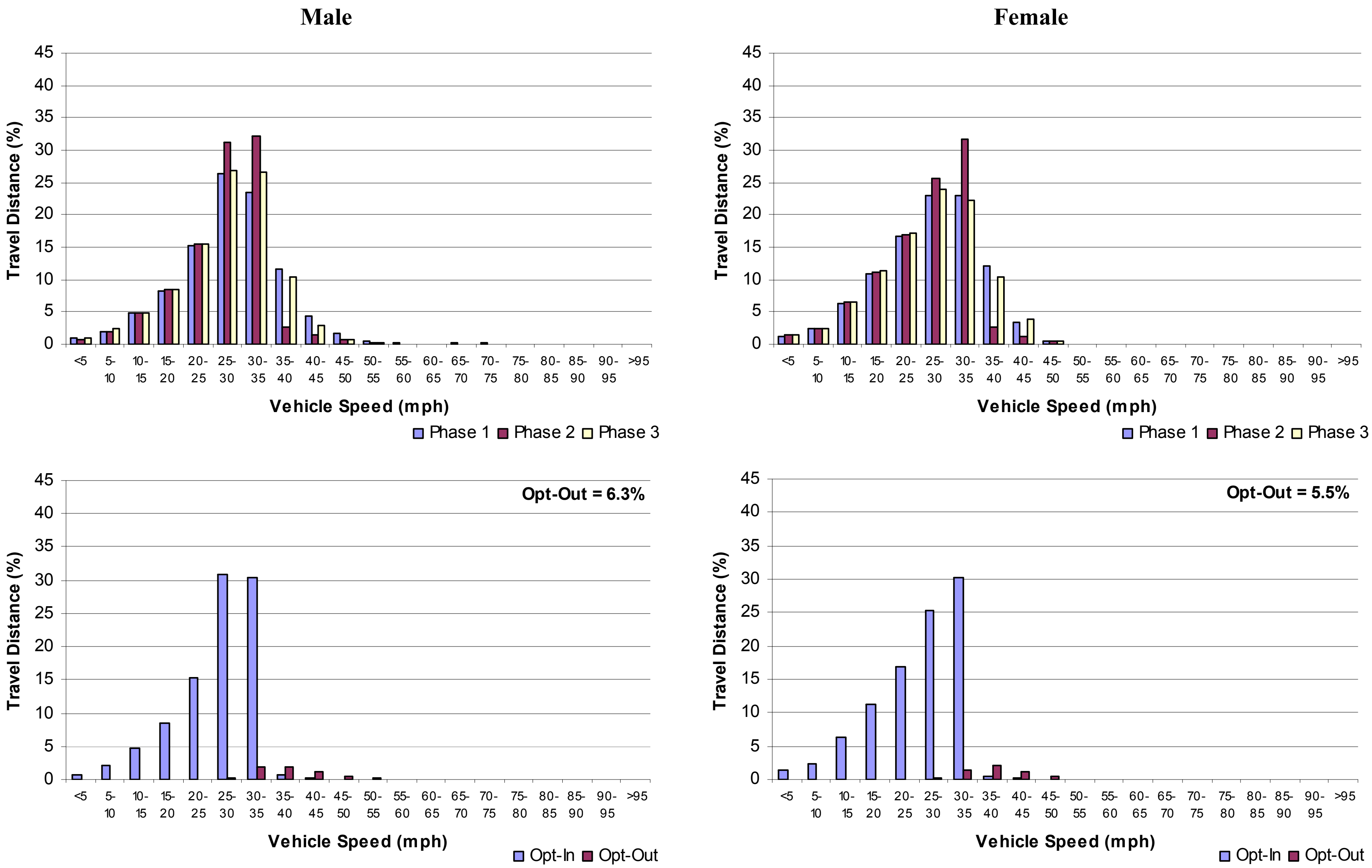


Figure 21: Comparison of the speed distribution in 30 mph zones between gender groups

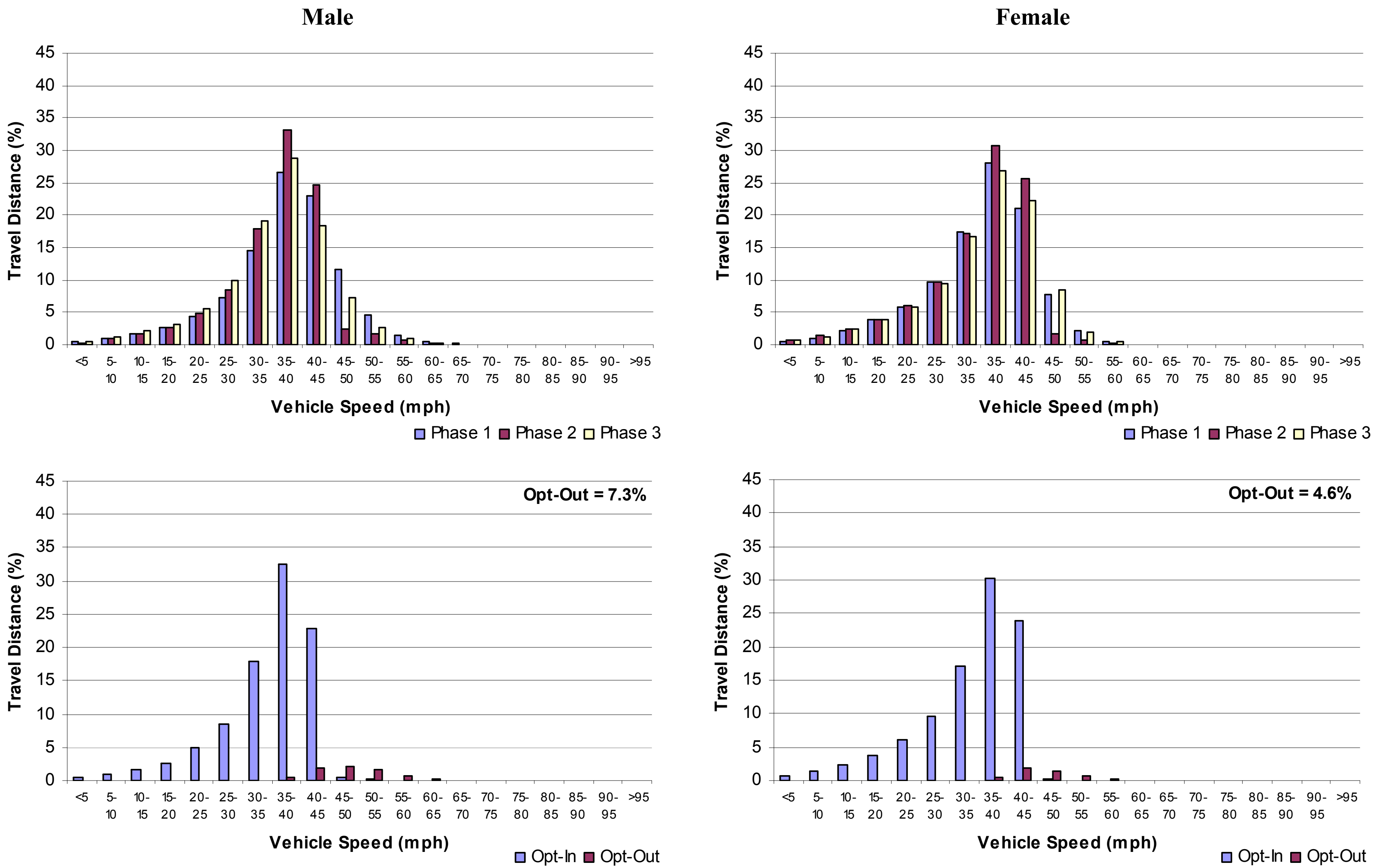


Figure 22: Comparison of the speed distribution in 40 mph zones between gender groups

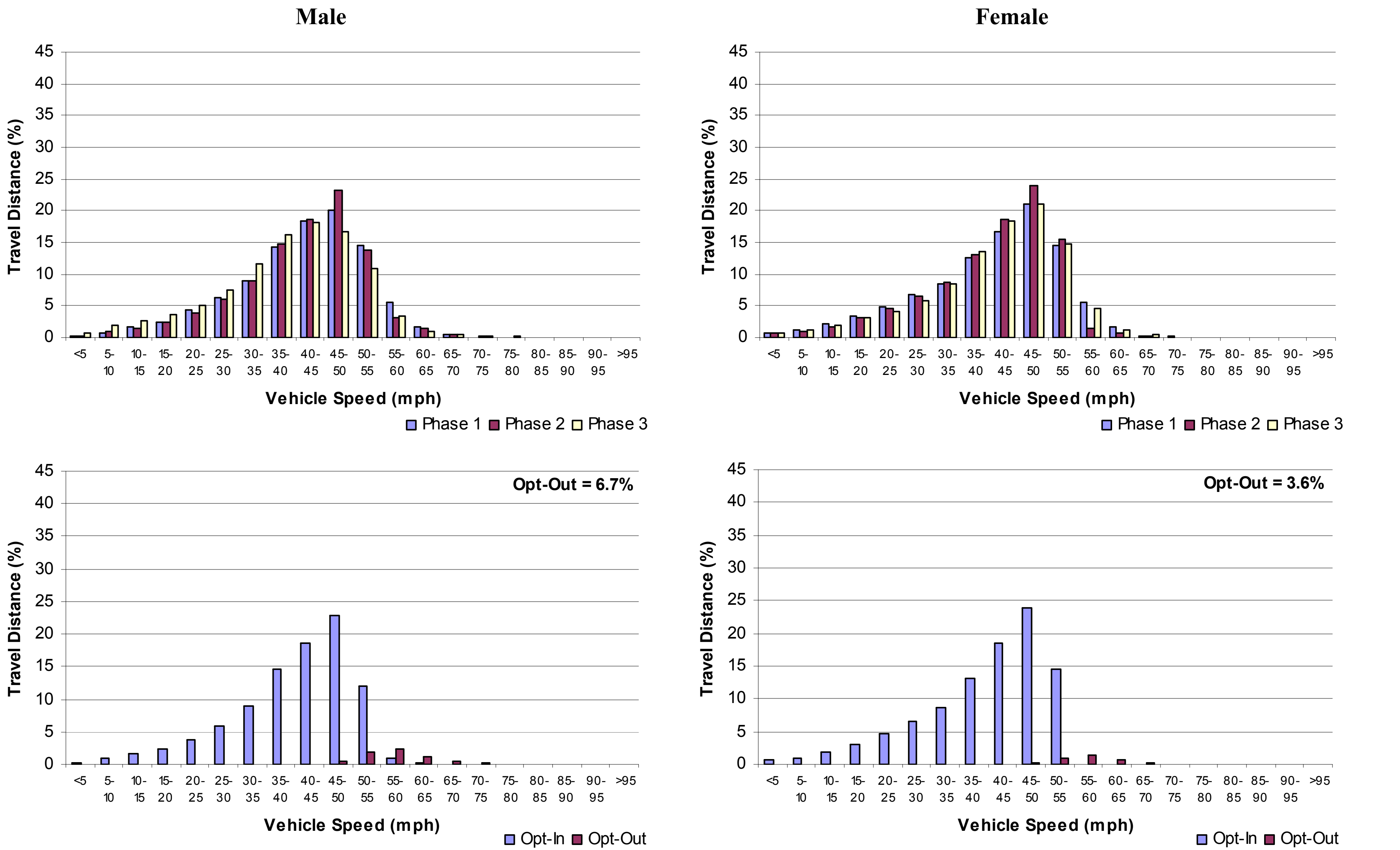


Figure 23: Comparison of the speed distribution in 50 mph zones between gender groups

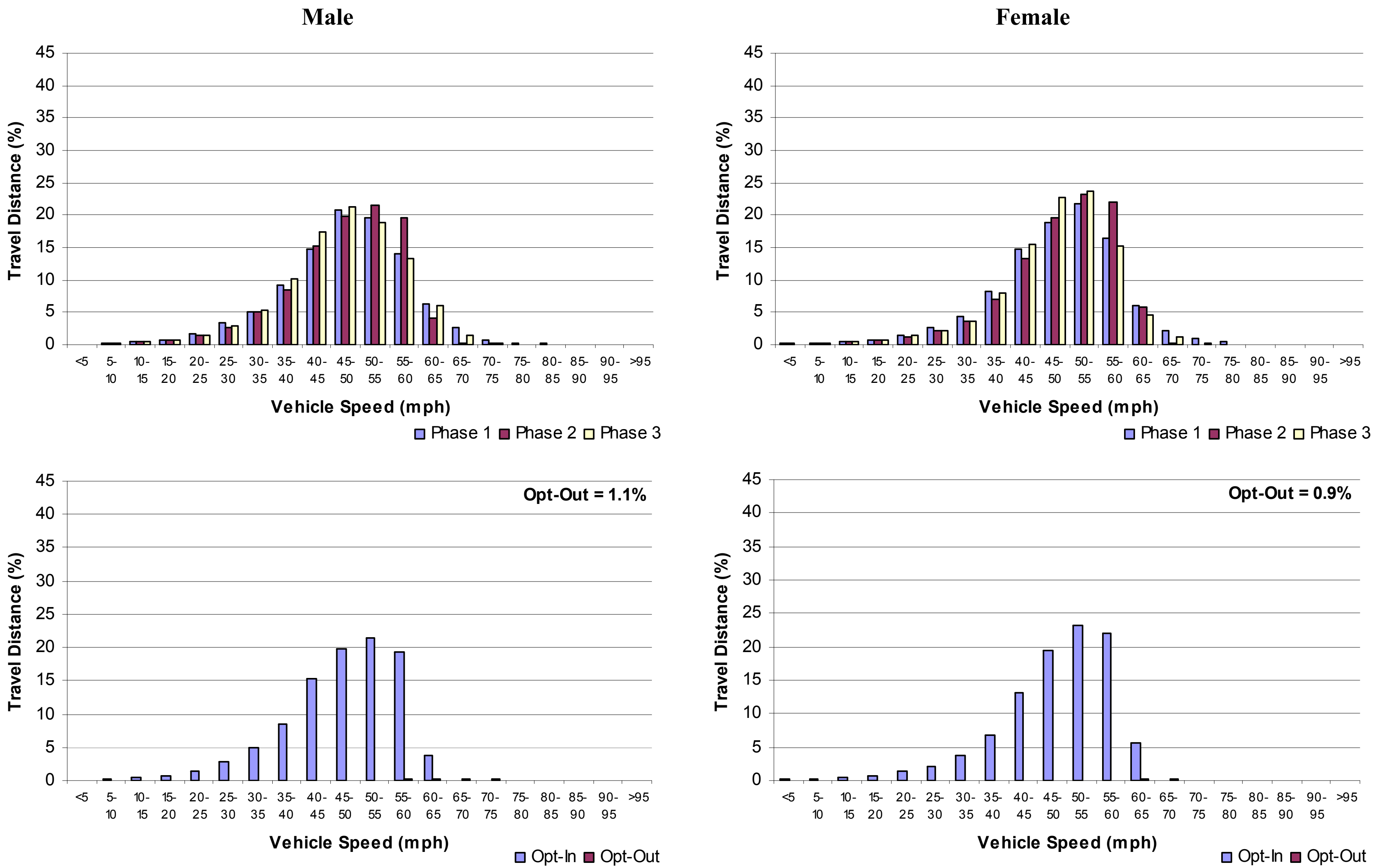


Figure 24: Comparison of the speed distribution in 60 mph zones between gender groups

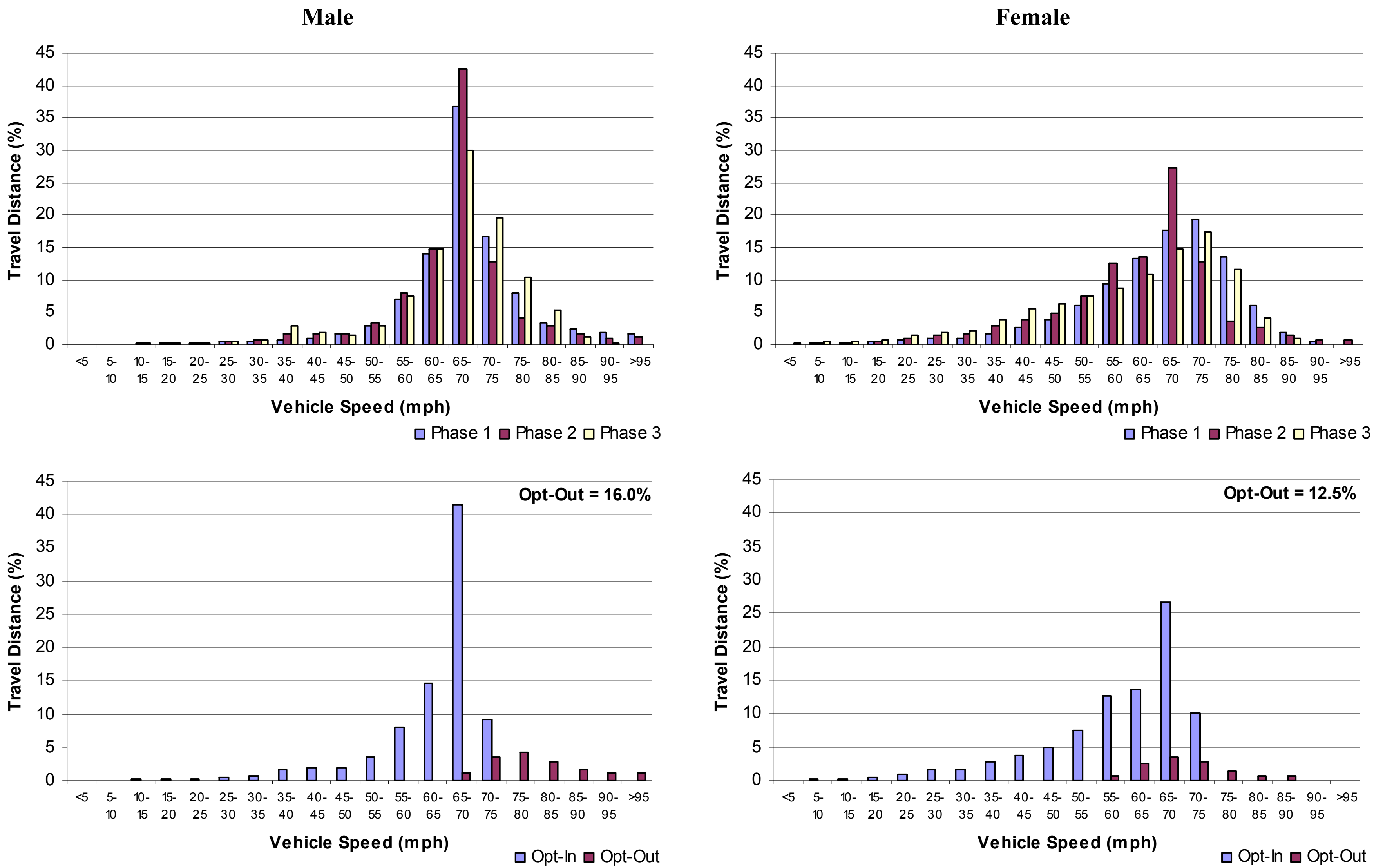


Figure 25: Comparison of the speed distribution in 70 mph zones between gender groups

Figure 26 compares the mean and the 85th percentile across trial phases in each speed zone between the two gender groups. As explained in Section 3.3.5, there were only three participants travelled in the 20 mph zones across all three trial phases. All of the three participants were female, and therefore there is no data for male participants in the 20 mph zones presented in Figure 26. 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 repeated measures 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.

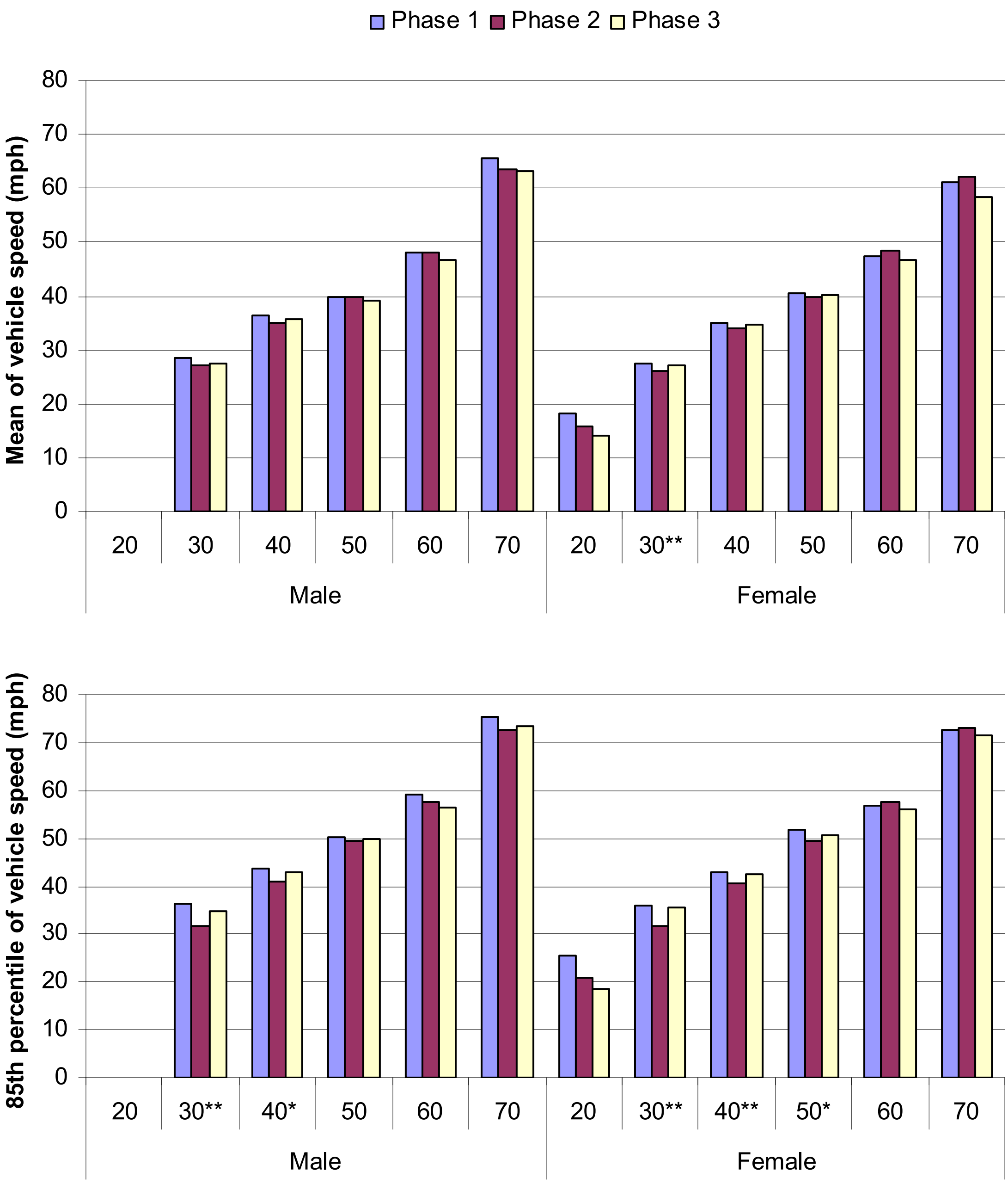


Figure 26: Comparison of key statistics of the speed distribution across trial phases between gender groups

3.4.2 Age

Table 21 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 older participants travelled in the 30 and 70 mph zones more than younger participants.

Table 21: 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	1	8	0.1	27	58	14
30 mph	2,648	7,096	1,683	6,039	20,051	5,471
40 mph	1,833	4,734	1,146	1,664	5,735	1,734
50 mph	1,011	3,020	674	941	3,355	1,156
60 mph	4,014	10,744	2,136	4,572	15,067	4,222
70 mph	3,932	10,806	2,793	8,578	21,882	7,664
Sum	58,280			108,230		

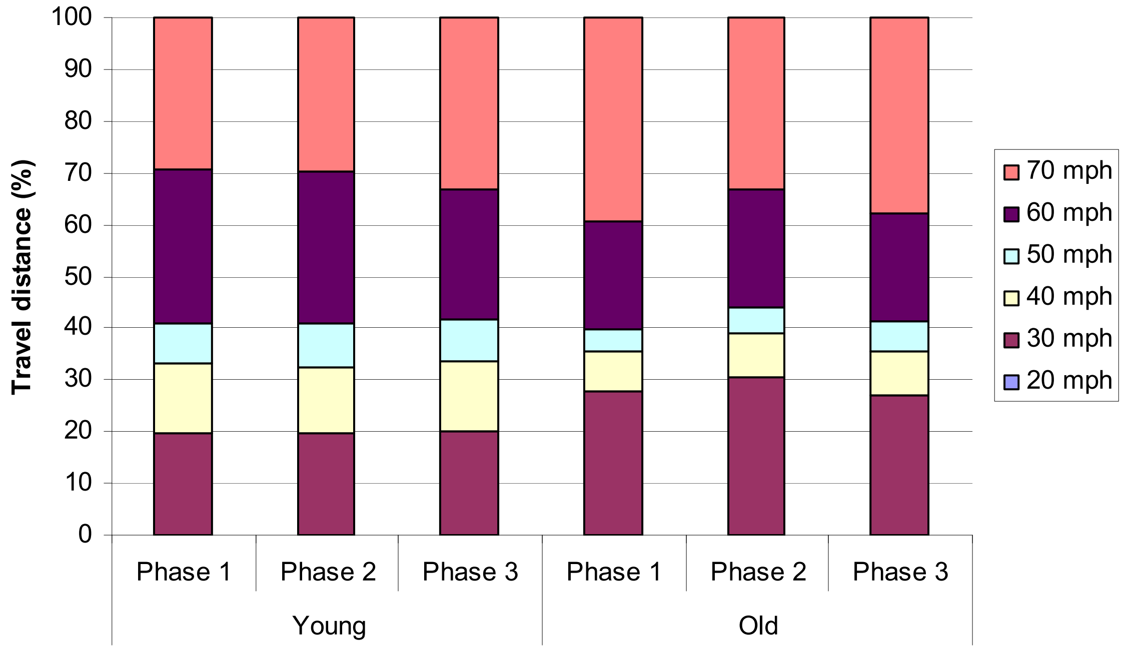


Figure 27: Comparison of patterns of travel distance between age groups

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 across all speed zones, apart from the 60 mph zones. It is also worth noting that the speed distribution of younger participants in the 20 mph zones was highly distorted due to lack of data representativeness (i.e. as depicted in Table 21).

