Transport Research Laboratory

Full time through junction running simulation study

by C Diels, A Dale, R Robbins, T Rees, I Summersgill

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Executive summary

UK motorways are experiencing growing congestion problems as the volume of traffic increases. Many innovative solutions are being considered within the current network to try and tackle this problem.

One scheme that has been created and already implemented in particular motorway networks is the use of the hard shoulder as an additional running lane. The hard shoulder running (HSR) scheme has created challenges in itself, and therefore further trials have been required to understand the impact on road users.

This scheme for increasing network capacity relies on the opening and closing of the hard shoulder when needed. For example, opening the hard shoulder when traffic is particularly congested or closing the hard shoulder if a breakdown has occurred. This study seeks to understand driver comprehension of hard shoulder running when driving through and entering/exiting junctions. It is vital that drivers are aware of the status of the lanes and that it does not cause confusion, as this could potentially lead to an accident.

The aim of this study is to investigate drivers' responses to a simulated Full Time Through Junction Running (FT TJR) scheme under conditions of high traffic density. This is to gain an overall understanding of how drivers are likely to behave in schemes of this nature, and to enable the creation of a safe and comprehensive design. The concept needs to be viewed by the motoring public as useable and a positive experience to ensure the additional network capacity is utilised in the correctly.

96 drivers were exposed to a simulated replica of junction 5 on the M42 Southbound a total of six times (each exposure referred to as a Junction 1, 2, 3 etc). Included in the sample were two different age categories, 17-44 years and 45+. Participants drove two routes with Lane Below Signal 1 (LBS1) closed (Route 1) or open (Route 2) in the majority of sections. In both routes they were required to leave the motorway at a specific junction and rejoin at the same junction to experience the novel lane markings and signs created for this trial.

Route 1

In route 1, LBS1 was open within junctions 1, 2, 3, 4 and 6, and closed for the rest of the route (including between junctions).

Only a few participants (approximately 7%) made use of the extra capacity provided by opening of LBS1 within the junctions. This is a desirable outcome as sudden lane changes in and out of LBS1 within a junction are unlikely to be advantageous in the context of road safety and traffic flow.

The vast majority adhered to the signs indicating LBS1 to be closed to traffic between junctions. This suggests that the red cross displayed on the gantries was well understood and effective in preventing drivers from using LBS1 as a normal running lane.

When the gantry signs turned blank from junction 4 onwards, it was observed that all participants correctly understood that LBS1 was not open to traffic and none of them illegitimately drove in LBS1, again indicating participants correctly understood lane status on the basis of provided signs.

Route 2

In route 2, LBS1 was open for the whole route except for within junction 4 and between junctions 5 and 6. The overall percentage of LBS1 use on the approach to a FT TJR junction was 19% and mirrors the percentage use observed in the study investigating use of additional capacity within the Part Time TJR scheme (Diels et al., 2009a).

One of the main findings was that, similar to the PT TJR scheme, participants tended to use LBS1 between junctions, but changed into LBS2 on their approach to a junction, even though LBS1 remained open to traffic. This suggests that participants are less inclined to use LBS1 within junctions. In addition, participants were also less likely to make use of LBS1 in merge areas, whereas beyond this point, LBS1 use increased again.

The finding that drivers are less likely to make use of LBS1 within the junction and in the merge area was also observed in the previous Part Time TJR study. This was initially ascribed to participants reluctance to cross the solid white line that crosses LBS1 and delineates the offside of the diverge. However, within the FT TJR scheme the solid white line is absent. The fact that a similar pattern is observed in both FT and PT TJR studies suggest that participants are more reluctant to make use of LBS1 within the junctions. This might be because drivers want to avoid potential conflicts with merging traffic. It is also possible that participants were unfamiliar with Through Junction Running and it would be of interest to consider their behaviour over time. It is likely that once accustomed to the new traffic situation provided by TJR, a higher LBS1 usage within junctions would be observed.

Questionnaire

Overall, the results of the questionnaire were largely in line with those obtained in the Part Time TJR study (Diels et al., 2009a). Participants reported to be clear whether it was allowed to use LBS1 as a normal running lane; reported a weak dislike of the use of LBS1; tended to feel slightly less confident than normal; where clear as to the current speed limit. It is of interest to note that similar to the PT TJR study, participants were not completely clear as to the status of LBS1 upon entering the motorway. This suggests that current signs employed on the on-slip may not be fully comprehended and alternative designs may be considered.