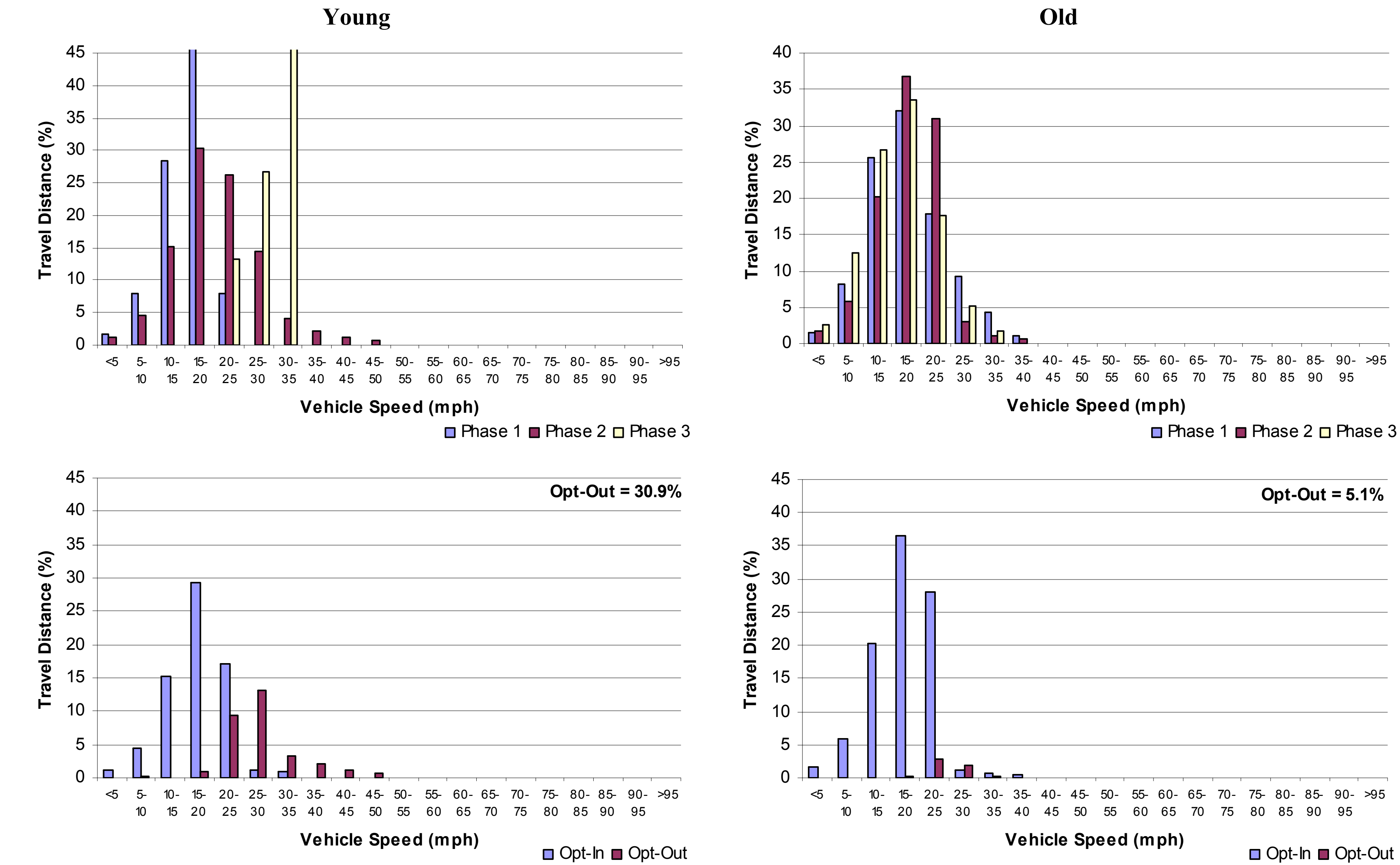


Figure 28: Comparison of the speed distribution in 20 mph zones between age groups

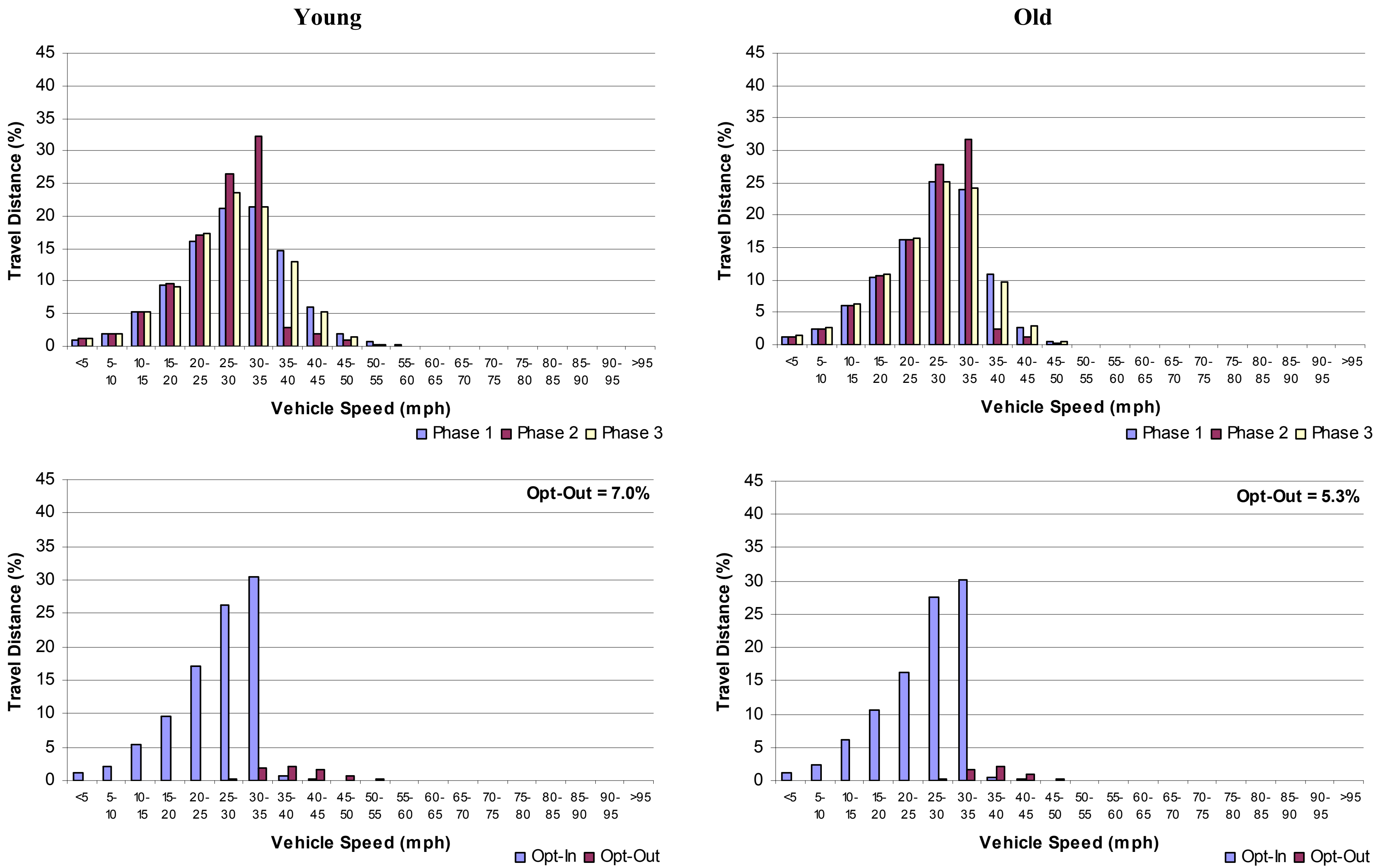


Figure 29: Comparison of the speed distribution in 30 mph zones between age groups

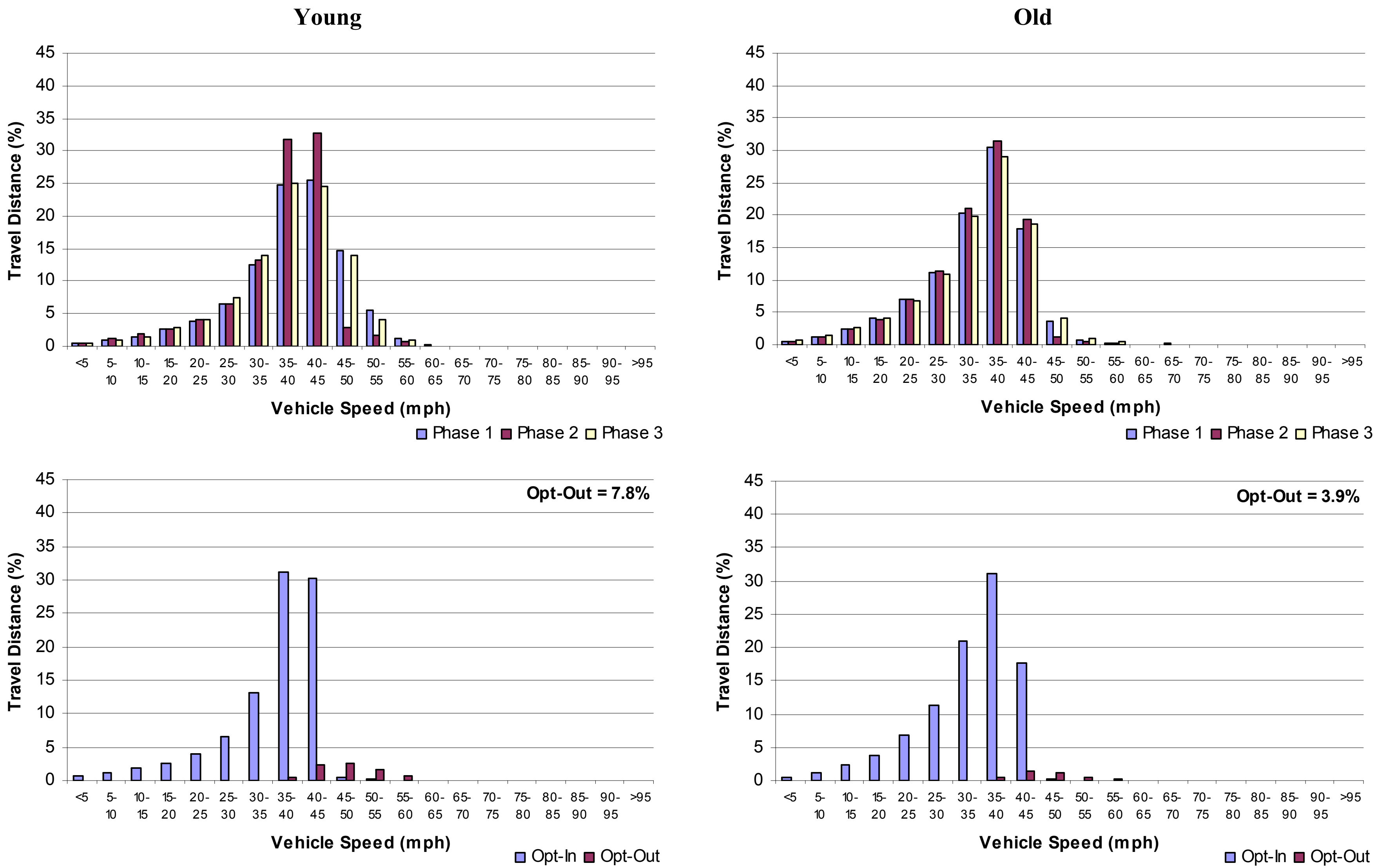


Figure 30: Comparison of the speed distribution in 40 mph zones between age groups

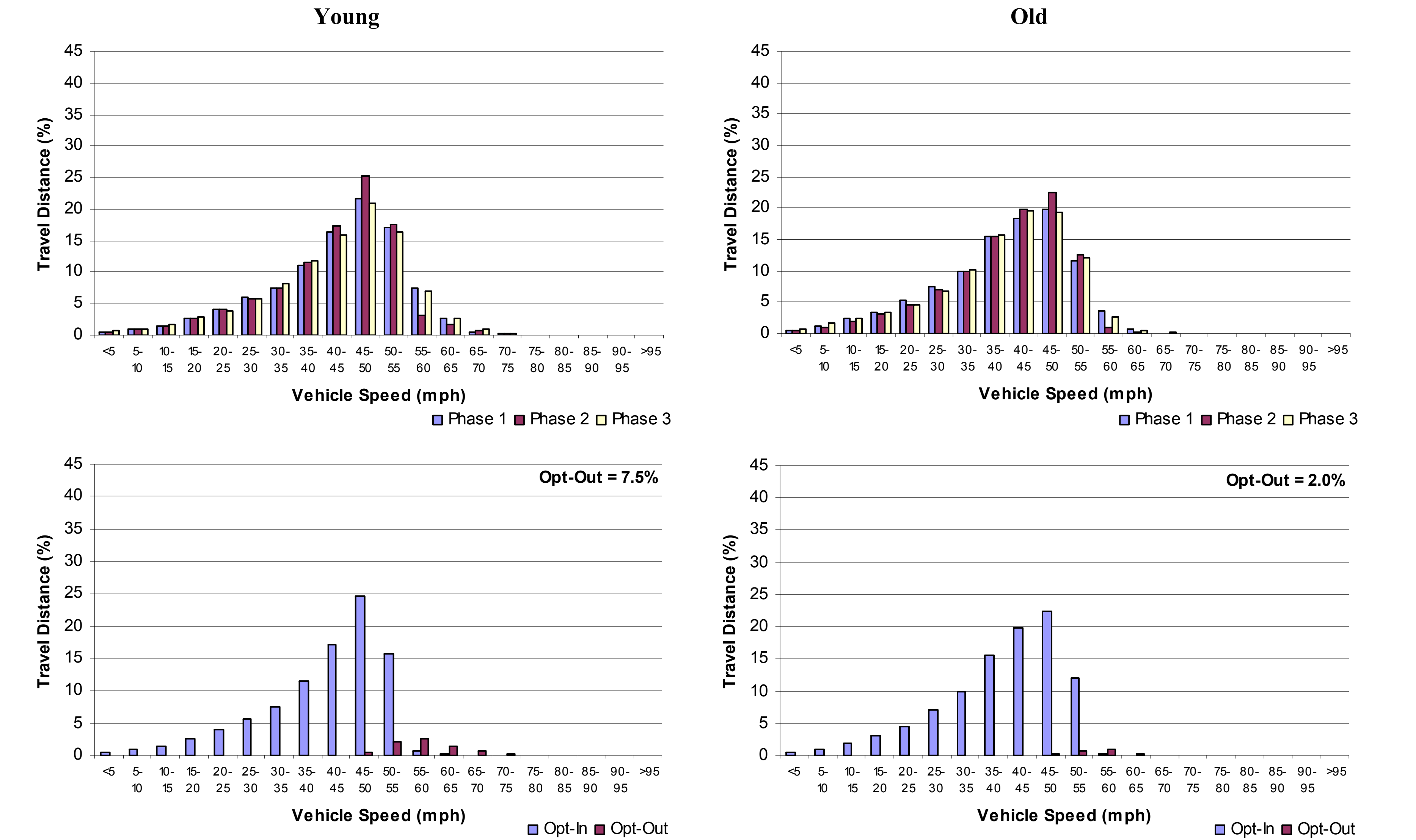


Figure 31: Comparison of the speed distribution in 50 mph zones between age groups

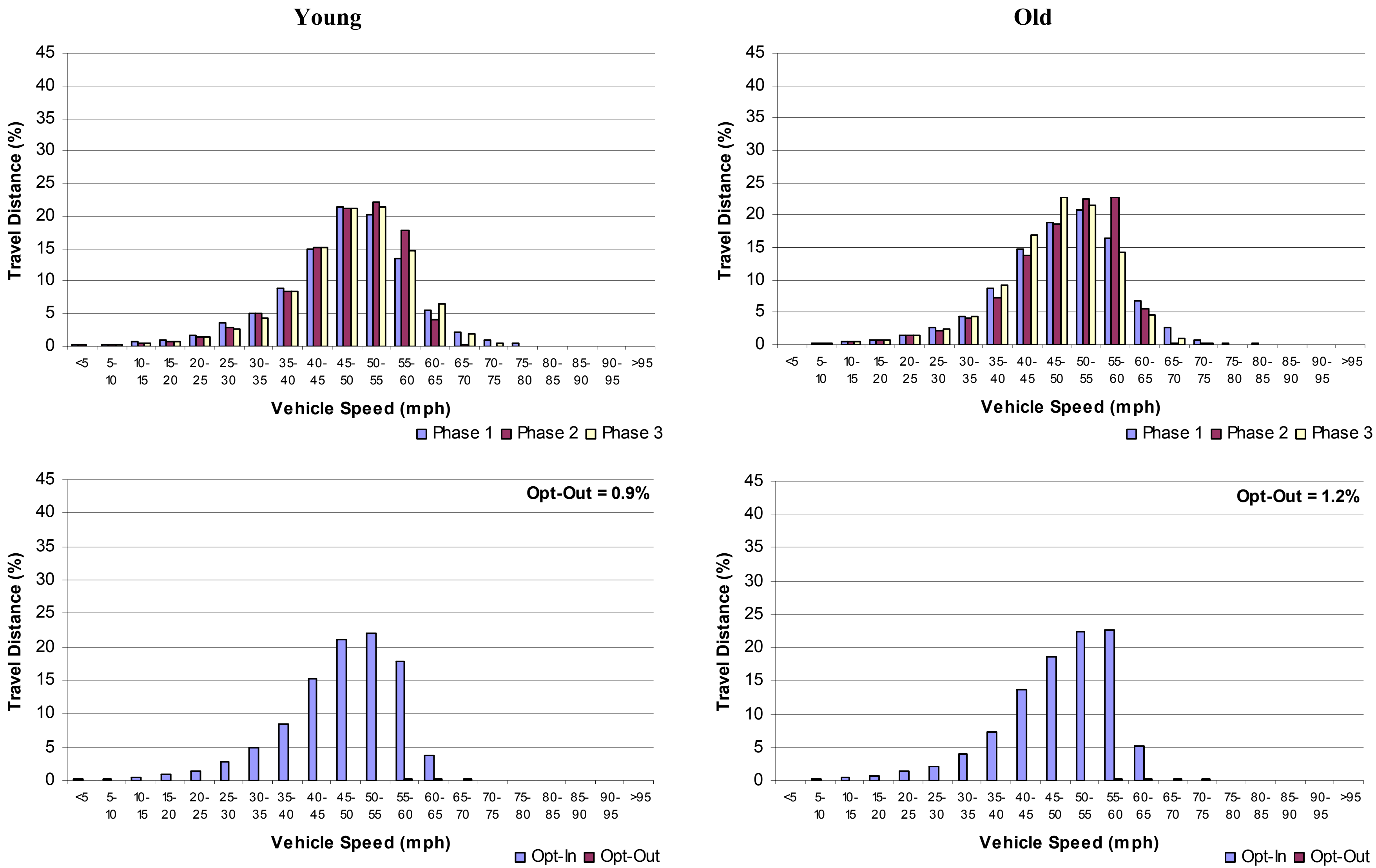


Figure 32: Comparison of the speed distribution in 60 mph zones between age groups

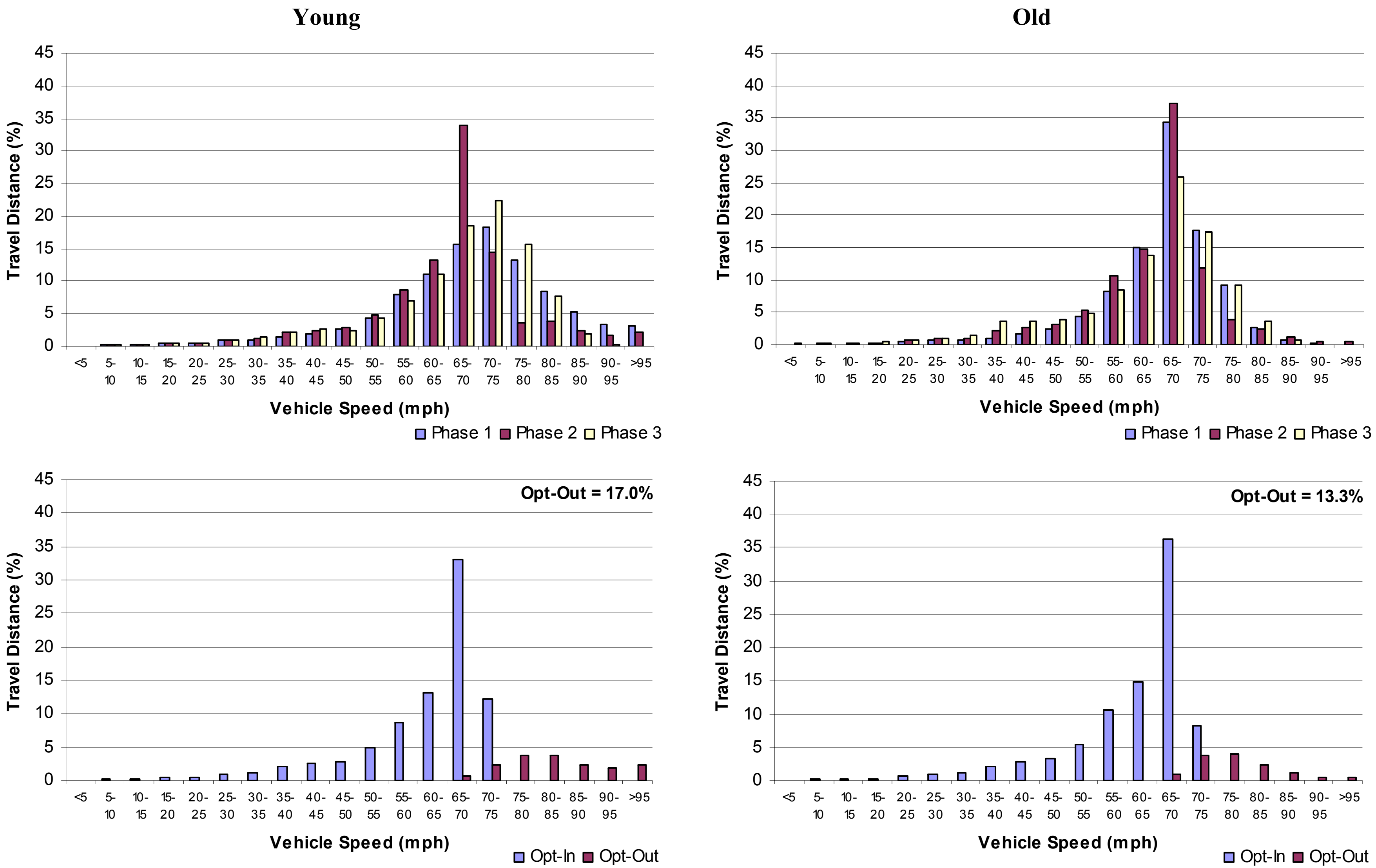


Figure 33: Comparison of the speed distribution in 70 mph zones between age groups

Figure 34 compares the mean and the 85th percentile across trial phases in each speed zone between the two age groups. The only three participants who had travelled in the 20 mph zones across all three trial phases were all older drivers and hence there is no data for younger participants in the 20 mph zones presented in the figure. Again as previously observed, ISA led to a 'V' shape across trial phases, except in some speed zones where distortion present due to difference in participants' reference to choice of speed across trial phases. Figure 34 also suggests that younger participants generally demonstrated slight higher mean speeds and higher 85th percentiles than their counterpart. A series of repeated measures 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 younger participants, especially in the urban areas.

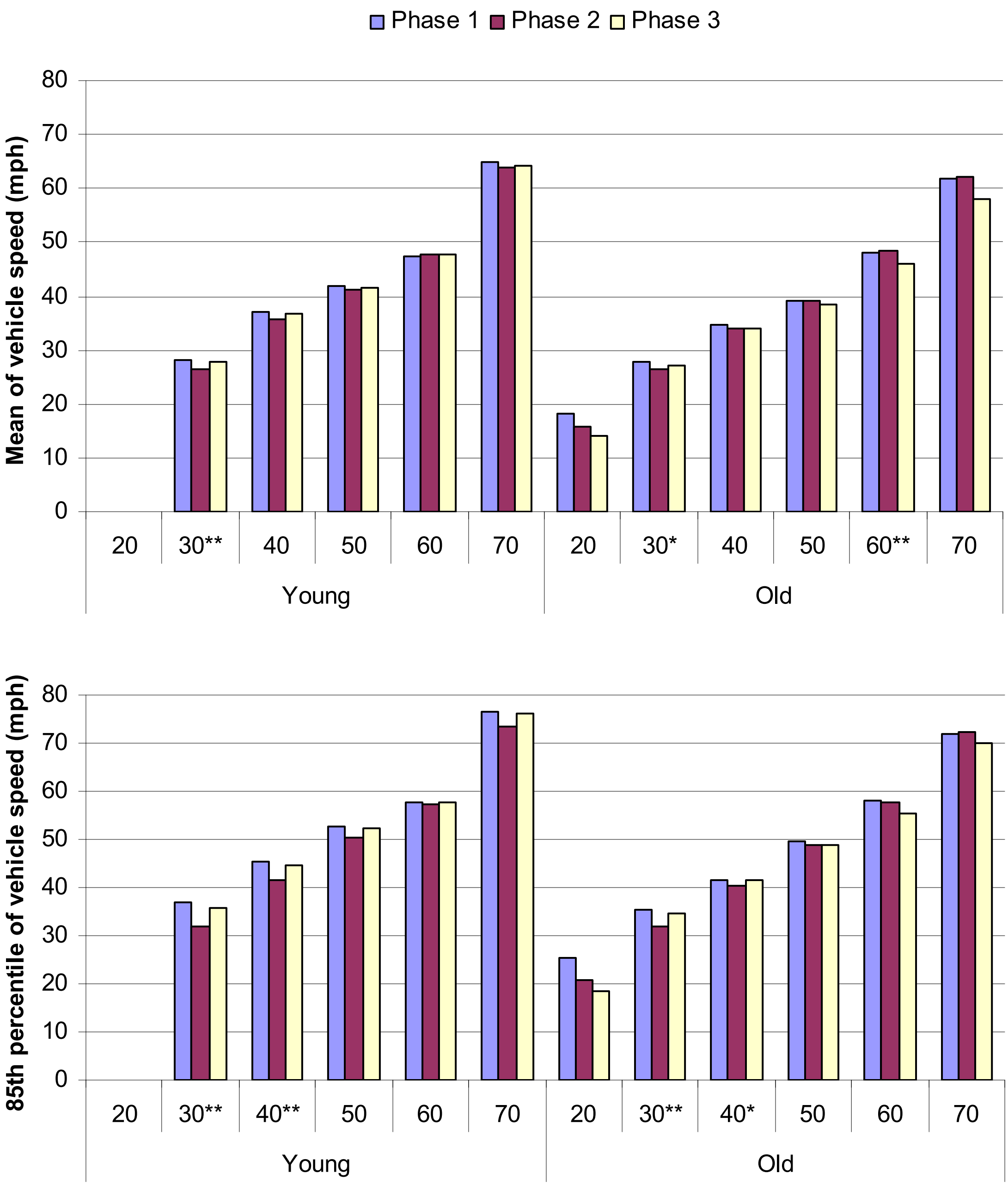


Figure 34: Comparison of key statistics of the speed distribution across trial phases between age groups

3.4.3 Intention to speed

Table 22 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. Figure 35 further compares the distribution of travel distance between the two groups, and reveals similar travel patterns across the two groups of participants. However, intenders seemed to have spent a slightly larger proportion of their travel distance in urban areas (i.e. 30 and 40 mph zones) in comparison with non-intenders.