1 Introduction

Use of the hard shoulder as an active running lane has been demonstrated to be an effective measure to reduce congestion and improve journey time reliability on the M42 Active Traffic Management (ATM) pilot project (Sultan et al., 2008). A refinement that has the potential to improve traffic flows further would be to allow traffic to use the hard shoulder (HS) through junctions – termed Through Junction Running (TJR).

Of course, the introduction of such schemes must not lead to a reduction in safety standards and, furthermore, the scheme must be reasonably intuitive such that naïve users on the scheme can use it comfortably and appropriately and do not feel threatened or insecure on their journey. Furthermore, drivers' opinions, attitudes and acceptance of such novel motorway schemes must be understood in order to create a scheme that is usable and viewed positively by the motoring public.

In a recent simulator study (Diels et al., 2009b); participants' behaviour was evaluated in response to Full Time Through Junction Running (FT TJR), a hard shoulder running scheme whereby the hard shoulder is permanently converted into a normal running lanes within the junction. Behaviour was evaluated in terms of their ability to respond to the new scheme (including signs and road marking) in a safe and appropriate manner. The results of this study were largely positive indicating a good understanding and use of the scheme without compromising road safety. One limitation of this study was however the relatively low traffic density in the simulated environment. Hence, the main aim of this study was to evaluate drivers' responses to FT TJR under conditions of high traffic densities.

An additional aim of this study was to provide a comparison between Full Time and Part Time TJR. In a further simulator study (Diels et al. 2009a), it was found that, overall, the majority of drivers understood and complied with the regulations of PT TJR. However, whereas a significant proportion chose to use the additional network capacity provided by TJR, drivers were less inclined to use LBS1 (Lane Below Signal 1) within junctions. In comparison to PT TJR, FT TJR provides a simplification in that the hard shoulder within junctions is open by default and as such provides a simpler traffic situation which, for example, does not require drivers to leave the hard shoulder when driving through a junction. In turn, this can be expected to reduce lane changing resulting in more effective use of the additional road capacity, as well as smoother traffic flows.

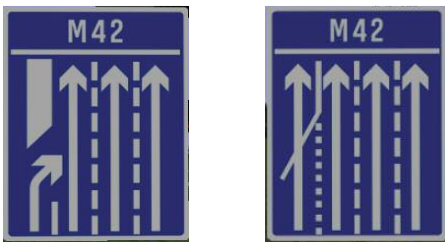


Figure 1: Signs indicating status of LBS1 as closed (left) or open (right)

In the current study, drivers were repeatedly exposed to FT TJR junctions designed to replicate the key characteristics of junction 5 on the M42 Southbound specifically. Figure 1 above illustrates the unique road signs proposed for this study, they are located at the end of the merge area and indicate the status of the hard shoulder, also referred to as Lane Below Signal 1 (LBS1). Figure 2 displays the differentiating lane markings of PT and FT TJR schemes. Note that the schematics are not drawn to scale.