Table 22: 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	8	23	6	20	42	7
30 mph	4,216	12,624	3,235	4,471	14,523	3,919
40 mph	2,044	5,987	1,650	1,454	4,481	1,230
50 mph	986	3,205	858	967	3,171	972
60 mph	3,525	10,081	2,148	5,061	15,731	4,211
70 mph	4,695	15,827	5,104	7,815	16,861	5,352
Sum	76,223			90,287		

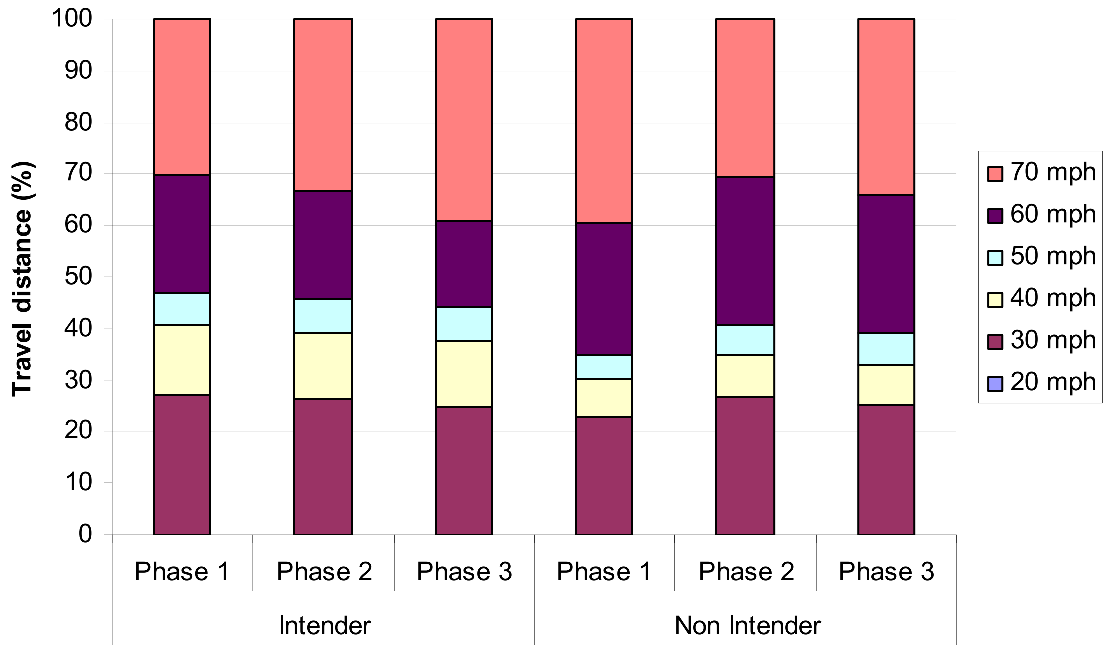


Figure 35: Comparison of patterns of travel distance between intention groups

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 across all speed zones, the difference was especially prominent in the 70 mph zone (i.e. Figure 41), which highlights the concern that those who needs ISA the most also overrode it most.

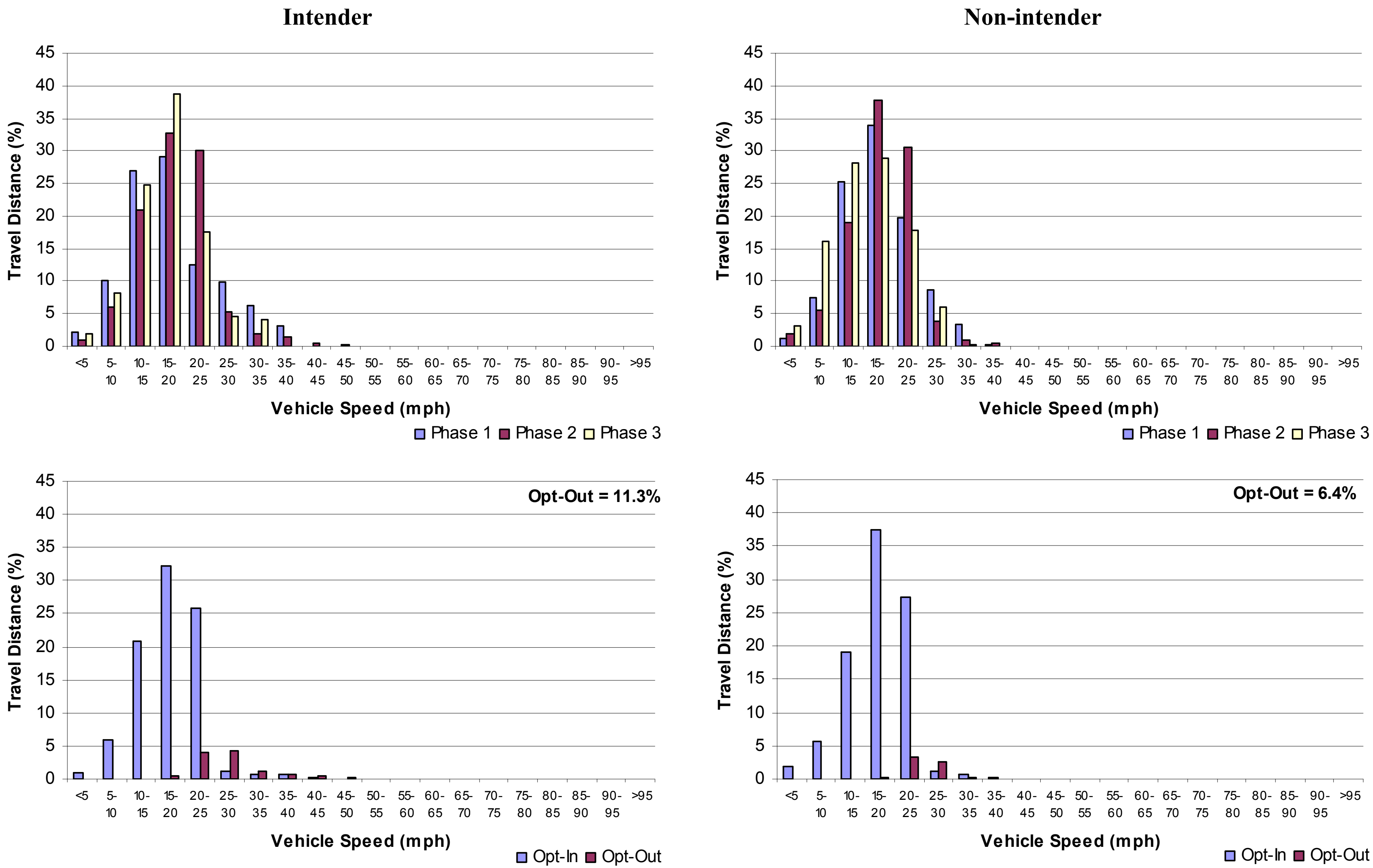


Figure 36: Comparison of the speed distribution in 20 mph zones between intention groups

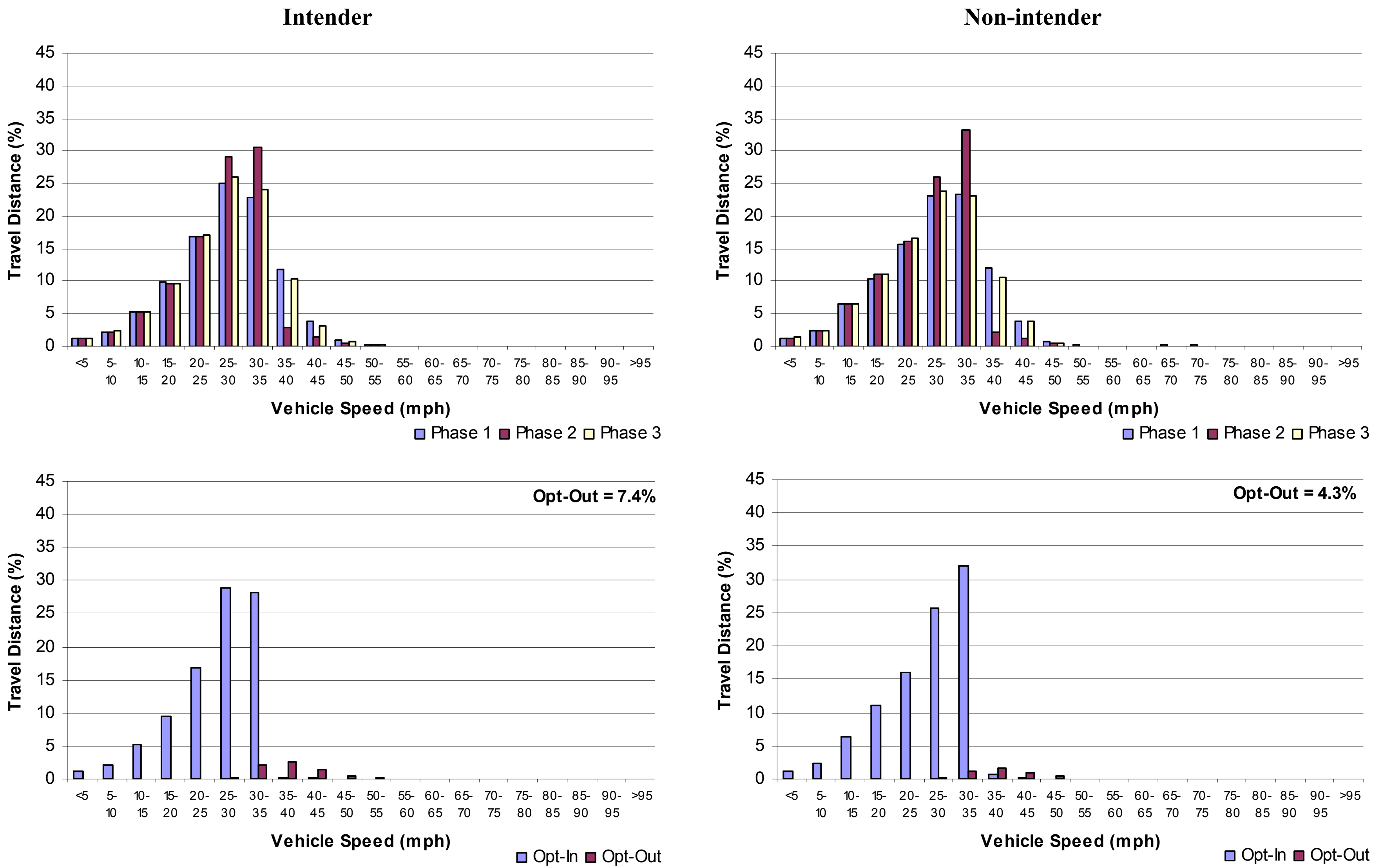


Figure 37: Comparison of the speed distribution in 30 mph zones between intention groups

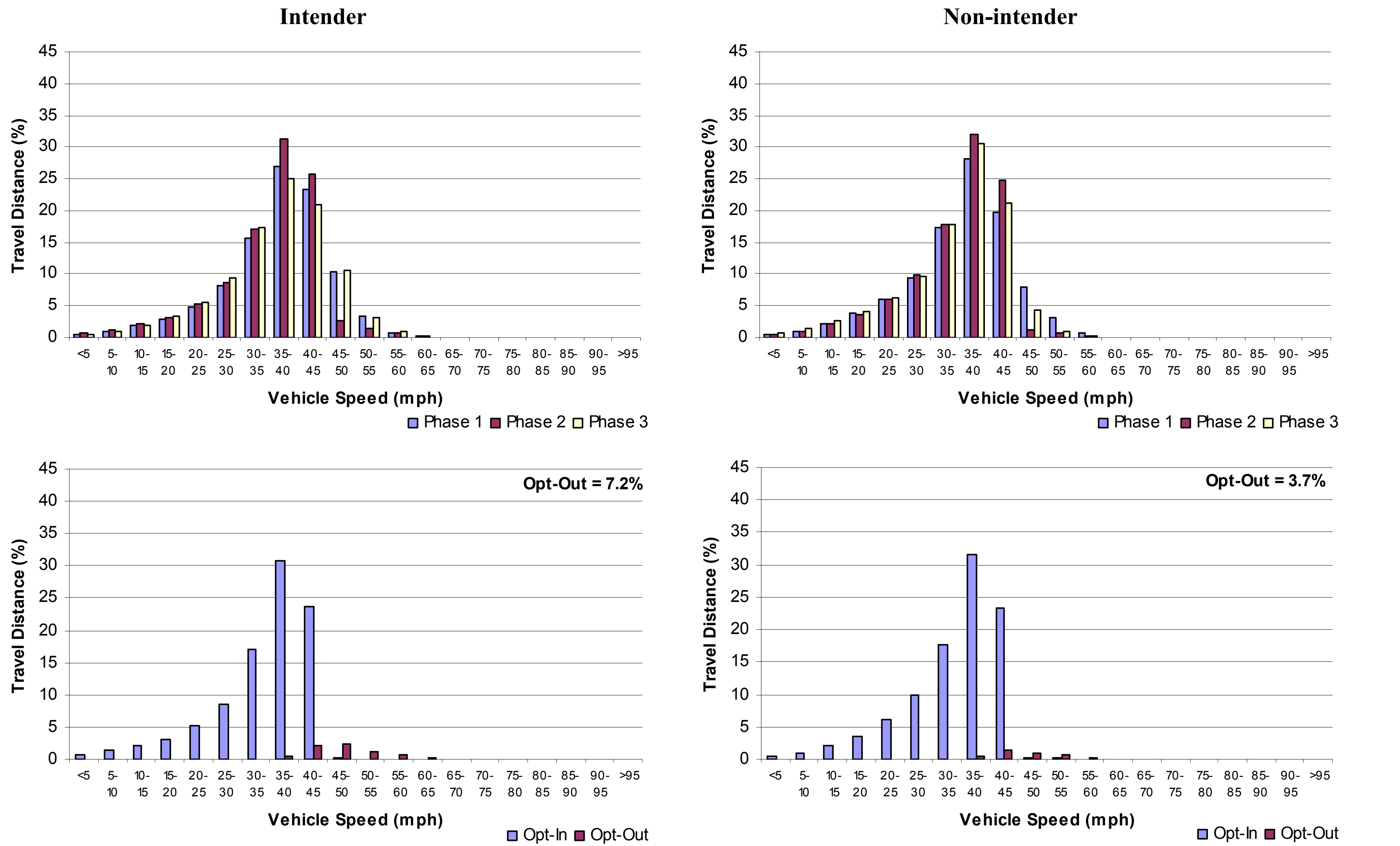


Figure 38: Comparison of the speed distribution in 40 mph zones between intention groups

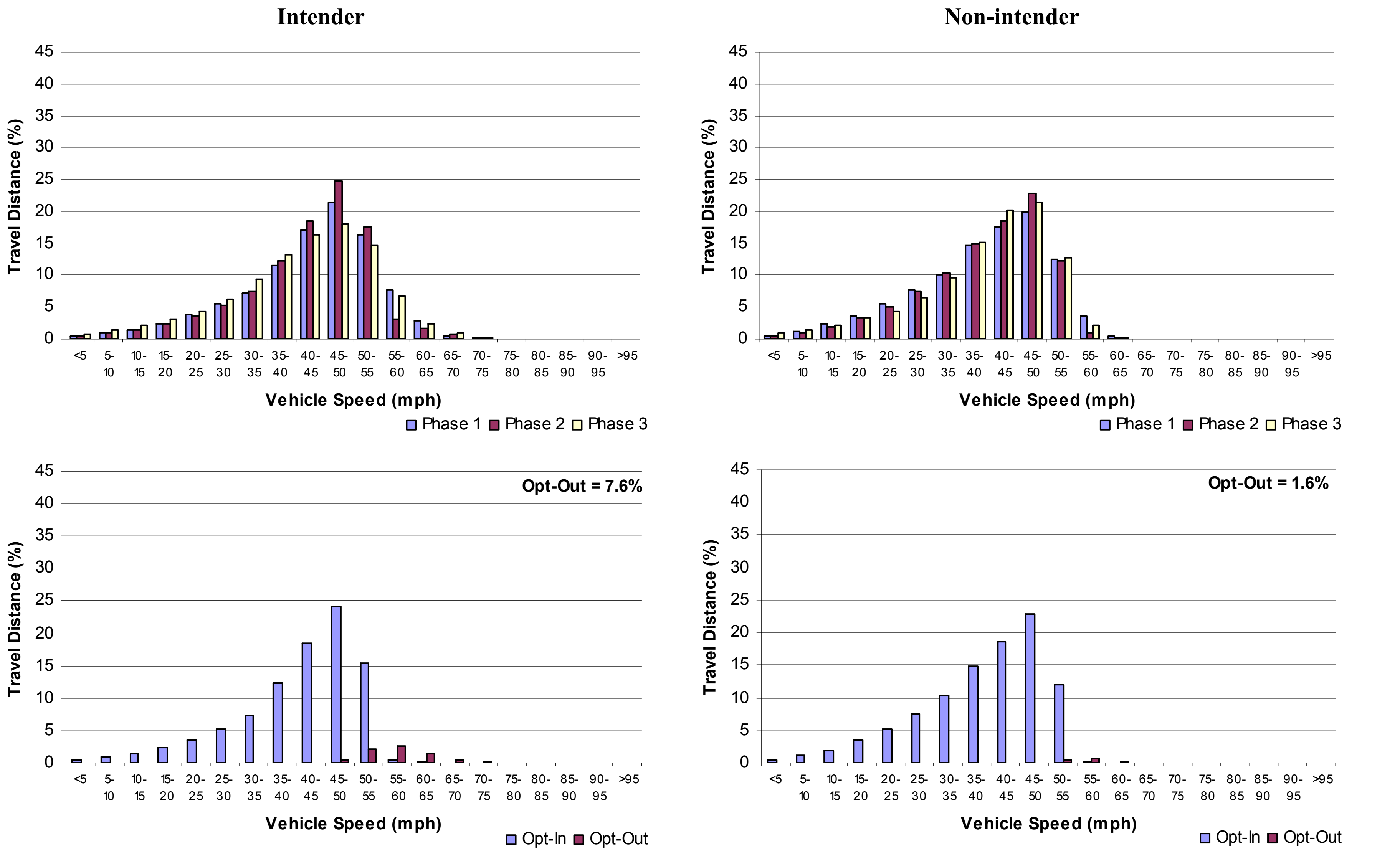


Figure 39: Comparison of the speed distribution in 50 mph zones between intention groups

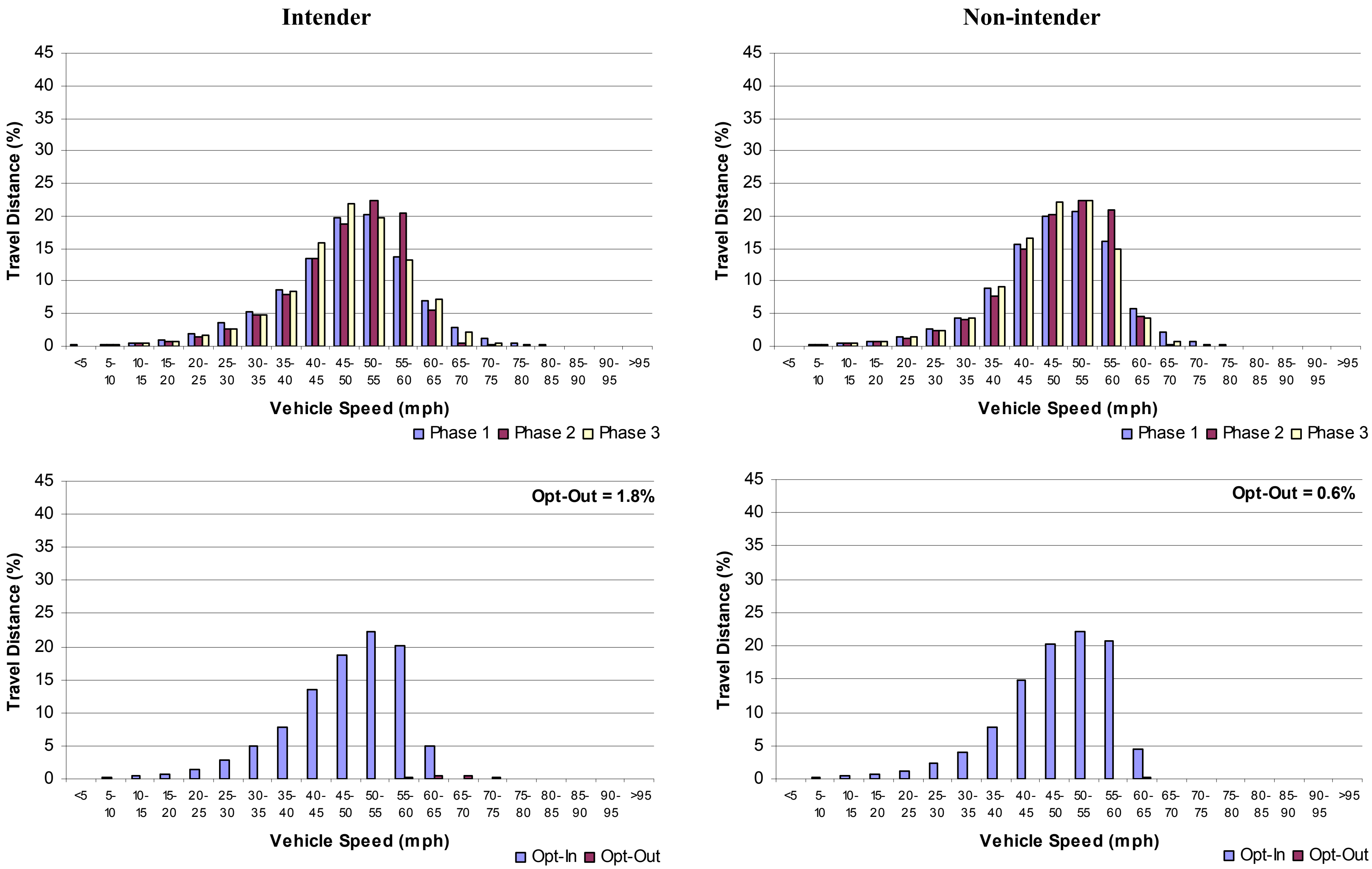


Figure 40: Comparison of the speed distribution in 60 mph zones between intention groups

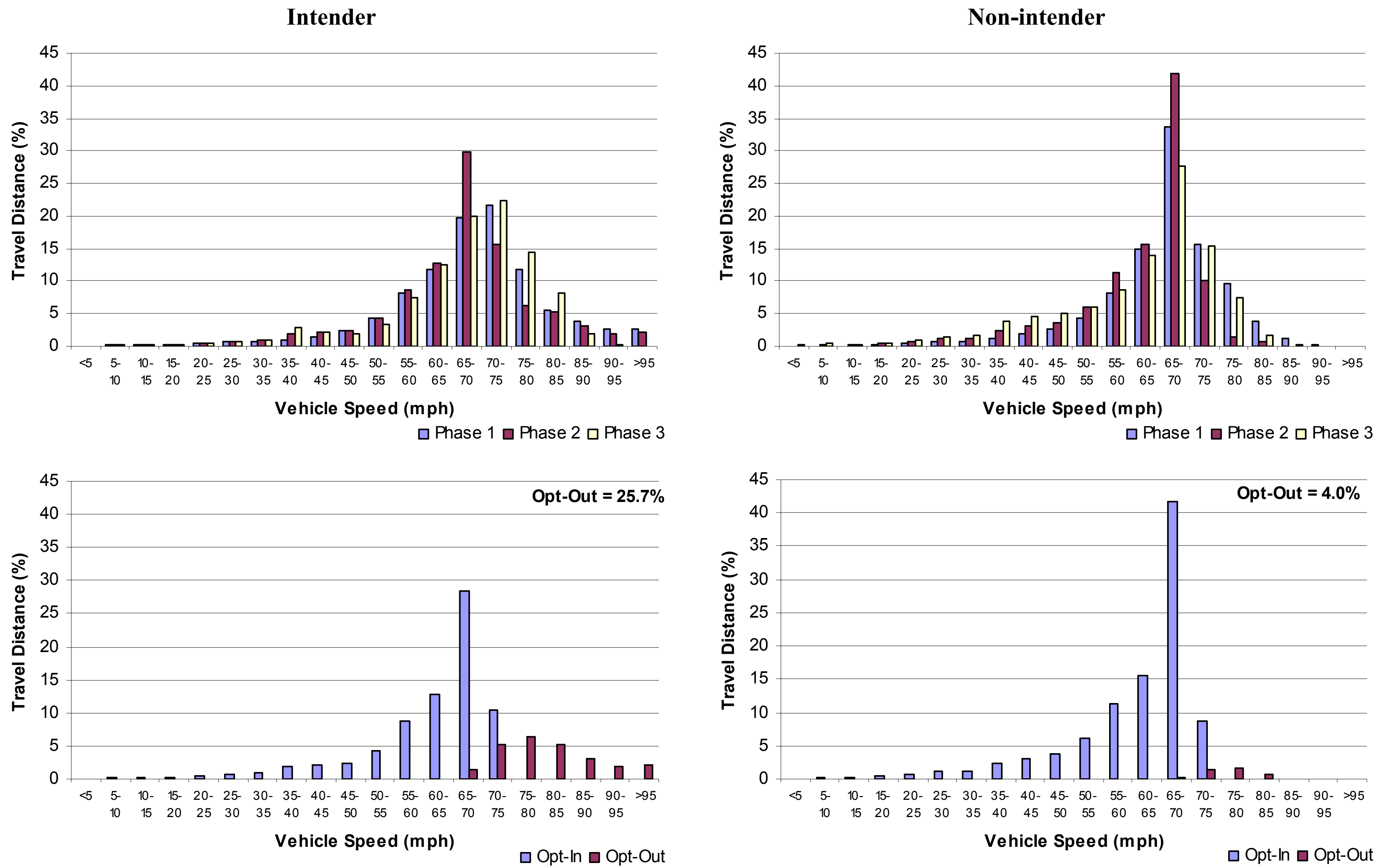


Figure 41: Comparison of the speed distribution in 70 mph zones between intention groups

Figure 42 compares the mean and the 85th percentile across trial phases in each speed zone between the two intention groups of participant. Intenders in general drove faster than non-intenders but the effect of ISA cutting down speed was also more prominent for the intender group. A series of repeated measures 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 intenders especially within lower speed zones, as indicated by the statistical test results.

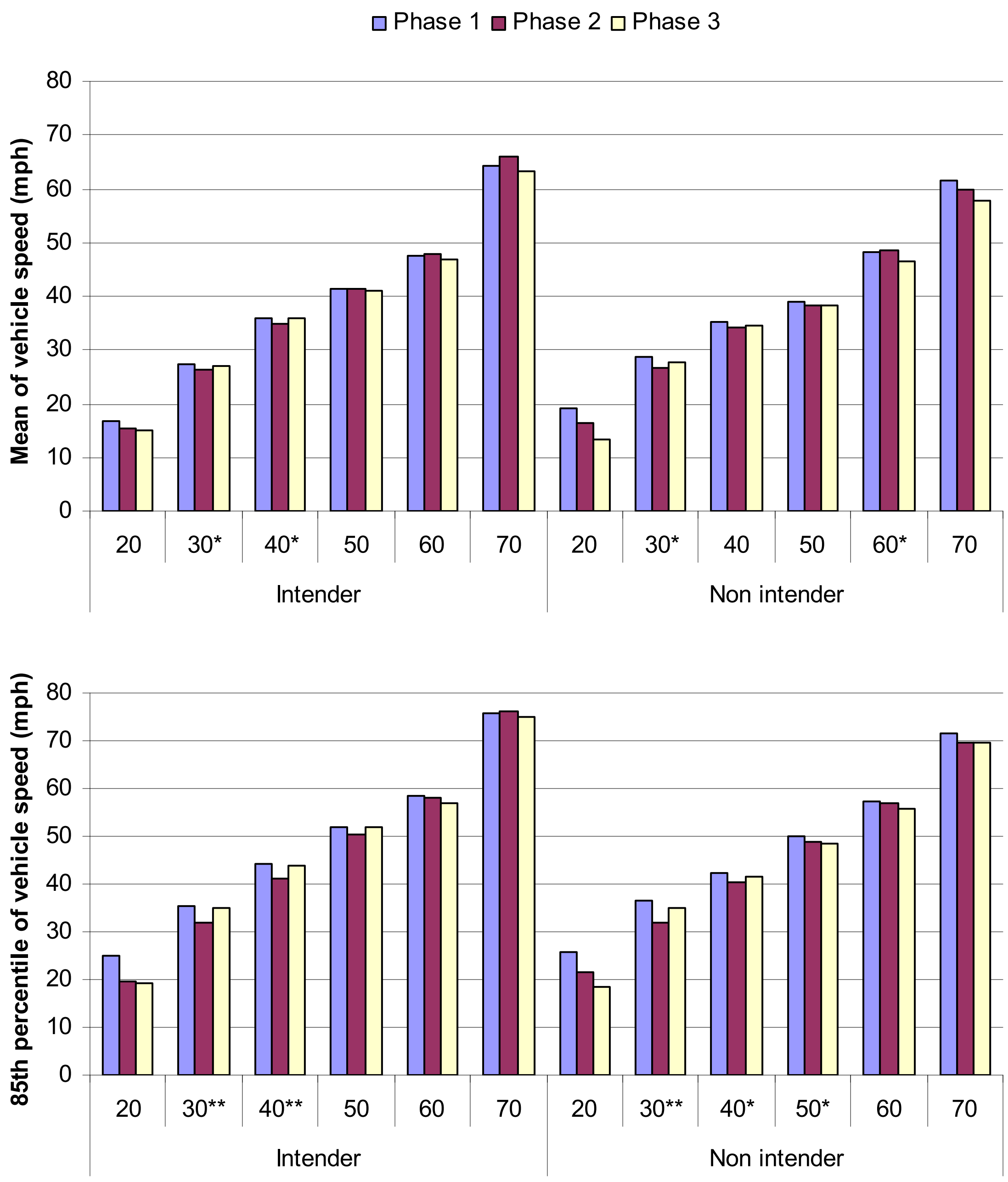


Figure 42: Comparison of key statistics of the speed distribution across trial phases between intention groups

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.

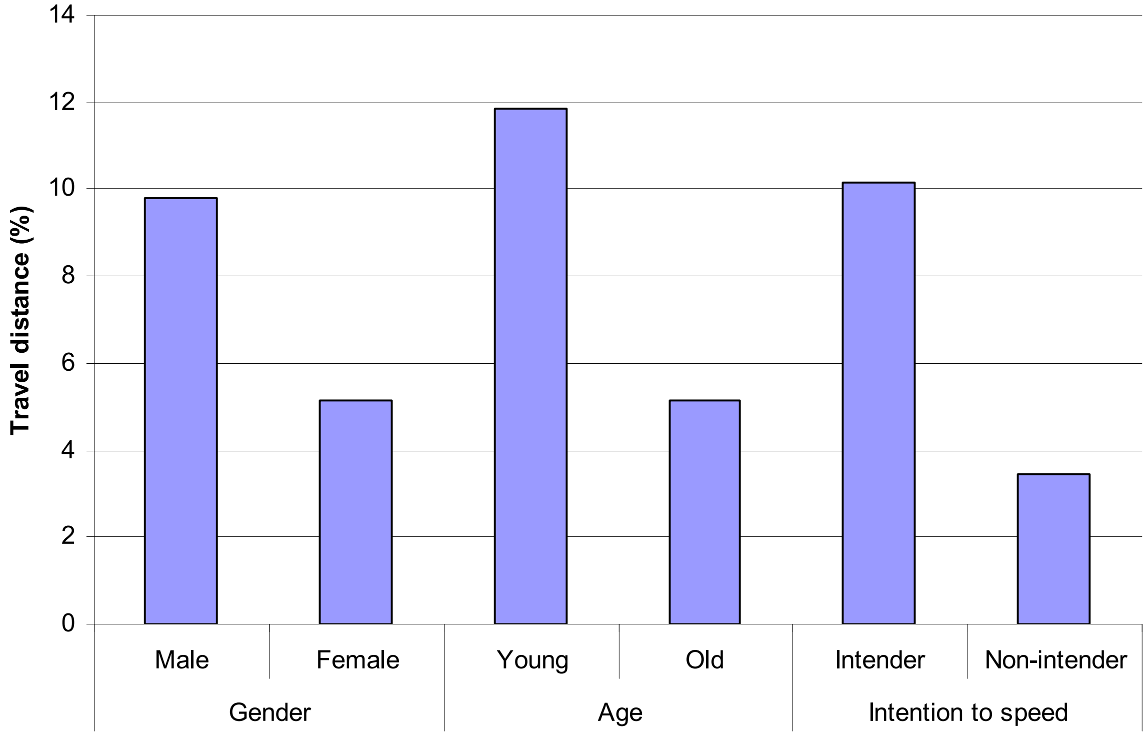


Figure 43: Comparison of overriding behaviour across demographic groups

3.5 Discussion

Based on the analyses presented in this chapter, the ISA system leads 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 15 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 stops excessive speeding, but also leads to a reduction in speed variability (i.e. Table 16 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 led to a diminished 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 of 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.

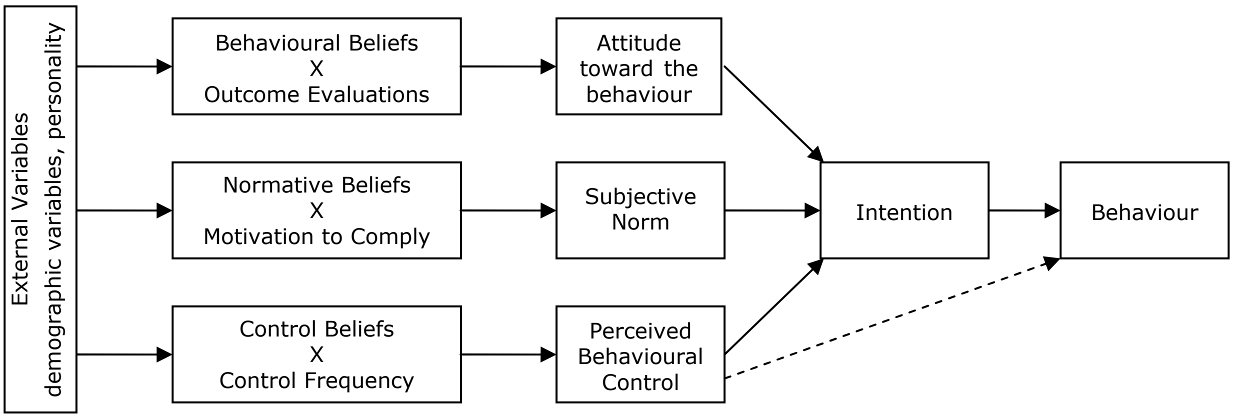


Figure 44: The Theory of Planned Behaviour (Ajzen, 1988)

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 the first field trial however is limited given the small sample size and will thus concentrate 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 sample size and between subject factors included (sex, age group, intention group) compromise the results and make it difficult to draw any strong conclusions. Indeed any significant interactions have been suppressed and ignored since little meaning can be attributed to these. 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.

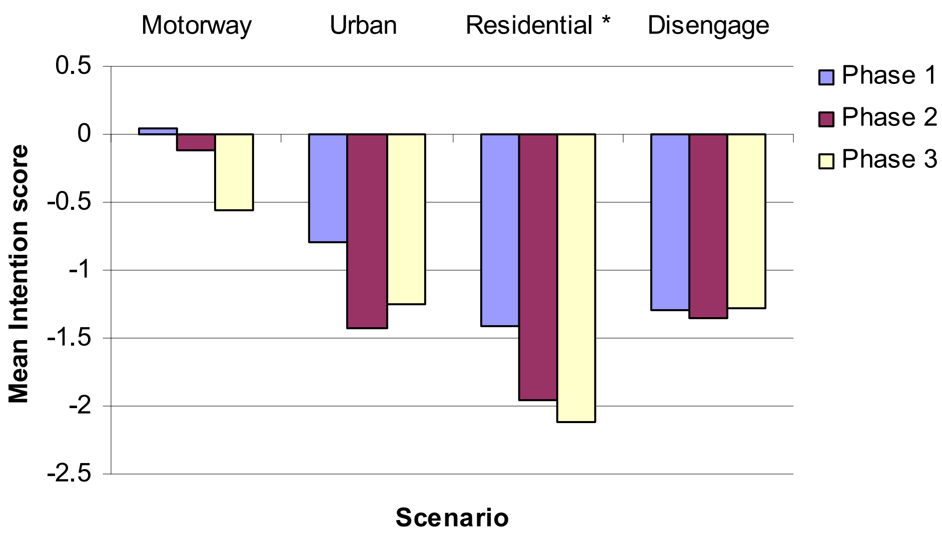


Figure 45: Mean intention scores by scenario

Figure 45 highlights the change in intentions over time for each scenario. The TPB proposes that intentions predict behaviour. 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 the motorway, urban or disengage scenario. Intentions to exceed the speed limit on a residential road however significantly decreased over time. Post hoc analysis however did not reveal any significant differences between time points. Nevertheless, participants were significantly less likely to intend to exceed the speed limit on a residential road following experience with the system. Although there is no significant effect of the ISA intervention for motorway and urban, over time participants tended to express weaker intentions to exceed the speed limit (it should be noted however that differences across means are minimal). 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. Differences over time were minimal and intention scores remained negative suggesting that the desire to override the system was weak.

Participants held negative attitudes towards exceeding the limit on urban and residential roads. (see Figure 46). Attitudes towards exceeding the speed limit on a motorway and disengaging the system were slightly positive. 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 in the urban and residential scenario during Phase 2. Indeed, for the urban scenario, attitudes were significantly less favourable towards speeding following experience with the system. Post hoc analysis however did not reveal any significant differences between time points. Differences across means for the remaining scenarios were extremely small however and little meaning should be attributed to these.

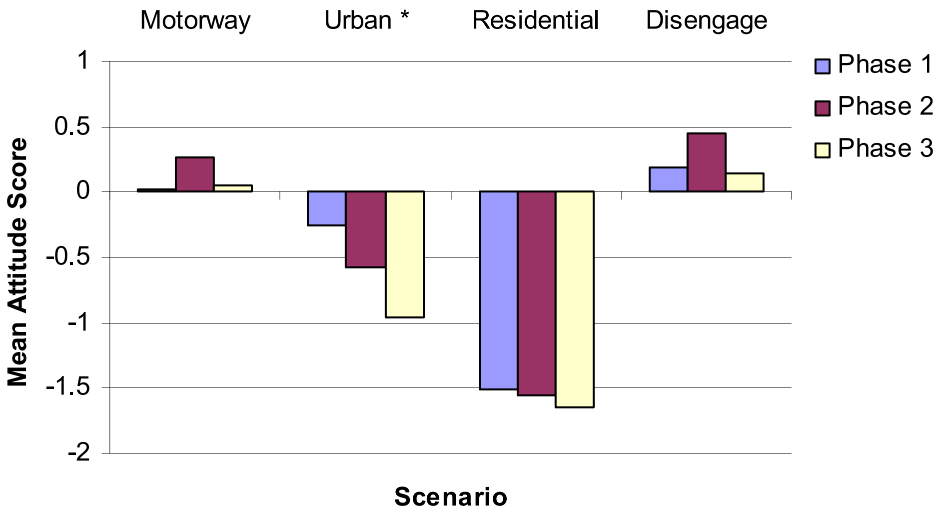


Figure 46: Mean attitude score by scenario

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.

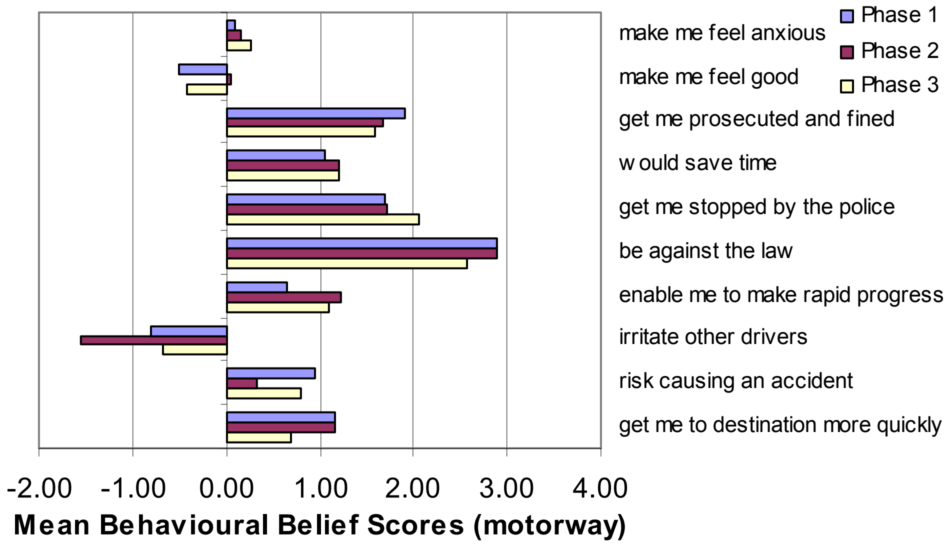


Figure 47: Mean behavioural belief scores for motorway scenario

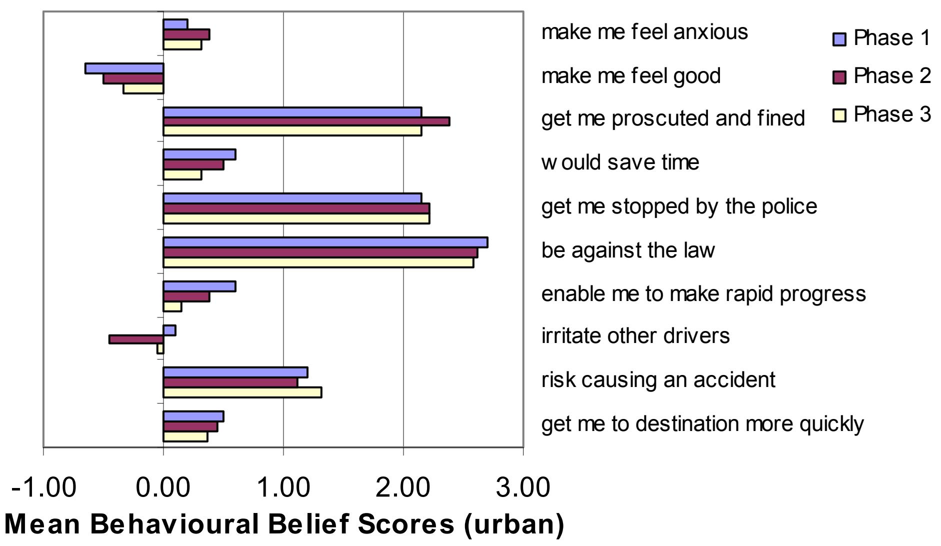


Figure 48: Mean behavioural belief scores for urban road scenario

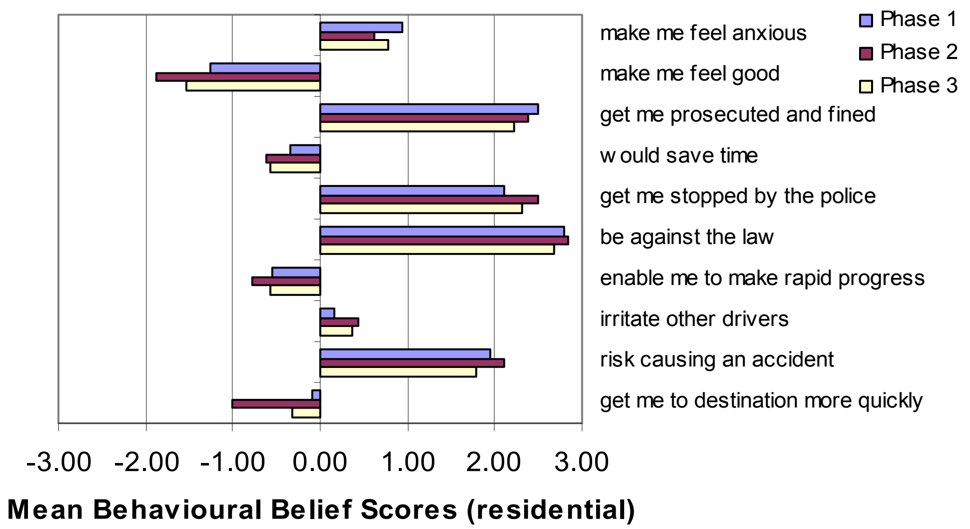


Figure 49: Mean behavioural belief scores for residential road scenario

Comparisons across the three speeding scenarios suggest that participants believed they would feel anxious speeding on all roads. During Phase 2 participants were even more likely to believe speeding would make them feel anxious (except for residential scenario). 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 residential 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 opinions relating to *being prosecuted and fined* and *stopped by the police* are somewhat at odds. Following experience with the system participants tended to believe that they were more likely to be stopped by the police. They were less likely however to believe that they would be prosecuted and fined. 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. Beliefs were at odds for the motorway scenario however where they believed speeding was likely to allow them to gain progress, perhaps given the lack of hazards on this road (e.g. pedestrians). Having gained experience of the system participants were less likely to believe that exceeding the speed limit would *irritate other drivers* (except for the residential scenario). For the urban road and motorway scenario, experience of the ISA system weakened the belief that speeding would risk causing an accident. Only in the residential scenario was this belief slightly strengthened. It may be suggested that when a participants' speed was restricted they evaluated the speed limits as inappropriate and thus exceeding these limits was construed as less harmful.

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 −0.84 to +1.67, 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.

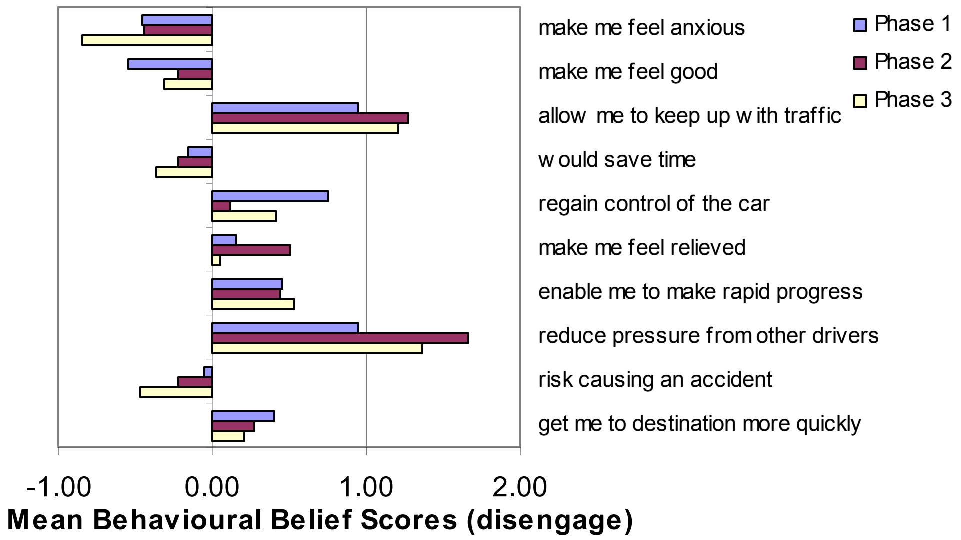


Figure 50: Mean behavioural belief scores for the disengage scenario

Figure 50 highlights that participants were unlikely to believe disengaging the system would make them *feel anxious* following prolonged 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* and *reduce pressure from other drivers.* They were unlikely to believe that disengaging the system would *risk causing an accident.*

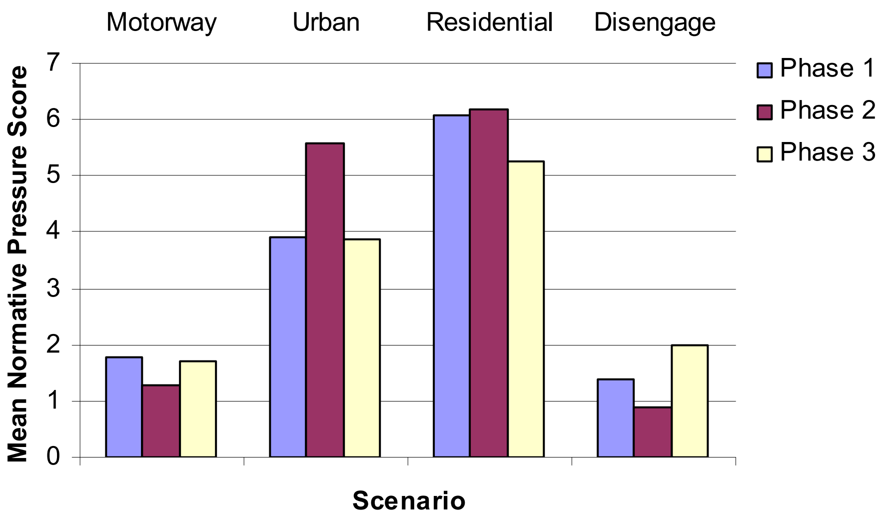


Figure 51: Mean normative pressure score by scenario

Perceived pressure from significant others increased during Phase 2 for the urban scenario (see Figure 51. Whilst driving with ISA on an urban road, participants felt their significant others were more likely to disapprove of them exceeding the speed limit. During phase 3 this perceived pressure was reduced. Little change was noted for the residential scenario. For the motorway and disengage scenario, when driving under the ISA control, 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 here 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.

Table 23: Mean motivation to comply scores over time

Referent Group	Phase 1	Phase 2	Phase 3
Police	5.00	5.61	5.39
Other road users	3.90	3.83	4.26
Family	4.70	5.06	4.42
Friends	3.90	4.17	4.05
Spouse/partner	4.40	4.72	4.74

As can be seen in Table 23, 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.

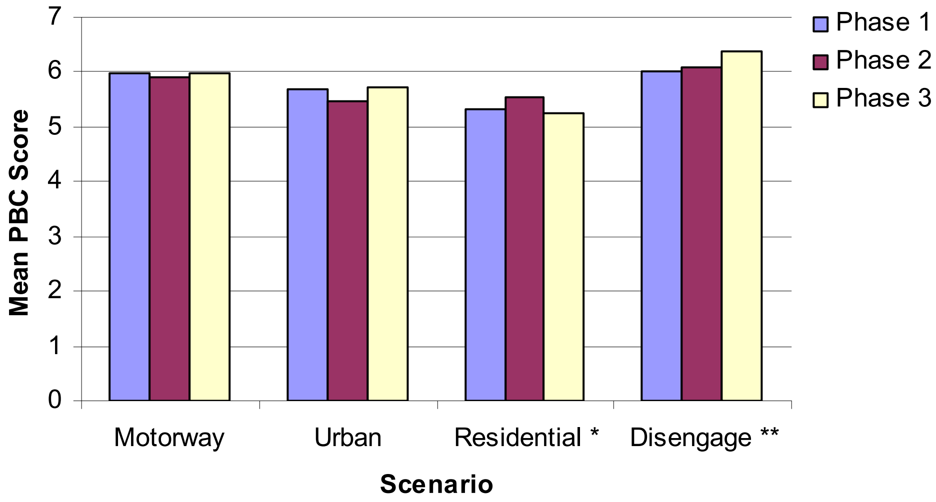


Figure 52: Mean perceived behavioural control score by scenario

Figure 52 shows that there were no significant differences in PBC scores over time for the motorway or urban scenario. A significant difference was found however across the residential and disengage scenario. For the residential scenario, post hoc analysis did not reveal any significant differences between time points. For the disengage scenario post hoc analysis revealed a significant increase in PBC from Phase 1 to Phase 3 and Phase 2 and 3; following removal of the ISA system, participants felt they were in greater control of their ability to disengage the system when compared to previously driving without ISA and driving with ISA.

Figure 53, Figure 54, Figure 55 and Figure 56 provide a comparison of the stated control factors over time and scenarios.