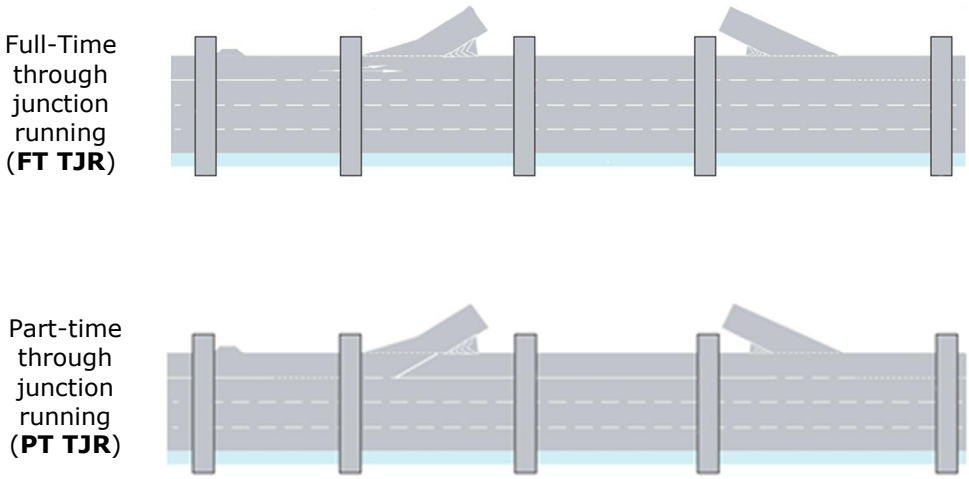


Figure 2: Schematics displaying lane markings for Full Time (FT) and Part Time (PT) through junction running schemes

Within the current study, the following issues were of particular interest:

- Understanding and responding to the signs and road markings to indicate TJR and the status of the hard shoulder (LBS1)
- Whether the different situations are comprehensible for both merging and diverging traffic
- Use of extra capacity provide by LBS1
- Comparison between Part Time and Full Time TJR
- Compliance with mixed Full Time and Part Time or non-TJR operational regimes
- Illegitimate or incorrect use of LBS1

2 Method

2.1 Participants

96 participants were recruited from the TRL participant database to take part in this study. All participants had previously been familiarised with the TRL driving simulator and all possessed a current valid driving licence. There were no particular inclusion/exclusion criteria based on previous experience of hard shoulder use.

Driving behaviour across the age range varies considerably (e.g. Schlag, 1993). Younger drivers are more likely to drive at faster speeds and more likely to engage in lane-changing behaviour. Older drivers are less likely to change lanes and therefore may fail to take advantage of the additional capacity that TJR provides. Consequently, their behaviour in response to TJR was of interest.

There were two levels of age across participants, Younger (17-44 years) and Older (45+ years) drivers. There were equal numbers of males and females in each age group.

2.2 Experimental design

Following a five-minute familiarisation drive to acquaint participants with the controls of the vehicle and allow them to settle down to normal behaviour in the simulated environment, the design required each participant to drive two routes in the simulator for a period of around 30 minutes each. In each drive, participants encountered open and closed hard shoulder sections (see Section 2.3 for detailed information on the route design). The order in which participant's drove both routes was counterbalanced to control for order effects. Each participant's session lasted for one and a half hours, and included introduction, familiarisation, and debriefing.

2.3 Route design

General features

Two routes were created consisting of approximately 28km of a 4-lane motorway containing 6 junctions. The routes incorporated 5 junctions of FT TJR and one junction of PT TJR (Route 1) and non TJR (Route 2). The road layout, signs, and lane markings in the route were based on Highways Agency documents, 'Managed Motorway Implementation Guidance – Dynamic use of the hard shoulder' and 'Managed Motorway Implementation Guidance – Through junction hard shoulder running'. Where relevant, specific design features of the M42 Junction 5 southbound were included.

The motorway surroundings were generic with fields and trees. Heavy traffic was present in both routes. Each autonomous vehicle within the simulation was programmed to follow the vehicle ahead as closely as possible. Whilst this created a high density of traffic, there did remain gaps between vehicles into which it was possible to drive the simulator vehicle.

Route Summary

The two routes differed in the placement of the FT and PT TJR sections and in the status of LBS1 (i.e. open versus closed) through the route. Table 1 and Table 2 show the configuration of the two routes. For detailed descriptions of route 1 and route 2 and associated signs it is referred to Appendix A and B.

Figure 3: Typical example of Route 1 Section 1

Figure 3 above illustrates a typical scene from Route 1, section 1. Note, LBS1 is closed with high traffic density.

Table 1 shows the configuration of the Route 1 and shows that LBS1 between junctions was closed throughout. LBS1 *within* junctions was always open with the exception of Junction 5 where PT TJR applied. This allowed for the evaluation of whether participants were conditioned into using LBS1 within junctions, and then chose to use it when it was closed. A variable speed limit (VSL) of 60mph was in place until the J3 to J4 link where it increased to 70mph and all signals were blank. Participants were asked to leave the motorway at Junction 3 and Junction 6 and rejoin the motorway from the same junctions.