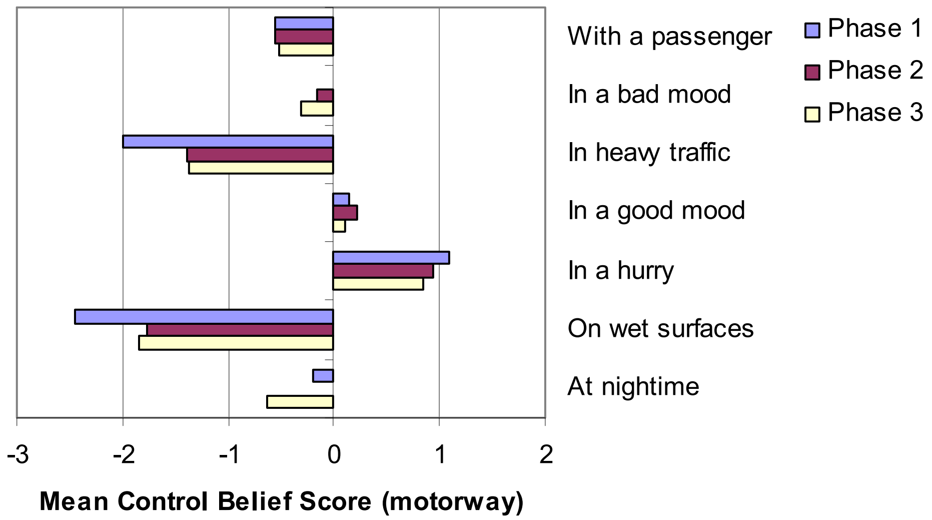


Figure 53: Mean control belief scores for motorway scenario

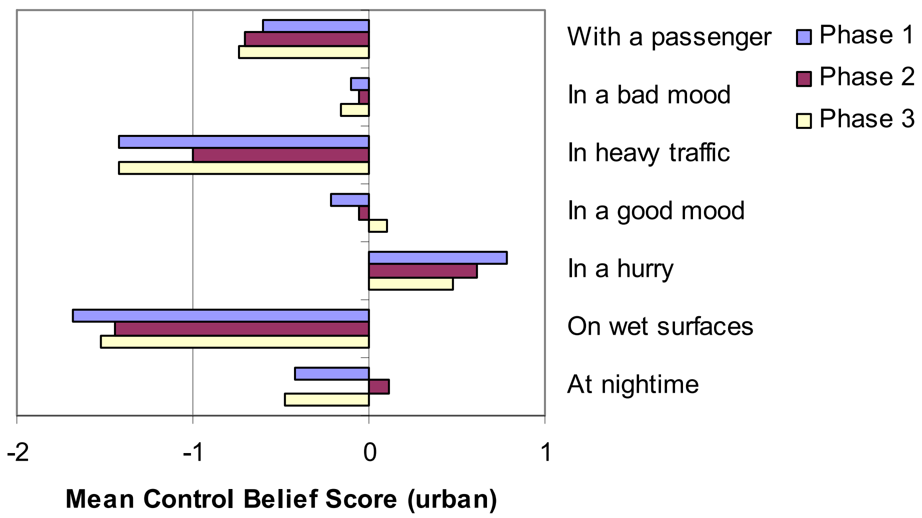


Figure 54: Mean control belief scores for urban scenario

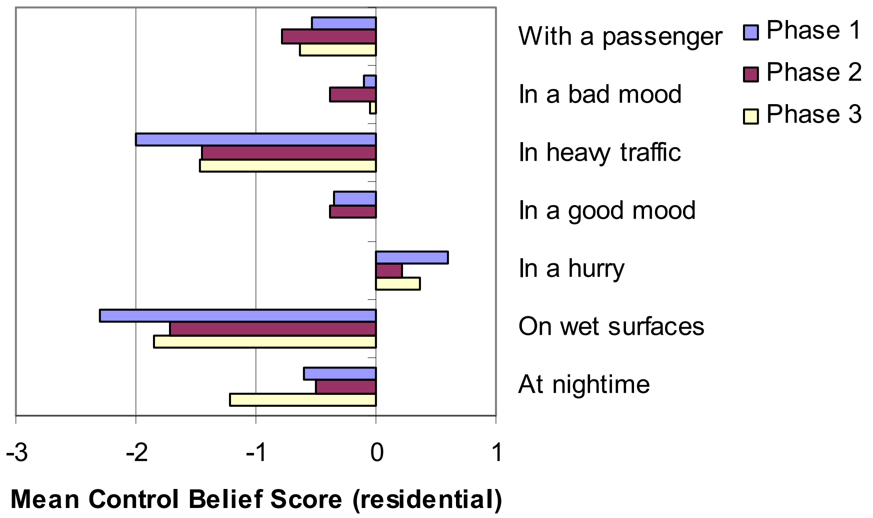


Figure 55: Mean control belief scores of residential scenario

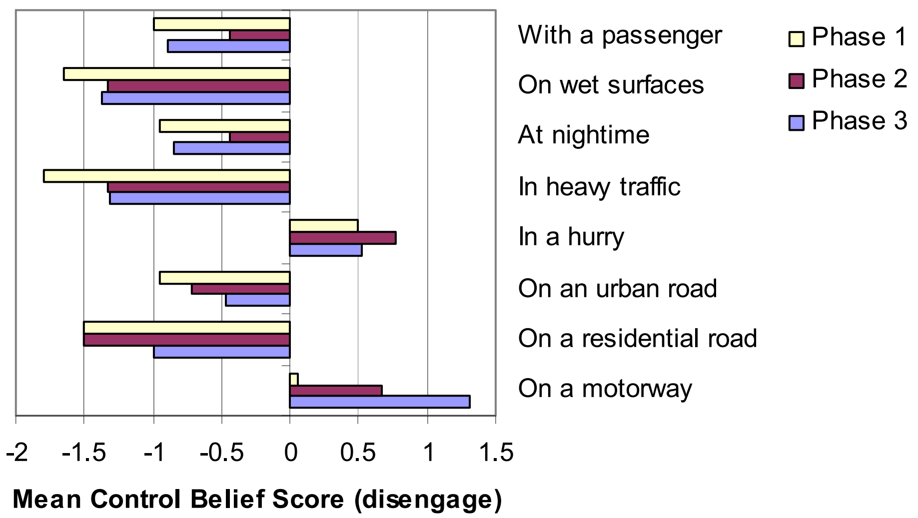


Figure 56: Mean control belief scores for disengage scenario

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 on a motorway. Participants may have disengaged the system to overtake, keep up with the fast moving traffic or simply because this road type affords the greatest opportunity to speed. Across all scenarios, the majority of control factors were generally regarded as less inhibiting during Phase 2 when compared to Phase 1. During Phase 1 participants felt that residential and urban roads were the most inhibiting roads. They were less likely to disengage the system on these roads than any other road type. However, as can be seen in Figure 56, experience with the ISA system slightly weakened this effect.

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). As has been shown already, speeding on motorways appeared most acceptable. There is no consistent pattern across scenarios and no significant differences over time were found.

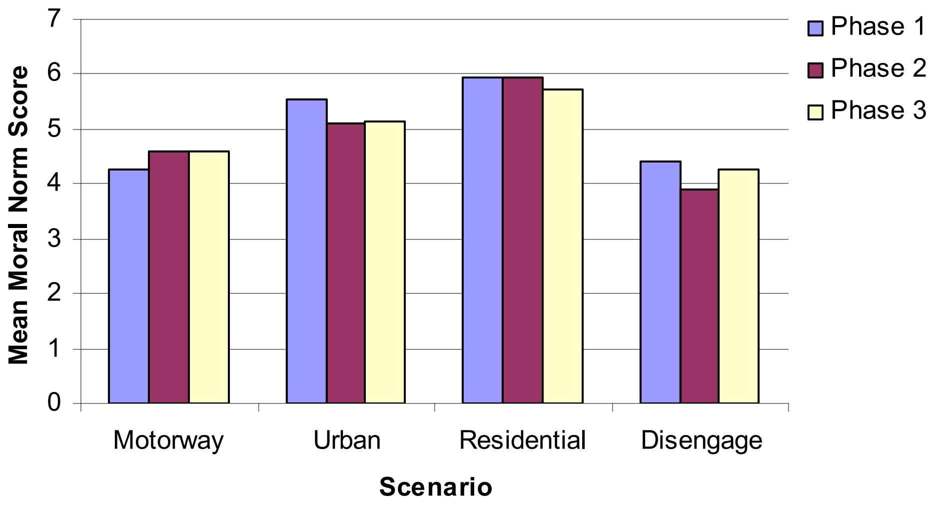


Figure 57: Mean moral norm score by scenario

Although participants tended to believe that exceeding the speed limit was morally wrong, they did not tend to anticipate regretting engaging in this behaviour (see Figure 58). Again 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 more likely to anticipate regretting speeding in the road scenarios. Indeed, for the urban scenario participants were significantly more likely to regret speeding following exposure to the system. Post hoc analysis however did not reveal any significant differences between time points. For the disengage scenario participants were significantly less likely to anticipate regretting over riding the system during Phase three than during Phase 1. This is perhaps a consequence of the participants' experience of false or inaccurately placed speed limits.

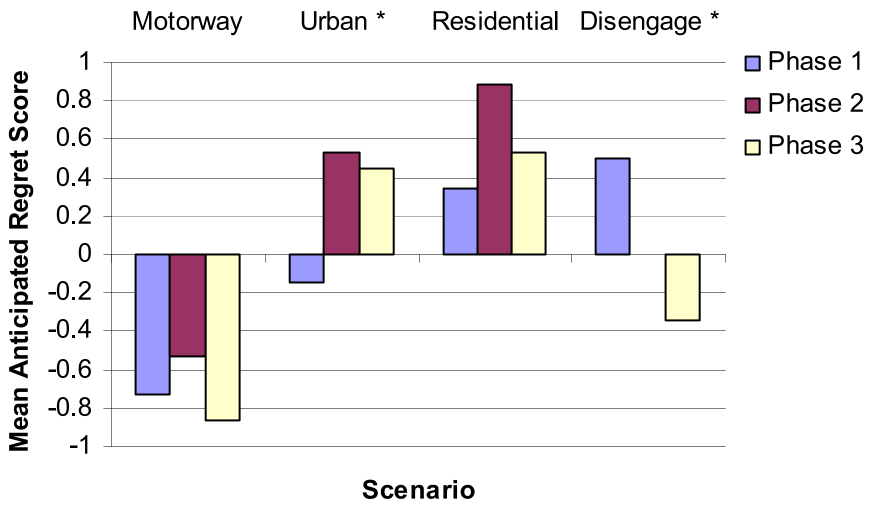


Figure 58: Mean anticipated regret score by scenario

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 the motorway, urban and residential scenarios, self-reported speeding in Phase 3 increased but was still lower than that reported at Phase 1, suggesting that the effects of ISA may have been sustained throughout unsupported driving. For the urban scenario this effect was confirmed as self reported speeding during phase 3 was found to be significantly lower than that reported during phase 1. There was also a significant difference in self reported speeding for the residential scenario, however post hoc analysis did not indicate any significant differences between individual time points.

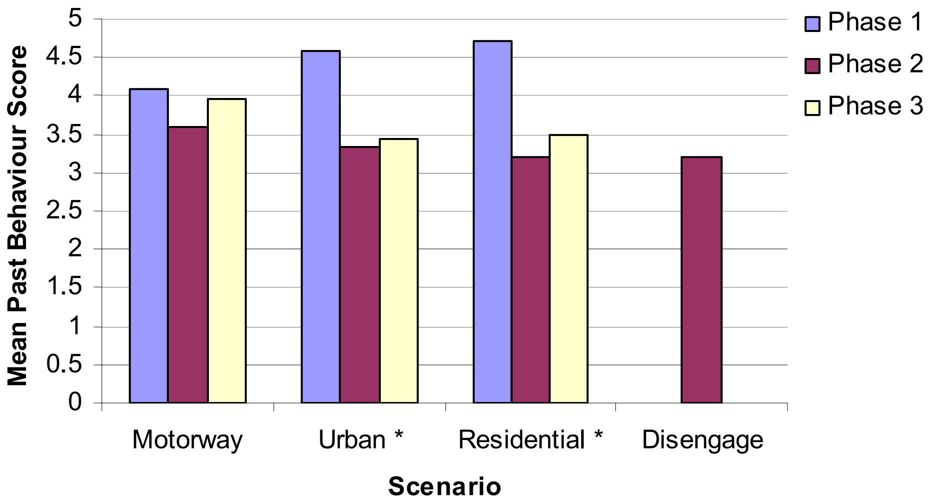


Figure 59: Mean past behaviour score by scenario

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 motorway and a residential road tended to decrease over time (although only slightly). Perceptions of risk for the urban and disengage scenario tended to increase following exposure to the ISA system. For all scenarios differences are minimal and non significant however.

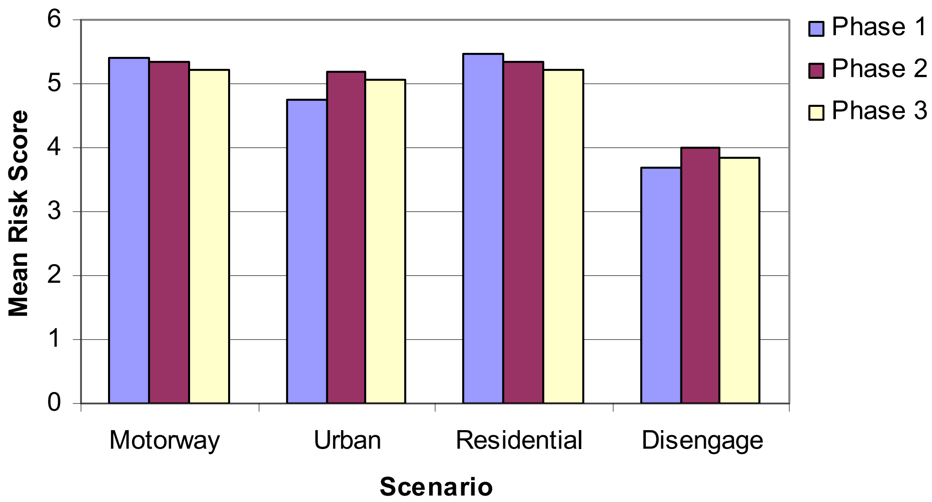


Figure 60: Mean risk score by scenario

Self identity measures were taken during each phase. As can be seen in Table 24, self-identity scores barely differed across phases. There was no significant difference in scores over time.

Table 24: Mean self-identity scores over time

Phase	Mean Score
Phase 1	5.80
Phase 2	5.61
Phase 3	5.53

Table 25: 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	0.72***	0.64**	0.82***	0.46*	0.71***	0.42	0.31	0.03	0.60**	0.33	0.40	0.60**
BE	0.64**	0.56*	0.29	0.51*	0.73***	0.25	0.05	0.33	0.68***	0.10	0.40	0.26
NBMC	-0.62**	-0.20	-0.14	0.16	-0.66**	-0.21	-0.19	0.20	-0.47*	-0.09	0.06	-0.22
PBC	0.63**	0.03	0.11	0.08	-0.02	0.20	-0.09	-0.18	0.25	-0.08	0.25	0.20
CBF	0.46*	0.33	0.44	0.44	0.45	0.50*	0.01	0.14	0.30	0.40	0.57*	0.40
MN	-0.76***	-0.65**	-0.57**	-0.27	-0.76***	-0.54*	-0.56*	0.03	-0.48*	-0.32	-0.51*	-0.36
AR	-0.85***	-0.59**	-0.59**	-0.15	-0.77***	-0.49*	-0.30	-0.08	-0.50*	-0.40	-0.48*	-0.44
PB	0.50*	0.76***	0.65**	–	0.53*	0.44	0.32	0.48*	0.62**	0.52	0.71***	–
RISK	-0.55*	0.24	-0.29	0.23	-0.62**	-0.41	-0.32	0.22	-0.44	0.03	-0.12	0.03
SI	-0.13	-0.08	-0.05	-0.01	-0.14	0.02	-0.03	-0.11	-0.41	-0.31	-0.30	-0.30

Table 25 provides a comparison of the TPB constructs significantly correlating with behavioural intentions over time and scenarios. There appeared to be little consistency in the correlates across scenarios and over time.

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 (except for residential and urban roads)
- 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 and urban roads)
- 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 (except for residential and urban roads)

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

There were no significant correlates with behavioural intentions for the urban scenario. 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 except for residential and urban roads)
- to believe that more positive than negative outcomes would result from exceeding the speed limit except for residential and urban roads)
- to perceive less normative pressure from significant others (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 motorway and urban roads)
- not to believe that exceeding the speed limit was morally wrong (except for urban roads)
- not anticipate regretting exceeding the speed limit (except for urban roads)
- to have exceeded the speed limit frequently in the past (except for urban roads)

Comparisons over time for the disengage scenario revealed an inconsistent pattern.

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. Anticipated regret and moral norm appear to be the most consistent predictor across time and scenarios. However, as was previously the case in Trial 2, attitudes also provided a reliable predictor.

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 and 3. Indeed, intentions to exceed the speed limit on residential roads decreased significantly over time. 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 few significant differences were found and thus conclusions are only tentative. For the disengage scenario differences were minimal and remained negative suggesting the desire to override the system was weak.

Attitudes correlated positively with intentions during Phase 1 such that those participants with more favourable attitudes towards speeding were more likely to intend to exceed the speed limit. Correlations were weak and generally non significant during Phase 2 and 3. There was little effect of the ISA system on participants' attitudes towards speeding. Attitudes towards exceeding the speed limit on a motorway were slightly positive and became more favourable with experience. Participants held negative attitudes towards exceeding the speed limit on residential and urban roads. Moreover, attitudes towards speeding on urban roads became significantly less favourable following experience with ISA. Although attitudes towards disengaging the system became more favourable, 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. Again however correlations with intentions measured during Phase 2 and 3 were weak. 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. Examination of the changes in behavioural beliefs identified several negative beliefs regarding speeding to be tackled. Compared with Phase 1, experience with the ISA system led participants to believe that exceeding the speed limit was more likely to make them feel anxious but also more likely to make them feel good. They believed it was less likely to lead to them being prosecuted and fined, less likely to irritate other drivers and less likely to lead to an accident. Several positive changes were also noted however. Following experience with the system, participants were more likely to believe that exceeding the speed limit would be against the law and less likely to believe that speeding would save time and get them to their destination on time. However, this was with the exception of the motorway, where speeding was believed to allow the driver to make rapid progress. Nevertheless these results are, on the whole, encouraging in that the system weakened those beliefs regarding journey time. Loss of time is a very influential factor in today's society and use of the system has begun to challenge and disprove critics concerns regarding increased journey time. In order to tackle the increase in negative beliefs, campaigns running during implementation should emphasise the negative emotive reactions to speeding, the direct link between speed and accidents and the risk of financial loss from fixed penalties. Changes were minimal within the disengage scenario.

Subjective norms generally 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 for the motorway and disengage scenario, 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. For the urban scenario particularly, subjective norm scores increased suggesting that ISA had positively influenced perceived pressure. 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. Participants felt they were in significantly greater control of their ability to disengage an ISA system following removal of the system.

On some occasions 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. The significance of these correlations however was inconsistent across time and scenarios. 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. Comparisons of the control factors suggests that following experience with the system participants generally view these factors as less inhibiting than before. Campaigns should emphasise 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 were inconsistent. However participants were significantly more likely to regret speeding on an urban road following exposure to the ISA system. For the disengage scenario moral norm scores decreased over time with experience of the system. Anticipated regret significantly weakened. 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 residential 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, there was a weak correlation between perceptions of risk and intentions. Participants' perception of the risk involved in speeding on a motorway and a residential road tended to decrease over time (although only slightly). Perceptions of risk for the urban and disengage scenario tended to increase following exposure to the ISA system. For all scenarios differences were minimal and non significant however.

Self-identity did not correlate with intentions such. Experience of the system did not appear to affect participants' perception of themselves as a safe driver.

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 26 have been reached.

Table 26: 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 27, the TPB constructs measured at the start of the trial do not successfully correlate with behaviour measures during Phase 1, Phase 2 or Phase 3 across all road scenarios. Only cognitions relating to speeding on a motorway successfully correlate with behaviour during Phase 1. 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

- 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 anticipate regretting exceeding the speed limit
- to perceive less risk in exceeding the speed limit

Examination of the correlations between cognitions measured following prolonged experience with ISA and behaviour during Phase 3 did not provide any significant correlations between cognitions and behaviour. Significant relationships are noted (see Table 28). Only past behaviour and control beliefs appear related to actual behaviour, in that those who have frequently exceeded the speed limit in the past tended to so motorways and urban roads and those who perceived factors as more likely to facilitate speeding were more likely to exceed the speed limit on a residential road.

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 29 only risk perceptions significantly correlate with behaviour. This correlation however is not in the expected direction. Correlations here offer little understanding of the relationship between cognitions and disengaging behaviour.

Table 27: 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	0.662**	0.554*	0.265	0.084	0.282	-0.052
ATT	0.533*	0.368	-0.036	-0.048	0.212	-0.228
BE	0.490*	0.192	-0.114	-0.150	0.152	-0.177
NBMC	-0.271	-0.223	0.204	0.182	-0.203	0.152
PBC	0.500*	0.570*	0.259	0.151	0.219	-0.187
CBF	0.499*	0.220	-0.078	-0.286	0.273	0.244
MN	-0.397	-0.432	-0.057	-0.053	-0.011	0.210
AR	-0.536*	-0.478*	-0.239	-0.221	-0.164	0.161
PB	0.403	0.345	0.108	0.076	0.457*	0.239
RISK	-0.484*	-0.340	-0.067	0.109	-0.362	-0.016
SI	-0.315	-0.280	0.292	0.402	-0.288	-0.143

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	0.024	0.047	0.156	0.179	0.096	0.120
ATT	0.076	-0.031	0.126	0.118	0.193	0.128
BE	-0.141	-0.128	-0.154	-0.008	-0.113	-0.131
NBMC	-0.117	0.029	-0.214	-0.032	-0.234	-0.220
PBC	-0.090	-0.274	0.009	-0.049	-0.015	0.103
CBF	-0.042	-0.108	0.176	0.056	0.237	0.207
MN	-0.225	-0.172	-0.316	-0.270	-0.429	-0.327
AR	-0.087	0.056	-0.099	0.014	-0.242	-0.156
PB	0.368	0.216	0.389	0.274	0.460	0.390
RISK	0.025	0.108	0.024	-0.055	-0.011	0.000
SI	0.097	0.162	-0.064	0.035	-0.042	-0.104

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	-0.199	-0.167	-0.041	0.209	-0.092	-0.081
ATT	0.210	0.210	0.259	0.311	0.225	0.219
BE	0.188	0.200	-0.048	-0.001	-0.087	0.024
NBMC	-0.103	-0.146	-0.219	-0.032	-0.079	-0.275
PBC	0.391	0.304	0.339	0.227	0.262	0.192
CBF	0.225	0.178	0.398	0.242	0.433	0.330
MN	-0.164	-0.157	-0.244	-0.560*	-0.137	-0.178
AR	-0.315	-0.333	-0.317	-0.428	-0.399	-0.470*
PB	0.216	0.241	0.141	0.269	0.318	0.330
RISK	-0.499*	-0.460*	-0.332	-0.468*	-0.306	-0.287
SI	0.057	0.022	-0.002	0.190	0.153	-0.016

Table 28: 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	0.364	0.148	0.119	0.261	-0.201	-0.085
ATT	0.462	0.243	0.464	0.390	0.451	0.424
BE	0.153	-0.069	-0.016	-0.104	-0.029	0.057
NBMC	-0.223	0.133	-0.418	-0.413	-0.180	-0.308
PBC	-0.343	-0.395	-0.139	0.098	0.149	-0.140
CBF	0.120	0.129	0.409	0.387	0.493*	0.471*
MN	-0.197	0.018	-0.285	-0.440	0.152	0.089
AR	-0.222	0.016	-0.230	-0.390	-0.059	-0.067
PB	0.627**	0.291	0.420	0.484*	-0.095	0.049
RISK	-0.350	-0.081	-0.365	-0.399	-0.255	-0.181
SI	0.022	-0.104	0.140	0.023	0.390	0.166

Table 29: 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	0.409
ATT	0.168
BE	0.062
NBMC	0.383
PBC	0.222
CBF	0.202
MN	-0.074
AR	-0.187
PB	–
RISK	0.527*
SI	0.352

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. Sex, age group and intention group were included as between subject factors.

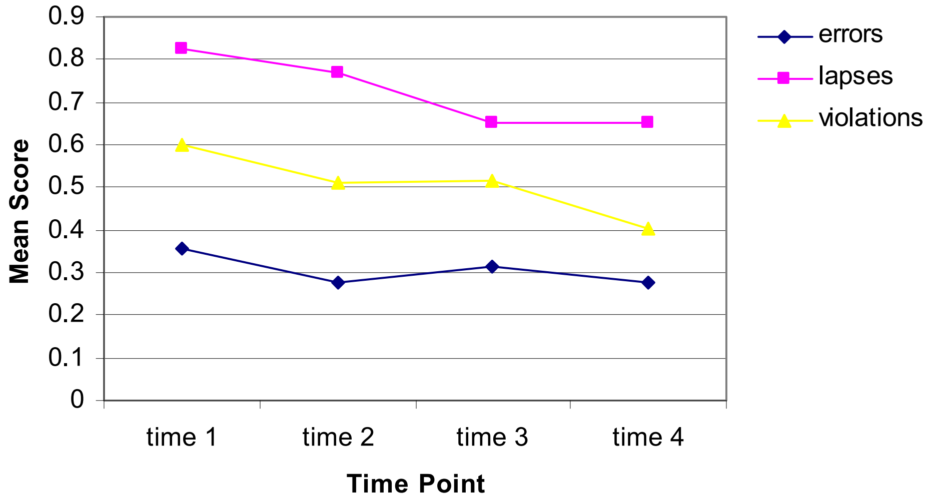


Figure 61: Mean error, lapse and violation score on DBQ over time

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.

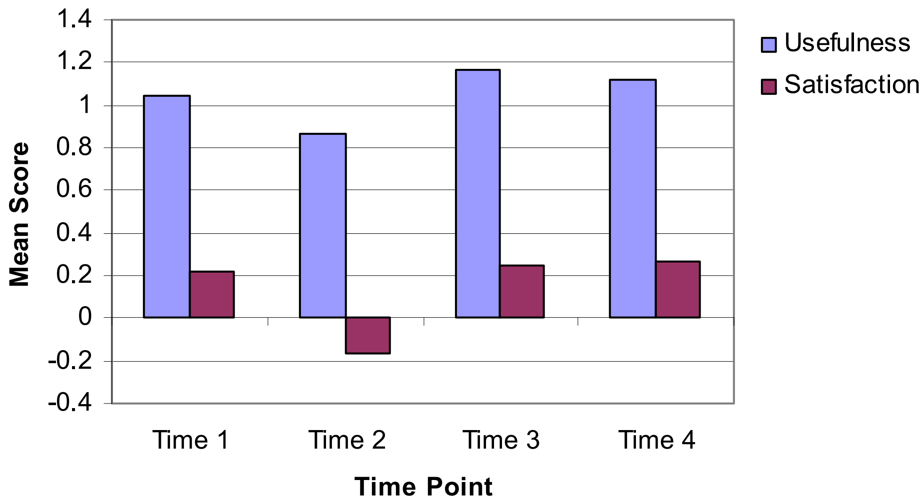


Figure 62: Acceptability ratings for the dimensions of "usefulness" and "satisfaction"

A repeated measures ANOVA (with sex, age group and intention group as between subject factors) 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 continued at a high level when the system was removed.

Similarly a repeated measures ANOVA (with sex, age group and intention group as between subject factors) did not confirm any significant change in satisfaction scores over time. Again satisfaction with ISA dipped following early exposure to the system, but this steadily rose with prolonged exposure, beyond the removal of ISA support.

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.

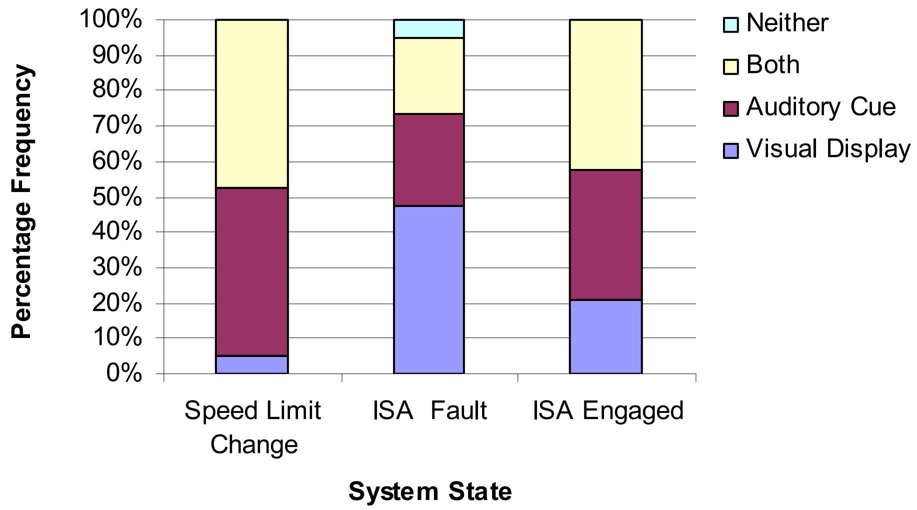


Figure 63: Most frequent cues relied upon for notification of system state changes during early exposure to ISA

There are very few differences in the way participants used the ISA system cues as their experience with the system increased. As experience progressed, the majority of participants tend to use both auditory visual cues to identify system state changes.