Table 1: Configuration of FT TJR Route 1

		Configuration			
Section	**Length**	**TJR**	**LBS1 *in section***	**LBS1 *within jct***	**Speed limit**
Lead-in	4km	N/A	Closed	N/A	60
Junction 1	4km	FT TJR	Closed	Open	60
Junction 2	4km	FT TJR	Closed	Open	60
Junction 3	4km	FT TJR	Closed	Open	60
Junction 4	4km	FT TJR	Closed	Open	70
Junction 5	4km	PT TJR	Closed	Closed	70
Junction 6	4km	FT TJR	Closed	Open	70
Lead out	4km	N/A	Closed	N/A	70

Table 2 show the configuration of route 2. Unlike Route 1, in Route 2, LBS1 was open between junctions with the exception of the latter part of junction 5, junction 6, and the lead out. LBS1 within junctions was open throughout with the exception of junction 4 which was a non-TJR junction. A 60mph VSL applied throughout. Participants were asked to leave the motorway at Junction 3 and rejoin the motorway from the same junction.

Table 2: Configuration of FT TJR Route 2

Section	Length	Configuration			
		TJR	LBS1 *in section*	LBS1 *within jct*	Speed limit
Lead-in	4km	N/A	Open	N/A	60
Junction 1	4km	FT TJR	Open	Open	60
Junction 2	4km	FT TJR	Open	Open	60
Junction 3	4km	FT TJR	Open	Open	60
Junction 4	4km	No TJR	Open	Closed	60
Junction 5	4km	FT TJR	Open	Open	60
Junction 6	4km	FT TJR	Closed	Open	60
Lead out	4km	N/A	Closed	N/A	60

In both Route 1 and 2, LBS2, LBS3 and LBS4 were active running lanes with heavy traffic present throughout.

Figure 4: Approach to junction 1 off slip (Route 1, Section 2)

Figure 5: Exit point junction 1 on slip (Route 1, Section 2)

The illustrations above in Figure 4 and Figure 5 display diverging and merging traffic respectively. Figure 4 demonstrates operational Full Time Through Junction Running with high traffic density (note, vehicle exiting main carriageway). In Figure 5, the hard

shoulder is shown to be closed ahead with traffic filtering onto the motorway from the slip road.

2.4 Participant instructions

Participants were delivered standard instructions before driving the simulator. They were told to 'drive as you normally do' and that their 'driving was not being judged'. They were also told that they 'should not treat the simulator like a computer game'.

Following the familiarisation drive, participants were briefed regarding the purpose of Hard Shoulder Running, but participants were not given any information about the Part Time and Full Time TJR scheme prior to the trial drive. Participants were further informed that they were required to leave the motorway at junction 3 and 6 in Route 1 and Junction 3 in Route 2 and to rejoin the motorway from the same junctions. A voice instruction was in place to remind the participants at which junction they had to exit and re-enter the motorway.

2.5 Measures

For each route, analysis of behaviour focussed on the following areas:

- Lane choice
- Speed choice
- Position(s) at which drivers choose to use LBS1
- Behaviour at junctions
    - Position at which drivers move to auxiliary lane for exit
    - Position at which drivers rejoin motorway at merge
    - Response to FT TJR signs/line markings
    - Use of FT TJR

Following the two drives, participants were asked to fill out a brief questionnaire (Appendix C). In addition to the standard background information, this included questions designed to elicit participants' views on:

- Clarity/legibility of the signs designating FT TJR
- Understanding of FT TJR operation
- Confidence using FT TJR
- Clarity of the diverge/merge
- Subjective safety at the diverge/merge

Analysis focussed on these issues and differences between the Younger and Older participants.

3 Results

Following the participants' demographics, driving behaviour results are presented for Route 1 and 2 separately. The questionnaire results are then presented for Route 1 and 2 together.

3.1 Demographics

Table 3 shows information about the participants involved in the trial. It can be seen that the trial encompassed a wide range of age and experience levels.