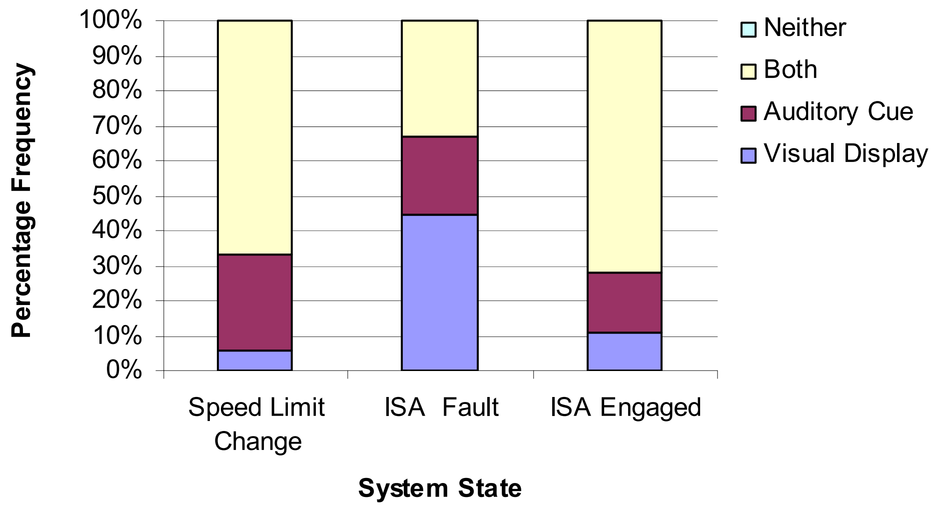


Figure 64: Most frequent cues relied upon for notification of system state changes following prolonged exposure to ISA

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

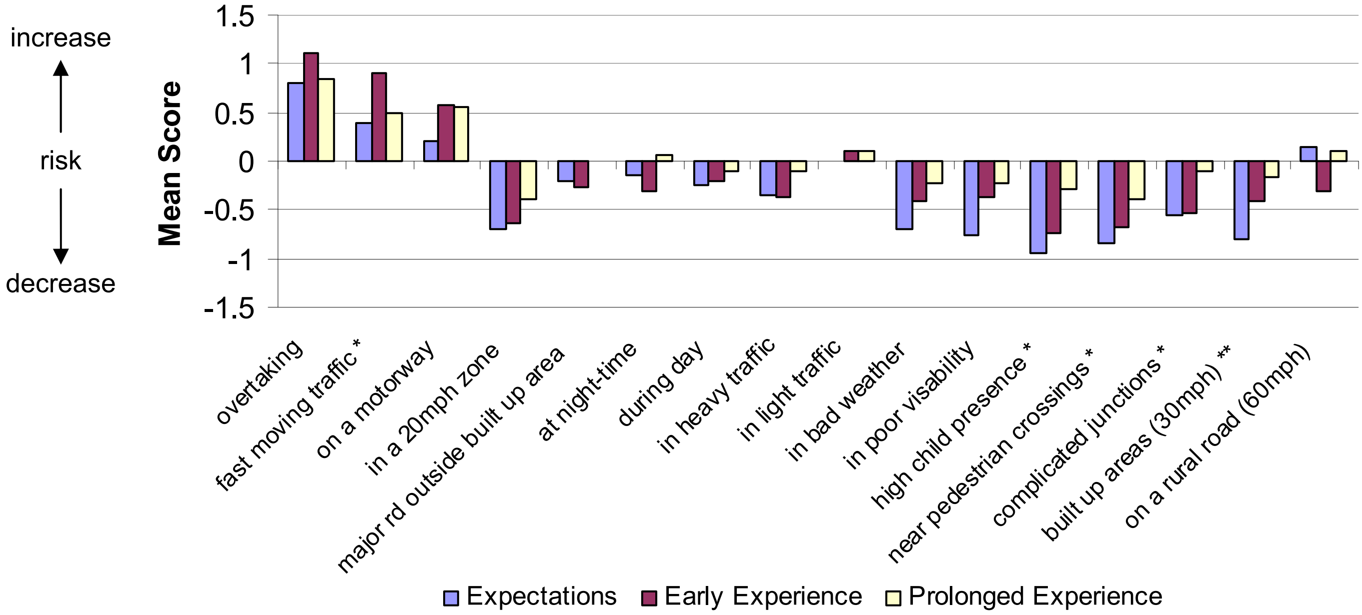


Figure 65: Perception of change in risk when driving with ISA compared to 'normal' driving

Figure 65 suggests participants felt at increased risk under ISA control when overtaking and driving on motorways, rural roads and in fast moving traffic compared to normal driving. This increased perceived risk surpassed their expectations and rose with prolonged experience (except for rural roads). Participants appeared to perceive an increase in risk when travelling on roads or in conditions which afforded the opportunity for driving at speed. A repeated measures ANOVA confirmed that participants' perception of the risk involved in driving in fast moving traffic with ISA significantly increased. Post hoc did not reveal any significant differences between time points. For all other driving conditions, participants tended to feel at less risk when driving with ISA compared to driving in a normal vehicle. Although participants believed that they were at less risk driving in an ISA car in areas with a high presence of children and near pedestrian crossing, these beliefs significantly weakened with experience of the system. Post hoc analysis did not reveal any differences between time points for either scenario however. Similarly, whilst participants also believed they were at less risk driving in built up areas and at complicated junctions with an ISA equipped car, these beliefs also weakened with prolonged experience. Indeed, perceptions of risk when driving with ISA in built up areas were significantly higher following prolonged experience when compared to their expectations of the system. Compared to early experience, participants perceptions of the risk involved at complicated junctions was also significantly greater following prolonged experience with the system. Participants perhaps realised that although ISA curtailed their speeds and thus increased their time to react to hazards, it was still their responsibility to remain attentive and take any necessary remedial action. Nevertheless, although the decrease in risk did not tend to meet their expectations, 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 frustrate others on the road but they did not expect it to frustrate themselves as the driver. When driving with the system however participants did report experiencing frustration, although this reduced with prolonged experience. The difference over time however was non-significant. Following experience with the system, participants were more likely to believe that their driving with ISA would prove a source of frustration to other drivers. Again however this trend was non-significant.

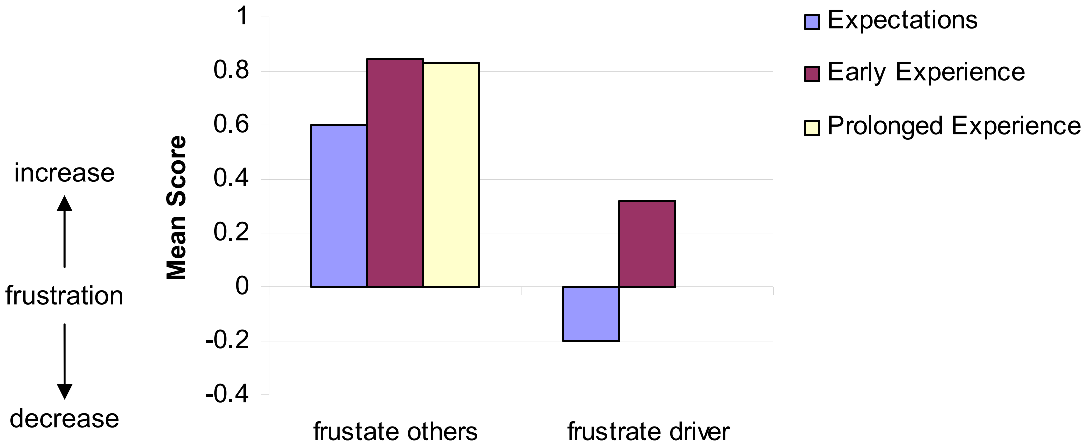


Figure 66: Influence of ISA on frustration experienced

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

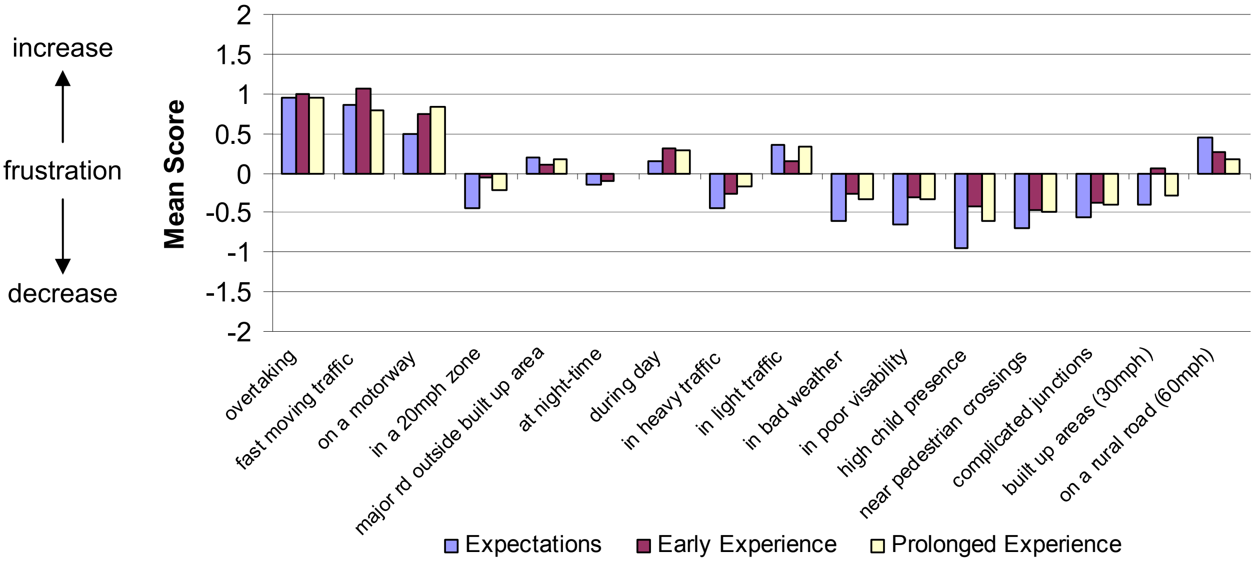


Figure 67: Perception of change in frustration experienced when driving with ISA compared to 'normal' driving

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, on major roads outside built up areas, during the day, in light traffic and on rural roads. Again the increased frustration seems typical to those situations which afford the opportunity to speed. For the majority of the other 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. 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.

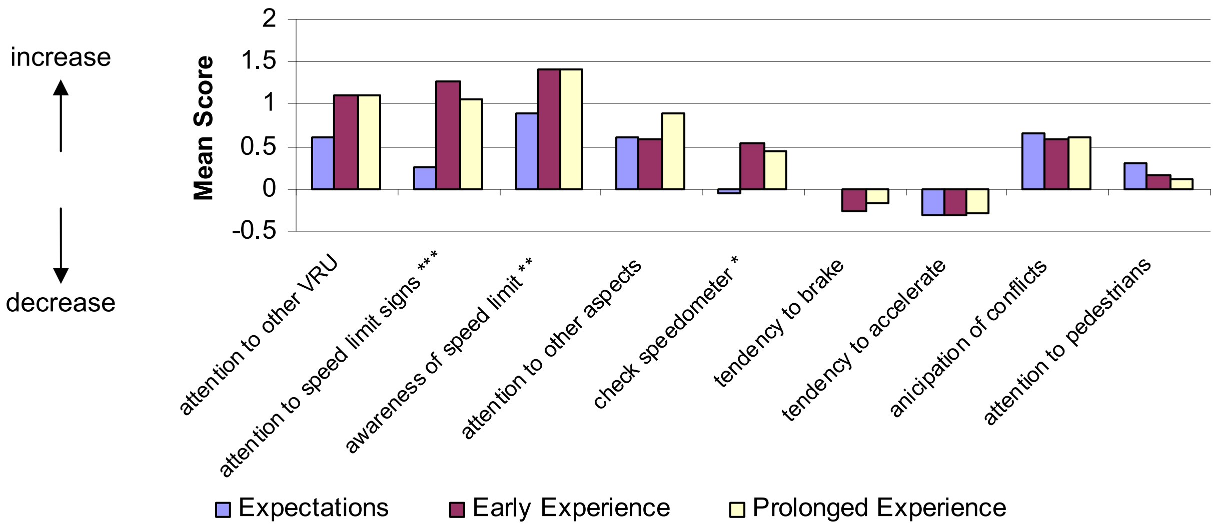


Figure 68: Perception of change in concentration when driving with ISA compared to 'normal' driving

Participants' attention to speed limit signs and their awareness of speed limits increased significantly beyond their expectations when driving with ISA compared to normal driving. Post hoc analysis revealed that participants' attention to and awareness of the speed limit significantly increased following their early and prolonged experience compared to their expectations. Participants' tendency to check the speedometer had initially increased but with prolonged use started to slightly decrease. The change was significant but post hoc analysis did not reveal any significant differences between time points. Similarly, participants' tendency to brake and accelerate decreased whilst driving with ISA compared to driving in an unsupported car. Differences across time points were not significant.

4.6.4 Driving experience

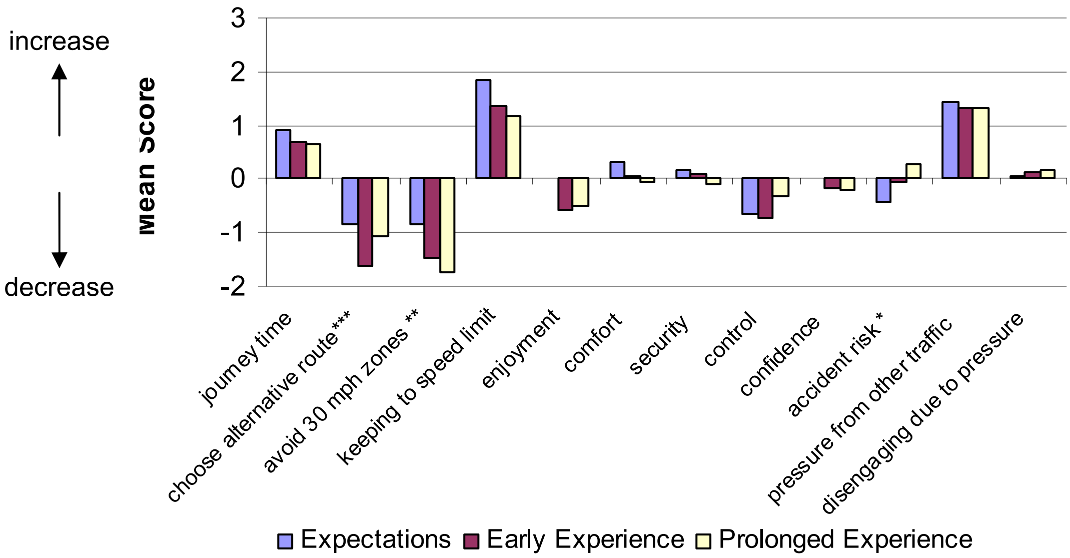


Figure 69: Perception of changes in driving experience when driving with ISA compared to 'normal' driving

Compared to 'normal' driving, participants perceived that journey times increased whilst driving with ISA (see Figure 69). This perceived increase in journey times however was less than participants initially expected. Driving with ISA also made it easier to keep to the speed limits compared to driving in a normal car, although this was slightly less easier than expected (perhaps due to inaccuracies in the map). Participants had rarely chosen alternative routes in order to avoid ISA warnings or avoided driving in 30mph speed zones. Indeed, participants were significantly less likely to choose an alternative route following early experience with the system than they had expected. However, following prolonged experience with the system participants were significantly more likely to choose an alternative route than during their early experience. As experience progressed, participants were also significantly less likely to avoid 30mph zones. Nevertheless the ratings for both remained negative suggesting that on the whole ISA did not affect participants driving patterns. Enjoyment decreased when driving with ISA compared to 'normal' driving. Whilst feeling slightly more secure, participants still felt in less control, more apprehensive and 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. Whilst this pressure seemed to decrease over time, participants' tendency to react to this and disengage the system increased with prolonged experience of the ISA system. These trends were not significant however. Participants felt at less risk of being involved in an accident when driving with ISA but this belief weakened significantly over time. The perceived decrease in risk following prolonged exposure to the system was significantly less than that expected.

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.

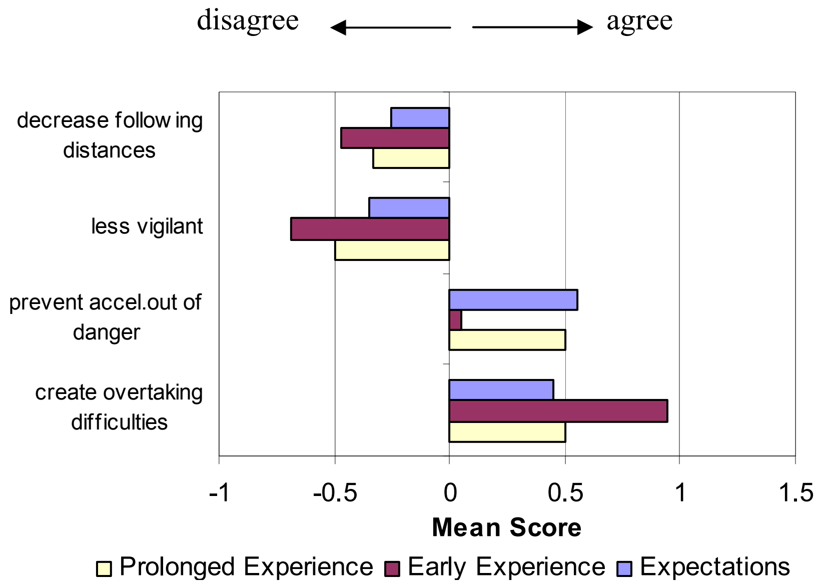


Figure 70: Participants opinions relating to common criticisms of ISA

As can be seen in Figure 70, participants disagreed that ISA had made them less vigilant drivers and decreased their adopted following distances. This disagreement strengthened overtime. Participants did believe however, that ISA created difficulties when overtaking and prevented the opportunity to accelerate out of danger. Although these beliefs changed during early experience of the system, opinions returned to those initially expressed following prolonged experience with the system. Changes in all opinions over time were not however statistically significant.

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 during early experience of the system participants felt more relief than they had expected when free to travel at their desired speed. They did not however drive faster than they had expected. With prolonged experience of the system participants appeared less likely to driver faster or experience relief, however differences across time points are minimal and non significant.

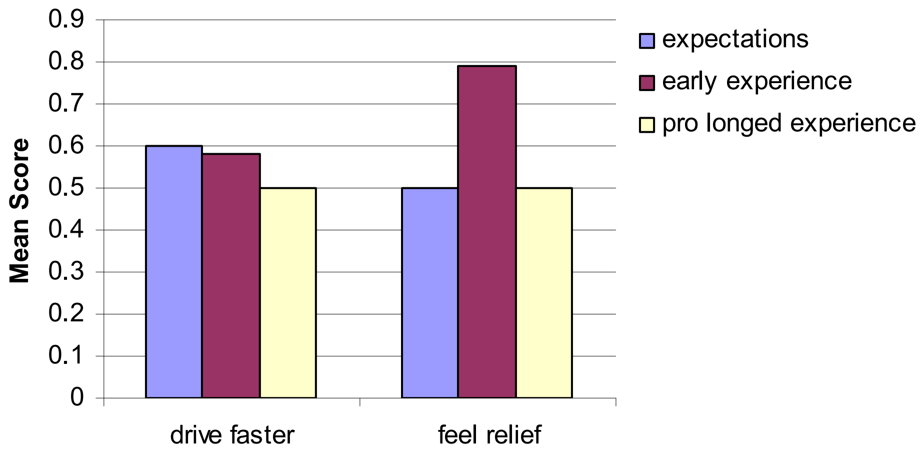


Figure 71: Participants reactions when ISA unavailable

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. Sixty five 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 £102. Sixty three percent of participants approved of the compulsory fitting of ISA to all new vehicles and 53% agreed to mandatory introduction of ISA for *all* drivers. Those who disagreed tended to approve of targeting ISA at specific high risk groups. Sixty seven percent approved of the mandatory introduction for novice drivers, 88% for the introduction for speed offenders and 55% for the introduction for professional drivers. Participants were unsure of the likelihood of the actual implementation of ISA throughout the UK (see Table 30). Responses were neutral but the change in direction of the mean suggests that prior to experience with the system participants thought ISA was unlikely to be put into operation throughout the UK, however with actual experience opinion shifted slightly as participants thought a national roll out of ISA was more likely. Again however responses centre around the midpoint reflecting relatively neutral responses and little meaning should be attributed to these trends.

Table 30: "ISA is a system that will probably never be put into operation throughout the UK: disagree-agree"

	Mean
Expectations	0.20
Early experience	0.11
Prolonged experience	-0.44

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 and 2 (Lai et al, 2005a; 2005b) with the only exception being a new trial route in Leicestershire was used.

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 Trial 1 and 2, 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

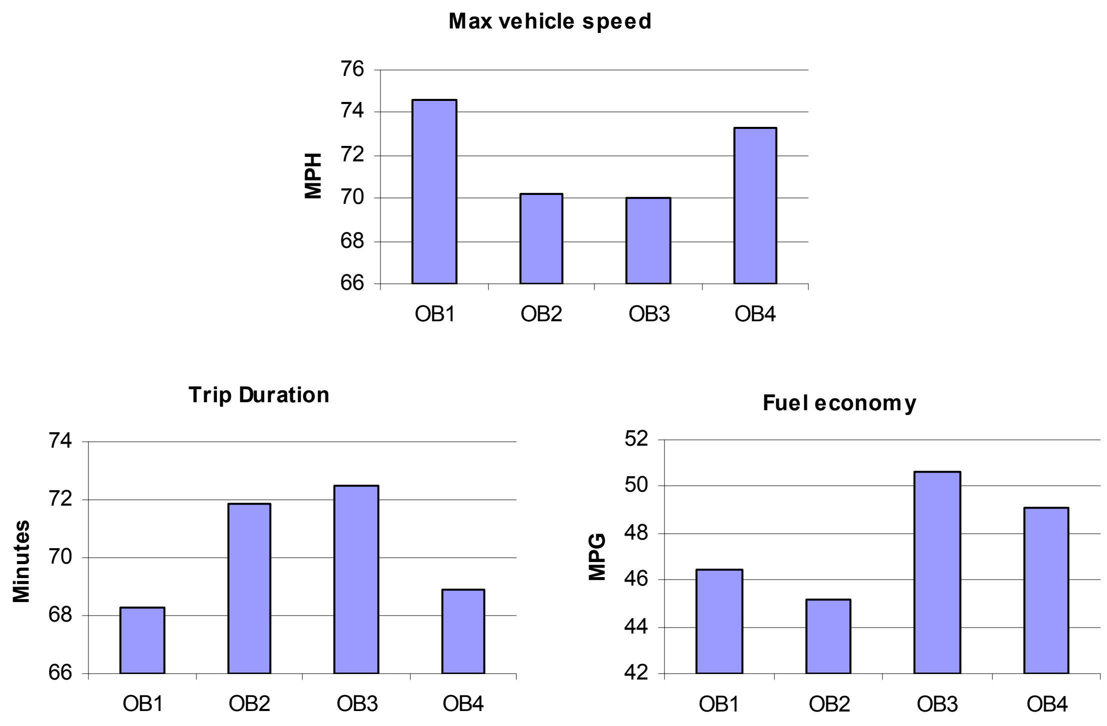


Figure 72: Comparison of trip related measures across trial phases

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, better fuel economy. The significance of the difference across the four drives over time is confirmed by the test results of repeated measures ANOVA, as depicted in Table 31. With respect to fuel economy, OB1 was not different from OB2 but was different from OB3 and OB4; OB3 was also different from OB4. This indicates that ISA did influence fuel economy.

Table 31: 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)	68.31 (2.76)	71.83 (2.48)	72.50 (3.04)	68.90 (2.43)	F(3,51) = 19.23	< 0.0005**		OB2	OB3	OB4
							OB1	**	**	×
							OB2		×	**
							OB3			**
Max speed (MPH)	74.60 (6.54)	70.18 (2.99)	70.01 (3.45)	73.30 (3.57)	F(3,54) = 11.11	< 0.0005**		OB2	OB3	OB4
							OB1	**	**	×
							OB2		×	**
							OB3			**
Fuel economy (MPG)	46.48 (3.68)	45.13 (4.35)	50.66 (3.27)	49.10 (3.09)	F(3,51) = 16.99	< 0.0005**		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.

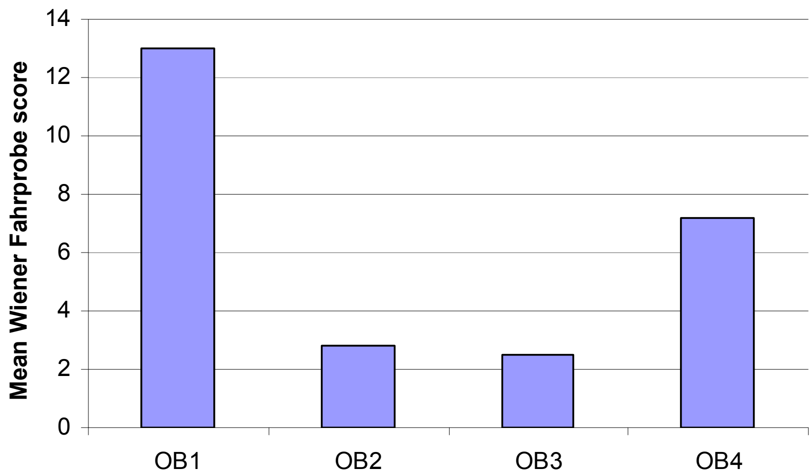


Figure 73: Mean Wiener Fahrprobe score across trial phases

The ANOVA test results presented in Table 32 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 32: Results of ANOVA and post-hoc t-test of Wiener Fahrprobe score across trial phases

<table>
<tr><th rowspan="3"></th><th rowspan="3">OB1</th><th rowspan="3">OB2</th><th rowspan="3">OB3</th><th rowspan="3">OB4</th><th colspan="6">Repeated measures ANOVA</th></tr>
<tr><th rowspan="2">F statistic</th><th rowspan="2">p value</th><th colspan="4">Post-hoc t-test</th></tr>
<tr><th></th><th>OB2</th><th>OB3</th><th>OB4</th></tr>
<tr><td rowspan="3">Mean Wiener Fahrprobe score</td><td rowspan="3">13.0</td><td rowspan="3">2.8</td><td rowspan="3">2.5</td><td rowspan="3">7.2</td><td rowspan="3">F(3,54) = 13.711</td><td rowspan="3">< 0.0005**</td><td>OB1</td><td>**</td><td>**</td><td>*</td></tr>
<tr><td>OB2</td><td></td><td>×</td><td>**</td></tr>
<tr><td>OB3</td><td></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.

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).

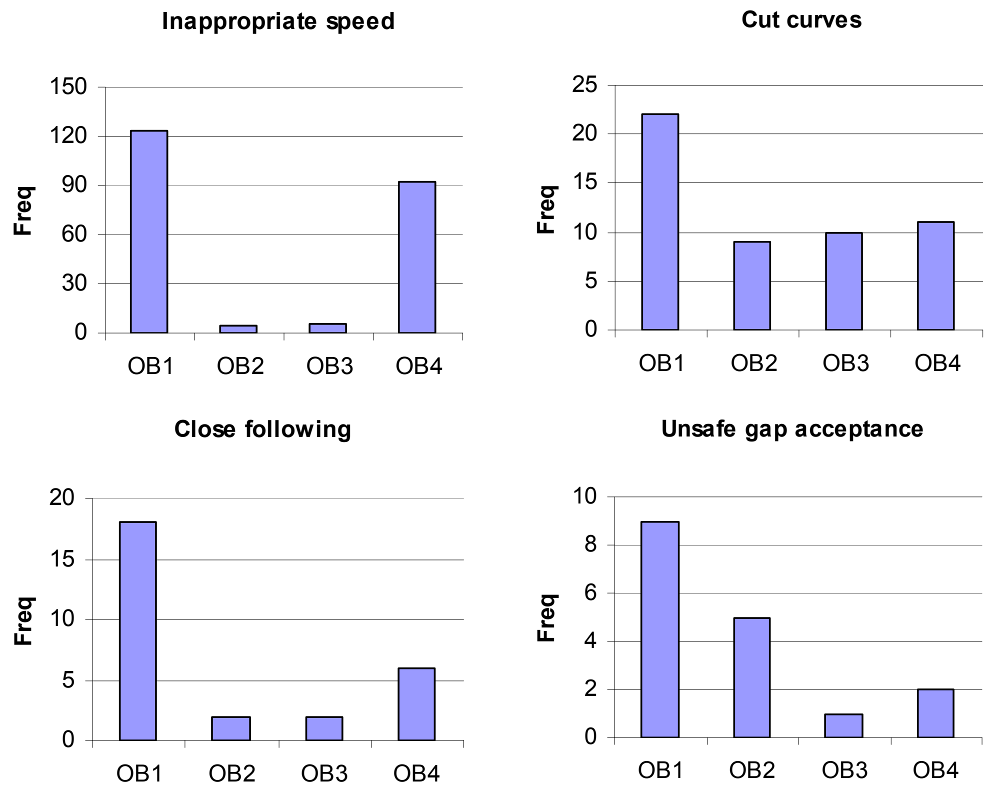


Figure 74: Observed negative driving behaviour across trial phases

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 33.

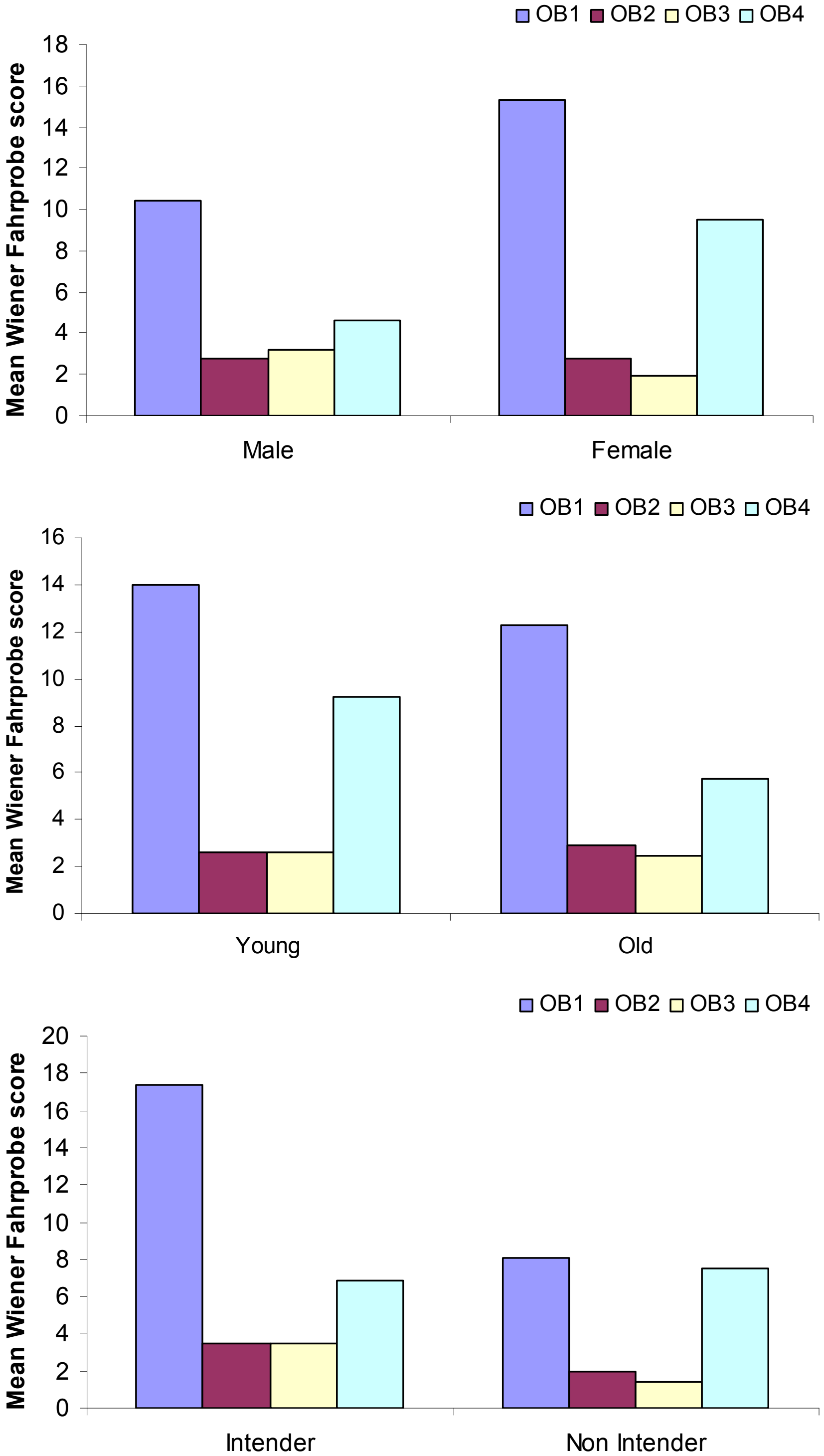


Figure 75: Mean Wiener Fahrprobe score across trial phases in terms of demographic groups

Table 33: 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	Repeated measures ANOVA: significance	Repeated measures ANOVA: Effect size	Post-hoc t-tests	OB2	OB3	OB4
Gender	Male	10.44	2.78	3.22	4.67	F(3,24) = 3.57	0.029*	0.308	OB1	*	*	*
									OB2		×	*
									OB3			×
	Female	15.30	2.80	1.90	9.50	F(3,27) = 11.86	< 0.0005**	0.569	OB1	**	**	*
									OB2		×	**
									OB3			**
Age	Young	14.00	2.63	2.63	9.25	F(3,21) = 9.34	< 0.0005**	0.572	OB1	**	**	*
									OB2		×	*
									OB3			*
	Old	12.27	2.91	2.45	5.73	F(3,30) = 5.60	0.004**	0.359	OB1	*	*	*
									OB2		×	*
									OB3			*
Intention to speed	Intender	17.40	3.50	3.50	6.90	F(3,27) = 10.15	< 0.0005**	0.530	OB1	**	**	*
									OB2		×	*
									OB3			*
	Non-intender	8.11	2.00	1.44	7.56	F(3,24) = 7.04	0.001**	0.468	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 34. 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 34: Reliability scores for NASA-RTLX measures

	OB1	**OB2**	**OB3**	**OB4**
Cronbach's Alpha (α)	0.771	0.414	0.443	0.739

Figure 76 shows the overall workload scores across trial phases, which indicates that workload decreased when driving with the ISA system. Changes in the perceived workload across trial phases suggest that participants felt the driving task became less demanding in the presence of the ISA system (i.e. workload score decreased from OB1 to OB2 and 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 with gender, age and intention group serving as between-subject factors was carried out. The results indicated that the changes over time were non-significant.

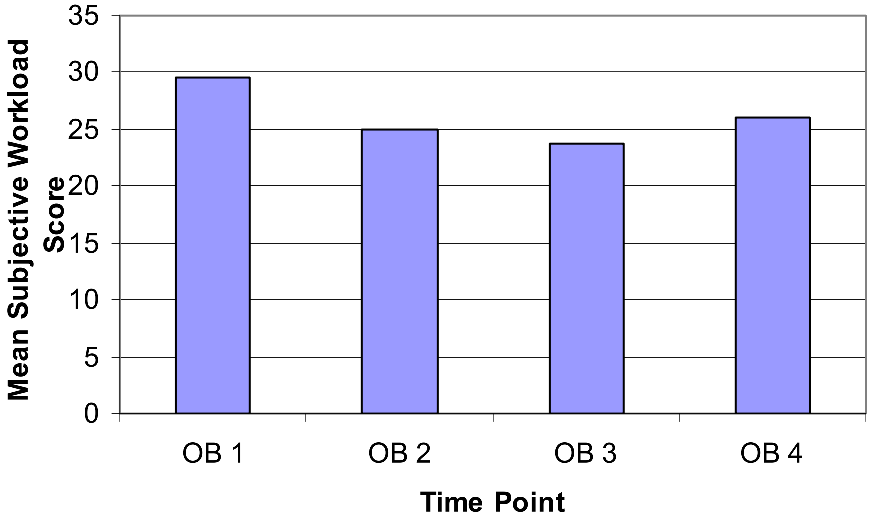


Figure 76: Mental workload scores over time

Figure 77 presents the mean scores of individual workload dimensions across the trial phases, which demonstrates a very similar pattern to that for overall workload scores as shown in Figure 76. In general, participants' perceived workload decreased when ISA was introduced and increased when ISA control was removed. Despite this drop in workload, participants felt that their performance had suffered.

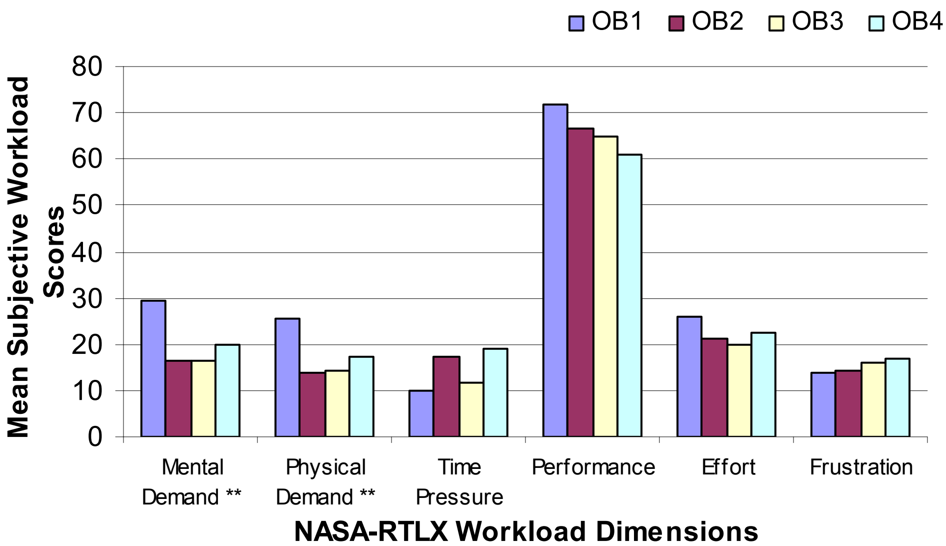


Figure 77: Individual dimension workload scores over time

Repeated measures ANOVA with gender, age and intention group serving as between-subject factors was employed to confirm the changes in workload scores over time. Mental workload ratings significantly decreased from OB1 to OB2 suggesting that the ISA system eased the mental workload associated with driving. A significant difference was also found across physical 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. Regarding fuel economy, OB1 was not statistically different from OB2, but was reliably different from OB3 and OB4. In addition, OB3 was also statistically different from OB4. This trend implies that participants were adapting their driving style at the beginning of Phase 2 (hence slight worse fuel economy at OB2, although the difference was not statistically significant) and had accommodated their driving style towards the end of Phase 2. The carry-over effect was also prominent due to OB4 being statistically difference from OB1. It is worth noting that the analysis of vehicle speed presented in Section 3.3 did not reveal significant carry-over effect. There seems to be a difference between drivers' behaviour when they were observed and not observed.

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. Frequencies of cut curves were reduced from Phase 1 to Phase 2, possibly due to more stable vehicle control as a result of reduced vehicle speed, and this change seemed to be well carried over to Phase 3. Unsafe gap acceptance was also reduced, with the carry-over effect lasted at least to the end of Phase 3.

In terms of subjective self-assessment, participants experienced reduced mental and physical workload. Although the carry-over effect was 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 trial to increase the power of statistical analysis).

6. CLUSTER TRIAL

6.1 Introduction

The purpose of the cluster trial was to create dense ISA traffic by manipulating the penetration rate of ISA vehicles in order to explore participants' responses to driving in a 'non-isolated' environment and to investigate the potential benefit of ISA to the entire traffic network. The ISA fleet drove on a chosen route six times on a Sunday with different levels of penetration. The methodology was identical to the one developed for Field Trial 1 (Lai et al, 2005a) with the only exception being that a new trial route between Warwickshire and Oxfordshire was used. The next section specifies the study design, followed by analysis results, and discussion.

6.2 Methodology

6.2.1 The trial route

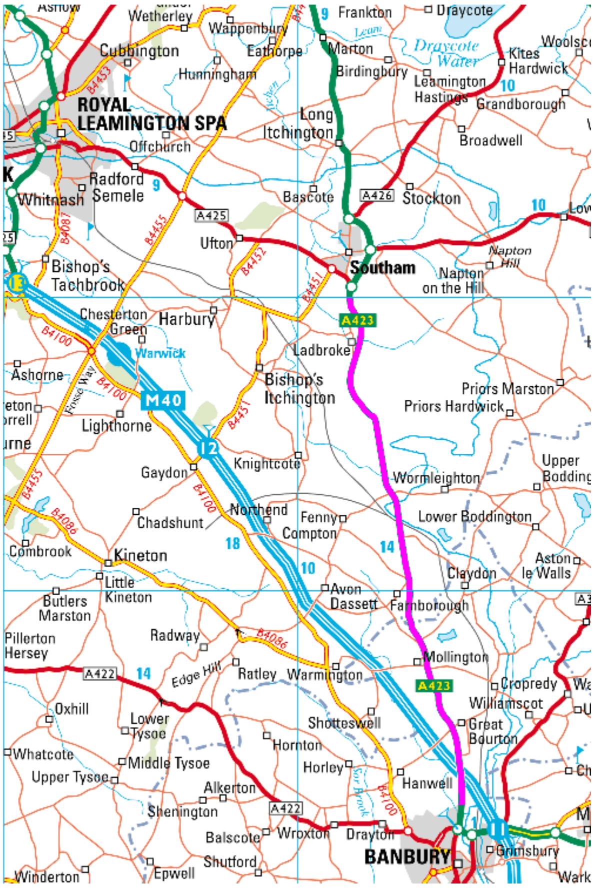


Figure 78: Map of the cluster trial route

The cluster trial was carried out on the A423 between Southam and Banbury as shown in Figure 78. The test route was approximately 12 miles long and it took about 15 minutes to drive from one end to the other. No roundabouts or signalised junctions were present on the test route. While there were unavoidably a few minor roads joining the test route, priority was always given to vehicles travelling on the test route. The aforementioned geometric conditions were considerations in choosing the candidate test route in order to minimise the interruption to the ISA platoon.

6.2.2 Headway measurement

As illustrated in Figure 79, three cameras were erected on the test route in order to monitor time headway of individual cars in the ISA platoon during each trial run. Camera sites were chosen on straight sections of the road in order to minimise headway variations introduced by unrelated factors such as geometric constraints which would affect the stability of vehicle speed as well as headway maintenance.

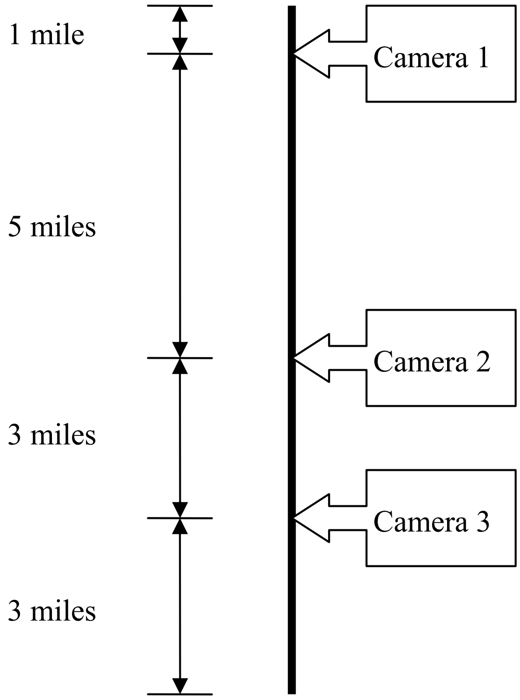


Figure 79: Camera positions on the cluster trial route

6.2.3 Driver responses

Driver responses to the manipulated dense ISA traffic were measured by questionnaires consisting of workload assessment and satisfaction with the ISA intervention, collected at the end of each trial run. User acceptance and opinions were also tapped at the end of the cluster trial.

6.2.4 Penetration manipulation

Various levels of ISA penetration was achieved by releasing ISA cars into the traffic following preset target values. Depending on the traffic flow when a trial run was being carried out, the manipulated penetration varied to some extent between the start point and end point of the route. The achieved penetration rates are depicted in Table 35.

Table 35: Penetration manipulation in the cluster trial

Run ID	Penetration at					Average penetration
	Start point	Camera 1	Camera 2	Camera 3	End point	
1	100	100	100	100	100	100
6	93	93	93	93	93	93
2	87	87	87	81	81	85
5	81	81	81	72	72	77
4	68	68	72	72	72	70
3	81	72	76	48	48	65

Note: figures shown in cells are percentages.

6.3 Results

6.3.1 Time headway

Time headway of ISA cars to lead vehicles was derived by video transcription. Not all ISA cars have contributed to the analysis of time headway. When an ISA car was following a non-ISA vehicle, this ISA car was excluded from the analysis to eliminate possible distortion, i.e. the non-ISA leading vehicle might have greater speed variation and hence would contaminate the data pattern of the following ISA car's time headway.

Figure 80 compares the mean time headway of valid ISA cars across various levels of penetration manipulation. It shows that mean time headway generally decreased in line with an increase in ISA penetration, except for the mean time headway derived from penetration rate in the band of 80-90%, which was perhaps affected by noise (e.g. other non-ISA cars within the ISA platoon). Although a reduced headway may initially seem to be a concern for road safety, the mean headway derived from the highest penetration band was still above the well-accepted safety criterion of the two-second gap (i.e. the Highway Code).

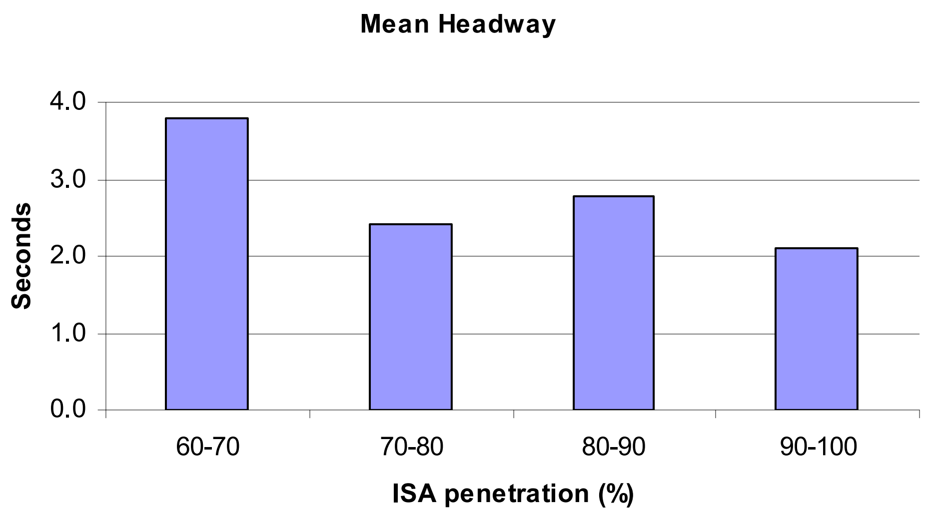
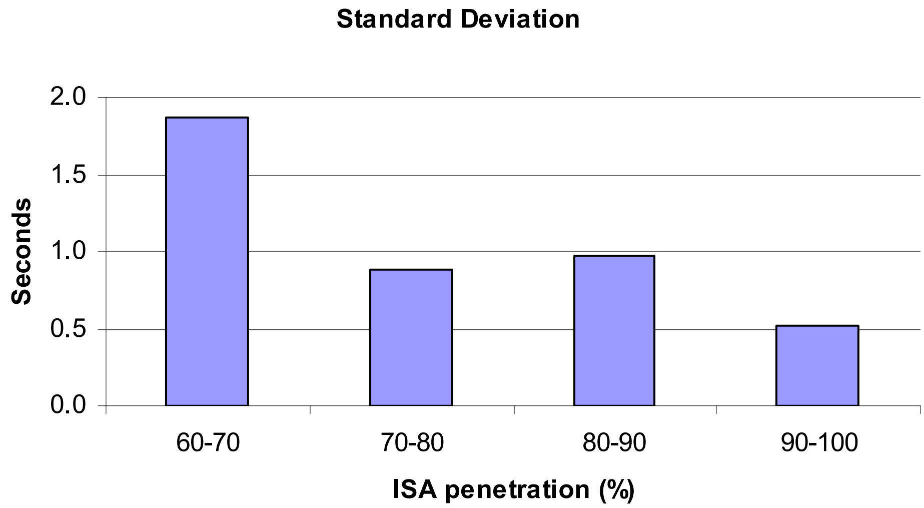


Figure 80: Mean time headway of ISA vehicles across penetration levels

In addition, the variability of time headway of ISA cars was also analysed, as illustrated in Figure 81. The standard deviation of time headway decreased in line with an increase in the penetration rate, except some noise present at the penetration band of 80-90%, similar to the mean time headway discussed above. However analysis of the coefficient of variation (CV) shows a smoother trend of diminished headway variability with an increase in the penetration rate. The analysis of headway variability indicates that the headway of ISA cars stabilises in line with an increase in ISA penetration, which provides promising implications for road safety.



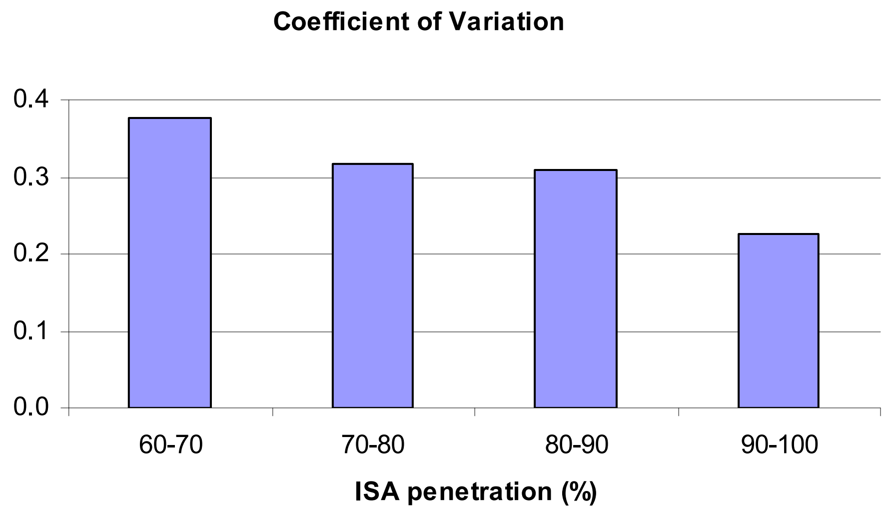


Figure 81: Variability of time headway of ISA vehicles across penetration levels

6.3.2 Driver responses

The NASA-RTLX was administered to measure subjective mental workload. An extra dimension which measures participants' perceived pressure from other traffic was also added. The data obtained from questionnaires showed a slight trend across ISA penetration rates. As can be seen in Figure 82 participants' mental workload decreased in line with an increase in ISA penetration. A similar pattern is also seen across the individual dimensions (Figure 83) where workload decreases in the high penetration drives and performance increases. A repeated measures ANOVA with age, sex and attitude group as between subject factors revealed that participants felt significantly less time pressure when driving in high penetration conditions compared to a medium penetration condition.

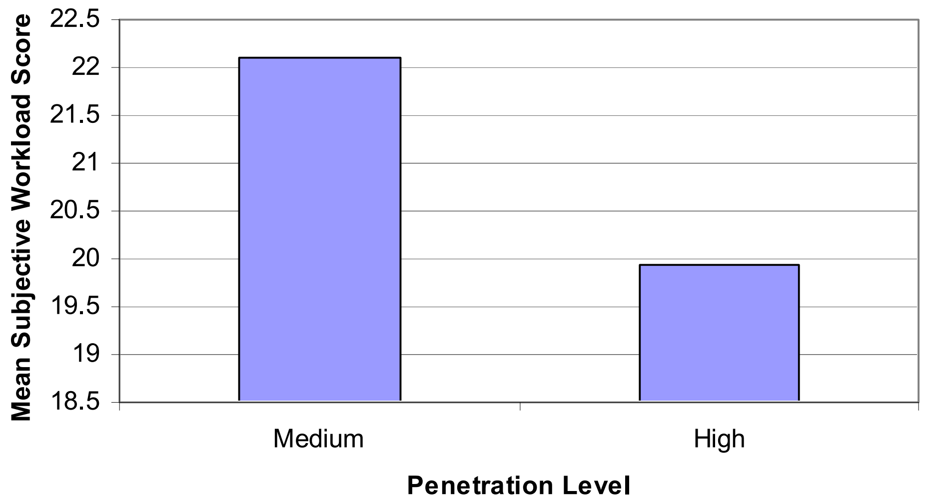


Figure 82: Mental workload in terms of ISA penetration

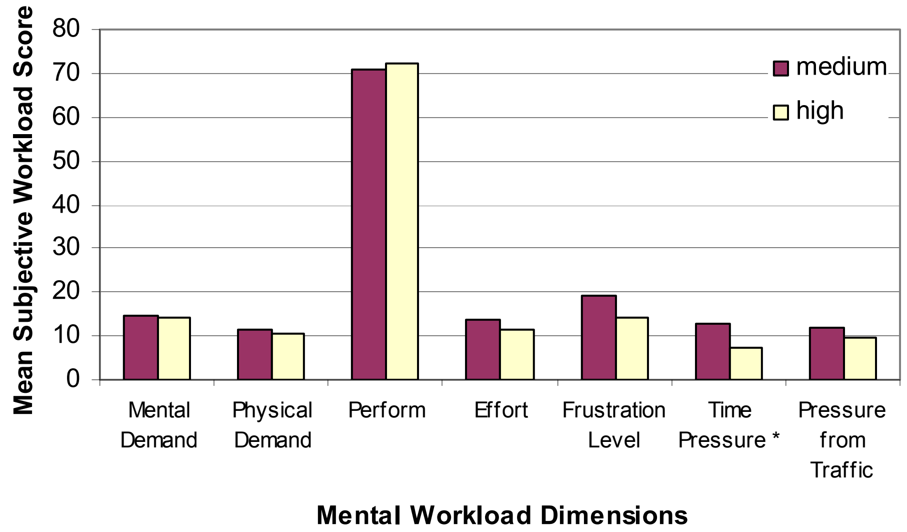


Figure 83: Individual dimension workload scores over time

Differences in participants' acceptability ratings were minimal and non-significant although, they did seem to be more satisfied with the ISA system when the presence of other ISA cars on the road was at it greatest (as illustrated in Figure 84).

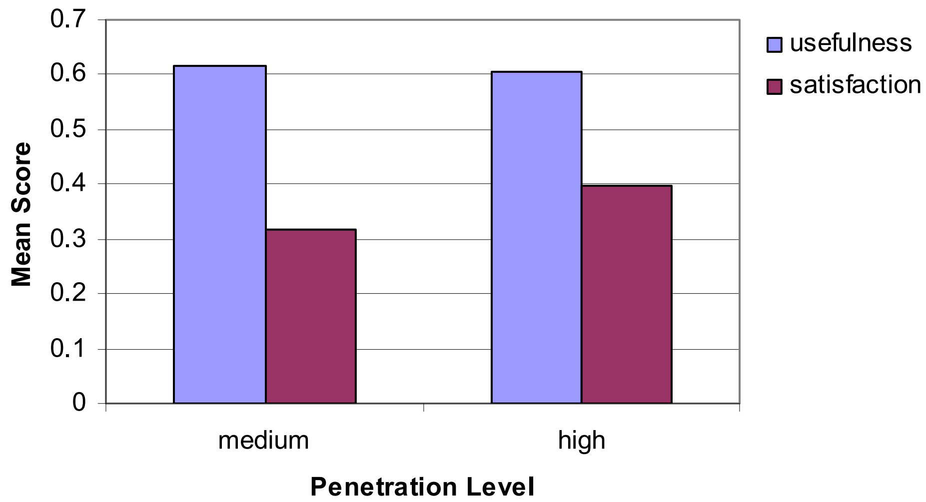


Figure 84: Acceptability ratings for the dimensions of "usefulness" and "satisfaction"

Following all six drives, participants were asked if they felt more or less pressure to keep within the speed limit and whether they were more relaxed or frustrated. Responses on the whole were positive and suggested that driving within an ISA platoon was indeed more relaxing:

"Knowing that the majority of vehicles around me were only going to be driving at the speed limits, made the pressure of keeping up with the flow of the traffic less stressful."

"Less frustration at being restricted due to knowledge that all or a majority of vehicles were also being restricted."

"I did feel more relaxed because I wasn't being pressured to drive faster."

Participants were also asked if these drives had changed their opinions about the feasibility and advantages of introducing ISA in the UK. Responses were somewhat mixed. Participants appreciated the benefits of an ISA fleet but held certain misgivings about its introduction:

"With everyone at the same speed there was little pressure to go any quicker. It changed and reduced the pleasure of driving. I might just as well been sat on a bus!"

"It was clear being at the back of the fleet that non-ISA drivers used their brakes much more frequently that ISA drivers, driving too close and more inconsistently in speed terms than ISA drivers."

"The cluster day definitely underlined the fact that if the system is introduced it would be less frustrating if everyone adopted it at the same time… I still have misgivings about the system though as I find it frustrating to be dictated to by a car… Occasionally I also find my attention wandering momentarily as I know the car is monitoring the speed limit."

6.4 Discussion

The cluster trial has led to encouraging results that increasing ISA penetration may facilitate vehicle headway stabilisation. This finding obviously provides positive implications for the entire traffic network. A more efficient traffic network will not only contribute to reductions in accident occurrence but also savings in social costs.

An increased penetration rate of ISA appeared to reduce participant's workload and increase their performance. Results on the whole were however non significant. Acceptability of the system appeared relatively unchanged although satisfaction scores were slightly higher when the number of ISA vehicles on the road was at its greatest.

7. CONCLUSIONS AND IMPLICATIONS

7.1 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 (14.5% 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, cut curves, close following, and unsafe gap acceptance, as revealed by the observation drives. Moreover, the results of the cluster trial showed that increased ISA penetration may facilitate vehicle headway stabilisation, which if realised generally should deliver positive benefits in terms of smoother operation and reduced accidents across the entire traffic network.

7.2 Attitudinal changes

Intentions to exceed the speed limit on a residential road significantly decreased following experience with the ISA system. Attitudes towards speeding on urban roads became significantly less favourable following experience with ISA. Unfortunately, attitudes towards speeding on a motorway were positive and became more favourable over time; however, this change was non-significant. 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. Pressure to keep within the speed limits was lowest for the motorway and the police were identified as the most influential referents. Participants were also unlikely to regret speeding on a motorway. Participants were however significantly more likely to regret speeding on an urban road following experience with the system. Throughout the analysis cognitions relating to speeding on a motorway were identified as the most the important targets for intervention. 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 persisted after ISA was switched off. 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.

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. Sixty five percent of participants were willing to have ISA installed in their vehicles if its use was voluntary. Moreover 63% agreed with the compulsory fitting of ISA to all new vehicles and 53% agreed to the mandatory introduction of ISA for all drivers. Those who disagreed were most in favour of ISA for speed offenders.

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

Table A1: ANOVA results for mean speed by gender

Gender group	Speed zone	Mean			Repeated measures ANOVA			Post-hoc t-tests		
		Phase 1	Phase 2	Phase 3	*F* statistic	significance	Effect size	PH1 vs PH2	PH1 vs PH3	PH2 vs PH3
Male	20									
	30	28.51	27.00	27.58	F(2,16) = 3.36	0.061	0.295	×	×	×
	40	36.43	35.18	35.55	F(2,16) = 2.01	0.166	0.201	×	×	×
	50	39.97	39.84	39.05	F(2,16) = 0.37	0.696	0.044	×	×	×
	60	48.13	47.90	46.61	F(2,16) = 1.93	0.178	0.194	×	×	×
	70	65.44	63.56	63.03	F(2,16) = 1.25	0.314	0.135	×	×	×
Female	20	18.29	15.91	13.97	F(2,4) = 2.21	0.226	0.525	×	×	×
	30	27.54	26.20	27.22	F(2,20) = 8.15	0.003**	0.449	**	×	*
	40	35.00	34.10	34.70	F(2,20) = 2.43	0.114	0.195	*	×	×
	50	40.60	40.00	40.22	F(2,20) = 0.68	0.516	0.064	×	×	×
	60	47.37	48.44	46.84	F(2,20) = 2.40	0.117	0.193	×	×	*
	70	61.04	62.30	58.44	F(2,20) = 1.42	0.266	0.124	×	×	×

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

Gender group	Speed zone	Mean			Repeated measures ANOVA			Post-hoc t-tests		
		Phase 1	Phase 2	Phase 3	*F* statistic	significance	Effect size	PH1–PH2	PH1–PH3	PH2–PH3
Male	20									
	30	36.14	31.86	34.75	F(2,16) = 10.14	0.001**	0.559	**	×	**
	40	43.54	40.85	42.85	F(2,16) = 4.46	0.029*	0.358	*	×	*
	50	50.07	49.31	49.79	F(2,16) = 0.34	0.719	0.040	×	×	×
	60	59.24	57.48	56.54	F(2,16) = 1.64	0.226	0.170	×	×	×
	70	75.21	72.73	73.55	F(2,16) = 1.44	0.265	0.153	×	×	×
Female	20	25.53	20.80	18.61	F(2,4) = 3.85	0.117	0.658	*	×	×
	30	35.80	31.85	35.37	F(2,20) = 26.12	< 0.0005**	0.723	**	×	**
	40	42.84	40.77	42.53	F(2,20) = 8.48	0.002**	0.459	**	×	*
	50	51.75	49.64	50.57	F(2,20) = 5.16	0.016*	0.340	**	*	×
	60	56.65	57.54	55.93	F(2,20) = 1.68	0.211	0.144	×	×	×
	70	72.64	72.88	71.59	F(2,20) = 0.15	0.863	0.015	×	×	×

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 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			
Young	20								PH2	PH3
								PH1		
								PH2		
	30	28.21	26.53	27.66	F(2,14) = 8.08	0.005**	0.536		PH2	PH3
								PH1	**	×
								PH2		*
	40	37.20	35.69	36.81	F(2,14) = 3.05	0.079	0.304		PH2	PH3
								PH1	*	×
								PH2		×
	50	42.00	41.27	41.41	F(2,14) = 0.19	0.829	0.026		PH2	PH3
								PH1	×	×
								PH2		×
	60	47.30	47.81	47.72	F(2,14) = 0.30	0.746	0.041		PH2	PH3
								PH1	×	×
								PH2		×
	70	64.92	63.86	64.16	F(2,14) = 0.11	0.895	0.016		PH2	PH3
								PH1	×	×
								PH2		×
Old	20	18.29	15.91	13.97	F(2,4) = 2.21	0.226	0.525		PH2	PH3
								PH1	×	×
								PH2		×
	30	27.82	26.58	27.19	F(2,22) = 3.61	0.044*	0.247		PH2	PH3
								PH1	*	×
								PH2		×
	40	34.61	33.85	33.94	F(2,22) = 1.87	0.178	0.145		PH2	PH3
								PH1	×	×
								PH2		×
	50	39.20	39.03	38.55	F(2,22) = 0.73	0.493	0.062		PH2	PH3
								PH1	×	×
								PH2		×
	60	47.99	48.46	46.09	F(2,22) = 5.91	0.009**	0.350		PH2	PH3
								PH1	×	×
								PH2		**
	70	61.76	62.20	58.07	F(2,22) = 2.85	0.079	0.206		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 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: *F* statistic	Repeated measures ANOVA: significance	Repeated measures ANOVA: Effect size	Post-hoc t-tests		
Young	20								PH2	PH3
								PH1		
								PH2		
	30	37.04	31.93	35.96	F(2,14) = 24.03	< 0.0005**	0.774		PH2	PH3
								PH1	**	✗
								PH2		**
	40	45.51	41.38	44.54	F(2,14) = 10.02	0.002**	0.589		PH2	PH3
								PH1	**	✗
								PH2		**
	50	52.80	50.49	52.17	F(2,14) = 3.51	0.058	0.334		PH2	PH3
								PH1	**	✗
								PH2		✗
	60	57.63	57.32	57.52	F(2,14) = 0.08	0.925	0.011		PH2	PH3
								PH1	✗	✗
								PH2		✗
	70	76.45	73.49	76.21	F(2,14) = 0.84	0.452	0.107		PH2	PH3
								PH1	✗	✗
								PH2		✗
Old	20	25.53	20.80	18.61	F(2,4) = 3.85	0.117	0.658		PH2	PH3
								PH1	*	✗
								PH2		✗
	30	35.23	31.81	34.52	F(2,22) = 12.62	< 0.0005**	0.534		PH2	PH3
								PH1	**	✗
								PH2		**
	40	41.58	40.42	41.43	F(2,22) = 4.86	0.018*	0.307		PH2	PH3
								PH1	**	✗
								PH2		*
	50	49.80	48.83	48.91	F(2,22) = 1.20	0.319	0.099		PH2	PH3
								PH1	✗	✗
								PH2		✗
	60	57.93	57.64	55.33	F(2,22) = 2.51	0.104	0.186		PH2	PH3
								PH1	✗	✗
								PH2		**
	70	72.03	72.36	69.98	F(2,22) = 0.96	0.399	0.080		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	PH1–PH2	PH1–PH3	PH2–PH3
Intender	20	16.76	15.25	15.21						
	30	27.37	26.41	27.18	F(2,18) = 5.91	0.011*	0.396	**	×	*
	40	36.02	34.92	35.79	F(2,18) = 3.67	0.046*	0.290	*	×	×
	50	41.51	41.40	41.11	F(2,18) = 0.08	0.926	0.008	×	×	×
	60	47.35	48.02	46.81	F(2,18) = 0.90	0.422	0.091	×	×	×
	70	64.34	65.93	63.30	F(2,18) = 0.74	0.492	0.076	×	×	×
Non-intender	20	19.06	16.25	13.35	F(2,2) = 1.68	0.373	0.627	×	×	×
	30	28.58	26.71	27.59	F(2,18) = 5.51	0.014*	0.380	*	×	×
	40	35.27	34.25	34.38	F(2,18) = 1.76	0.200	0.164	×	×	×
	50	39.12	38.45	38.28	F(2,18) = 1.35	0.285	0.130	×	×	×
	60	48.07	48.38	46.66	F(2,18) = 3.65	0.047*	0.288	×	×	*
	70	61.70	59.80	57.72	F(2,18) = 2.00	0.165	0.182	×	×	×

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 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	24.87	19.66	19.06						
	30	35.47	31.77	35.03	F(2,18) = 19.51	< 0.0005**	0.684	**	×	**
	40	44.06	41.15	43.80	F(2,18) = 9.18	0.002**	0.505	**	×	**
	50	51.82	50.33	51.79	F(2,18) = 1.63	0.223	0.154	×	×	×
	60	58.38	57.92	56.73	F(2,18) = 0.62	0.549	0.064	×	×	×
	70	75.94	76.16	75.16	F(2,18) = 0.08	0.920	0.009	×	×	×
Non-intender	20	25.86	21.37	18.39	F(2,2) = 1.53	0.395	0.605	×	×	×
	30	36.44	31.94	35.15	F(2,18) = 13.87	< 0.0005**	0.606	**	×	**
	40	42.25	40.46	41.54	F(2,18) = 3.75	0.044*	0.294	×	×	*
	50	50.17	48.66	48.64	F(2,18) = 5.09	0.018*	0.361	*	*	×
	60	57.25	57.10	55.68	F(2,18) = 2.29	0.130	0.203	×	*	×
	70	71.65	69.46	69.78	F(2,18) = 0.91	0.421	0.092	×	×	×

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

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

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	PH1 vs PH2	PH1 vs PH3	PH2 vs PH3
SI	5.802	5.55	5.516	F (2,28) = 0.712	0.499	0.048	×	×	×

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		T2	T3	T4
ACCEPTABILITY	USE	1.047	0.867	1.165	1.116	F (3,30) = 0.413	0.588	0.040	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		T2	T3	T4
DRIVER BEHAVIOUR QUESTIONNAIRE	LAPSE	0.729	0.711	0.645	0.606	F (3,39) = 0.510	0.678	0.038	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	Repeated measures ANOVA: significance	Repeated measures ANOVA: Effect size	Post-hoc t-tests: EXP vs EAR	Post-hoc t-tests: EXP vs PRO	Post-hoc t-tests: EAR vs 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

<table>
<tr><th rowspan="2"></th><th rowspan="2"></th><th rowspan="2">Expect</th><th rowspan="2">Early Use</th><th rowspan="2">Prolonged Use</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="6">FRUSTRATION</td><td rowspan="3">frustrate myself</td><td rowspan="3">-0.070</td><td rowspan="3">0.253</td><td rowspan="3">0.159</td><td rowspan="3">F (2,26) = 0.653</td><td rowspan="3">0.529</td><td rowspan="3">0.048</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</td><td></td><td>×</td></tr>
<tr><td rowspan="3">frustrate others</td><td rowspan="3">0.701</td><td rowspan="3">0.881</td><td rowspan="3">0.859</td><td rowspan="3">F (2,26) = 0.213</td><td rowspan="3">0.809</td><td rowspan="3">0.016</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</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 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		EAR	PRO
FRUSTRATION	overtaking	0.198	0.245	0.204	F (2,26) = 0.009	0.991	0.001	EXP	×	×
								EAR		×
	fast moving	0.887	1.089	0.893	F (2,26) = 0.413	0.666	0.031	EXP	×	×
								EAR		×
	motorway	0.461	0.797	0.912	F (2,26) = 1.552	0.231	0.107	EXP	×	×
								EAR		×
	20mph	-0.454	-0.303	-0.200	F (2,26) = 0.424	0.579	0.032	EXP	×	×
								EAR		×
	major road (40-60mph)	0.132	0.048	0.151	F (2,26) = 0121	0.887	0.009	EXP	×	×
								EAR		×
	night-time	-0.256	-0.132	-0.147	F (2,26) = 0.399	0.675	0.030	EXP	×	×
								EAR		×
	day time	0.167	0.312	0.299	F (2,26) = 0.347	0.710	0.026	EXP	×	×
								EAR		×
	heavy traffic	-0.542	-0.346	-0.255	F (2,26) = 0.649	0.531	0.048	EXP	×	×
								EAR		×
	light traffic	0.357	0.182	0.373	F (2,26) = 0.423	0.659	0.032	EXP	×	×
								EAR		×
	bad weather	-0.598	-0.360	-0.391	F (2,26) = 0.461	0.636	0.034	EXP	×	×
								EAR		×
	poor visibility	-0.605	-0.376	-0.391	F (2,26) = 0.546	0.586	0.040	EXP	×	×
								EAR		×
	child presence	-1.013	-0.445	-0.716	F (2,26) = 2.291	0.121	0.150	EXP	×	×
								EAR		×
	ped. crossing	-0.781	-0.502	-0.594	F (2,26) = 0.568	0.573	0.042	EXP	×	×
								EAR		×
	compl. junction	-0.559	-0.371	-0.500	F (2,26) = 0.318	0.731	0.024	EXP	×	×
								EAR		×
	built up (30mph)	-0.455	-0.132	-0.365	F (2,26) = 0.727	0.493	0.053	EXP	×	×
								EAR		×
	rural road (60mph)	0.342	0.162	0.014	F (2,26) = 0.694	0.508	0.051	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: *F* statistic	Repeated measures ANOVA: significance	Repeated measures ANOVA: Effect size	Post-hoc t-tests		
CONCENTRATION	atten. to other road users	0.636	1.161	1.006	F (2,26) = 3.134	0.060	0.194		EAR	PRO
								EXP	×	×
								EAR		×
	atten. to speed limit signs	0.075	1.232	0.896	F(2,26) =13.816	0.000	0.515		EAR	PRO
								EXP	***	*
								EAR		×
	awareness of limit	0.769	1.397	1.346	F (2,26) = 6.803	0.005	0.362		EAR	PRO
								EXP	*	*
								EAR		×
	atten. to aspects of driving	0.525	0.543	0.819	F (2,26) = 0.952	0.399	0.068		EAR	PRO
								EXP	×	×
								EAR		×
	check speedo	-0.359	0.610	0.428	F (2,26) = 3.424	0.048	0.208		EAR	PRO
								EXP	×	×
								EAR		×
	tendency to brake	-0.027	-0.283	-0.224	F (2,26) = 0.443	0.647	0.033		EAR	PRO
								EXP	×	×
								EAR		×
	tendency to accel	-0.158	-0.289	-0.316	F (2,26) = 0.250	0.781	0.020		EAR	PRO
								EXP	×	×
								EAR		×
	anticip. of conflicts	0.652	0.717	0.584	F (2,26) = 0.148	0.863	0.011		EAR	PRO
								EXP	×	×
								EAR		×
	attent. to pedestrian	0.375	0.231	0.151	F (2,26) = 0.955	0.370	0.068		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 B12: ANOVA results for participants' perceptions of change in driving experience when driving with ISA

<table>
<tr><th rowspan="2"></th><th rowspan="2"></th><th rowspan="2">Expect</th><th rowspan="2">Early Use</th><th rowspan="2">Prolonged Use</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="36">DRIVING EXPERIENCE</td><td rowspan="3">journey time</td><td rowspan="3">1.025</td><td rowspan="3">0.624</td><td rowspan="3">0.755</td><td rowspan="3">F (2,26) = 1.657</td><td rowspan="3">0.219</td><td rowspan="3">0.113</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</td><td></td><td>×</td></tr>
<tr><td rowspan="3">Alternative route</td><td rowspan="3">-0.930</td><td rowspan="3">-1.883</td><td rowspan="3">-1.014</td><td rowspan="3">F (2,26) = 8.548</td><td rowspan="3">0.001</td><td rowspan="3">0.397</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>**</td><td>×</td></tr>
<tr><td>EAR</td><td></td><td>**</td></tr>
<tr><td rowspan="3">Avoid 30mph</td><td rowspan="3">-0.879</td><td rowspan="3">-1.857</td><td rowspan="3">-1.726</td><td rowspan="3">F(2,26)= 10.348</td><td rowspan="3">0.003</td><td rowspan="3">0.443</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>**</td><td>*</td></tr>
<tr><td>EAR</td><td></td><td>×</td></tr>
<tr><td rowspan="3">Keep to limit</td><td rowspan="3">1.818</td><td rowspan="3">1.329</td><td rowspan="3">1.088</td><td rowspan="3">F (2,26) = 3.341</td><td rowspan="3">0.052</td><td rowspan="3">0.218</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</td><td></td><td>×</td></tr>
<tr><td rowspan="3">enjoyment</td><td rowspan="3">-0.144</td><td rowspan="3">-0.555</td><td rowspan="3">-0.600</td><td rowspan="3">F (2,26) = 1.569</td><td rowspan="3">0.234</td><td rowspan="3">0.108</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</td><td></td><td>×</td></tr>
<tr><td rowspan="3">security</td><td rowspan="3">0.196</td><td rowspan="3">0.164</td><td rowspan="3">-0.059</td><td rowspan="3">F (2,26) = 0.694</td><td rowspan="3">0.509</td><td rowspan="3">0.051</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</td><td></td><td>×</td></tr>
<tr><td rowspan="3">control</td><td rowspan="3">-0.479</td><td rowspan="3">-0.783</td><td rowspan="3">-0.383</td><td rowspan="3">F (2,26) = 1.341</td><td rowspan="3">0.279</td><td rowspan="3">0.093</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</td><td></td><td>×</td></tr>
<tr><td rowspan="3">confidence</td><td rowspan="3">0.025</td><td rowspan="3">-0.090</td><td rowspan="3">-0.223</td><td rowspan="3">F (2,26) = 0.515</td><td rowspan="3">0.604</td><td rowspan="3">0.038</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</td><td></td><td>×</td></tr>
<tr><td rowspan="3">accident risk</td><td rowspan="3">-0.460</td><td rowspan="3">-0.096</td><td rowspan="3">0.288</td><td rowspan="3">F (2,26) = 4.611</td><td rowspan="3">0.019</td><td rowspan="3">0.262</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>*</td></tr>
<tr><td>EAR</td><td></td><td>×</td></tr>
<tr><td rowspan="3">comfort</td><td rowspan="3">0.279</td><td rowspan="3">0.077</td><td rowspan="3">-0.144</td><td rowspan="3">F (2,26) = 0.896</td><td rowspan="3">0.389</td><td rowspan="3">0.064</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</td><td></td><td>×</td></tr>
<tr><td rowspan="3">pressure from traffic</td><td rowspan="3">1.467</td><td rowspan="3">1.341</td><td rowspan="3">1.379</td><td rowspan="3">F (2,26) = 0.342</td><td rowspan="3">0.713</td><td rowspan="3">0.026</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</td><td></td><td>×</td></tr>
<tr><td rowspan="3">opt out</td><td rowspan="3">0.195</td><td rowspan="3">0.090</td><td rowspan="3">0.100</td><td rowspan="3">F (2,26) = 0.080</td><td rowspan="3">0.923</td><td rowspan="3">0.007</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</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 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.

<table>
<tr><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">Expect</td><td rowspan="2">Early Use</td><td rowspan="2">Prolonged Use</td><td colspan="3">Repeated measures ANOVA</td><td colspan="3" rowspan="2">Post-hoc t-tests</td></tr>
<tr><td>F statistic</td><td>significance</td><td>Effect size</td></tr>
<tr><td rowspan="12">COMMON CRITICISMS</td><td rowspan="3">Overtaking difficulties</td><td rowspan="3">0.447</td><td rowspan="3">0.875</td><td rowspan="3">0.522</td><td rowspan="3">F (2,26) = 0.773</td><td rowspan="3">0.433</td><td rowspan="3">0.056</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</td><td></td><td>×</td></tr>
<tr><td rowspan="3">Accel out of danger</td><td rowspan="3">0.495</td><td rowspan="3">0.167</td><td rowspan="3">0.464</td><td rowspan="3">F (2,26) = 0.402</td><td rowspan="3">0.673</td><td rowspan="3">0.030</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</td><td></td><td>×</td></tr>
<tr><td rowspan="3">less vigilant</td><td rowspan="3">-0.359</td><td rowspan="3">-0.785</td><td rowspan="3">-0.493</td><td rowspan="3">F (2,26) = 0.952</td><td rowspan="3">0.399</td><td rowspan="3">0.068</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</td><td></td><td>×</td></tr>
<tr><td rowspan="3">decrease following distances</td><td rowspan="3">-0.088</td><td rowspan="3">-0.361</td><td rowspan="3">-0.092</td><td rowspan="3">F (2,26) = 0.419</td><td rowspan="3">0.662</td><td rowspan="3">0.031</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</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 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

<table>
<tr><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">Expect</td><td rowspan="2">Early Use</td><td rowspan="2">Prolonged Use</td><td colspan="3">Repeated measures ANOVA</td><td colspan="3" rowspan="2">Post-hoc t-tests</td></tr>
<tr><td>F statistic</td><td>significance</td><td>Effect size</td></tr>
<tr><td rowspan="6">DROP OUT</td><td rowspan="3">drive faster</td><td rowspan="3">0.570</td><td rowspan="3">0.524</td><td rowspan="3">0.441</td><td rowspan="3">F (2,26) = 0.573</td><td rowspan="3">0.490</td><td rowspan="3">0.042</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</td><td></td><td>×</td></tr>
<tr><td rowspan="3">feel relief</td><td rowspan="3">0.522</td><td rowspan="3">0.669</td><td rowspan="3">0.508</td><td rowspan="3">F (2,26) = 0.322</td><td rowspan="3">0.645</td><td rowspan="3">0.024</td><td></td><td>EAR</td><td>PRO</td></tr>
<tr><td>EXP</td><td>×</td><td>×</td></tr>
<tr><td>EAR</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 significant at the 0.001 level
4. × denotes the mean difference is not significant

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

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

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
	PHYSICA L	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
	TRAFFI C	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