Table 3: Demographic information for participants involved in the FT TJR trial

	Sex	N	Age (years)		Driving licence held (years)		Annual driving distance (miles)	
			Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range
Younger	M	24	29.1 (6.96)	19-42	11.6 (6.73)	2-23	16200 (9013)	8000-40000
	F	24	28.5 (7.18)	18-44	10.3 (7.15)	1-26	10125 (5643)	2000-30000
Older	M	24	59.3 (7.67)	45-72	39.8 (7.93)	26-53	9130 (3891)	3500-20000
	F	24	57.8 (8.06)	45-72	36.7 (6.89)	20-46	7312 (3113)	1500-14000
Total		96	43.4 (16.68)	18-72	24.3 (1.44)	1-53	10765 (6755)	1500-40000

3.2 Driving behaviour – Route 1

For the analysis per junction each junction was split into 4 sections as illustrated in Figure 6. Section 1 consisted of the area between gantry P28 and the nose of the diverge. Section 2 was the within junction section and was defined as the area between the nose of the diverge and merge. Section 3 consisted of the auxiliary lane between the nose of the merge to the start of the 75m taper. Section 4 consisted of the area between the start of the 75m taper and P28 gantry of the following section.

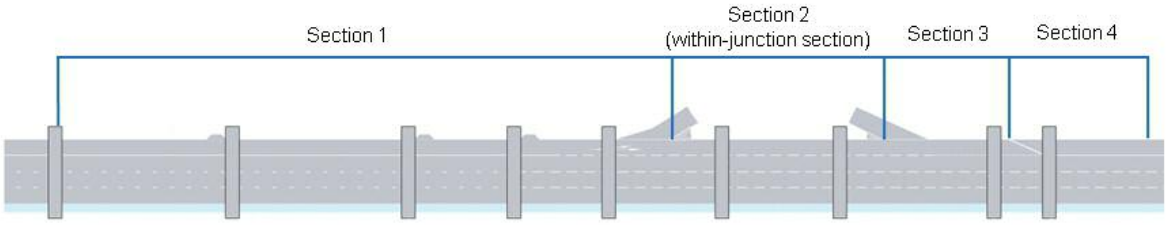


Figure 6: Diagram illustrating the 4 sections per junction

3.2.1 Lead in

The main aim of the lead in section was to allow participants to settle down to normal behaviour in the simulated environment. In addition, the lead-in section allowed for the evaluation of differences in driving speed between age categories and (il)legitimate use of LBS1. As previously observed (Schlag et al., 2003; Diels et al., 2009ab), it was found that Younger drivers drove faster than Older drivers and this difference was found to be statistically significant (t=2.477, df=91, p=.015). Regarding the use of LBS1, only two of the participants illegitimately drove in LBS1 which was closed for traffic. Note that all participants started their drive in LBS2.

3.2.2 LBS1 use in Section 2 of Junctions 1-6 Route 1

In Route 1, LBS1 in section 2 was open in all but one of the junctions (junction 5). To evaluate if and to what extent participants made use of the additional capacity provided within the junction, the number of participants and their percentage use of LBS1 was calculated and is shown in Table 4. Note that participants left and subsequently rejoined the motorway in junctions 3 and 6, and consequently, no percentage use was calculated for these junctions.

It can be seen that only few participants (± 7%) drove in LBS1 in section 2 in each junction. If participants drove in LBS1 section 2, however, they tended to use it for a considerable proportion of the time. More detailed description of lane usage (including LBS1) will be provided for each junction individually in the following sections.

Table 4: Number of participants (n) who used LBS1 in sections 2, Route 1 (including mean percentage of time spent in LBS1 for those participants)

LBS1 usage sections 2	Junction 1	Junction 2	Junction 4	Junction 5
n	6	6	8	0
Percentage use	54%	58%	68%	n/a

3.2.3 Junction 1

In junction 1, LBS1 was closed for traffic in all sections except for section 2. Results showed that none of the participants illegitimately drove in LBS1.

Table 5 shows the percentage lane use in Junction 1 for the Younger and Older participants. In line with previous findings of the PT TJR study, the percentage use across the three running lanes (LBS2-4) was fairly evenly spread, whereas, compared to Younger drivers, Older drivers tended to drive in LBS2 and were less inclined to drive in LBS4. These effects were found to be statistically significant ($p<.014$).

Table 5: Percentage lane use Junction 1 (Route 1) by age category

	LBS1	LBS2	LBS3	LBS4
Young	0.8%	28%	35%	35%
Old	1.0%	48%	31%	17%
Total	0.9%	37%	33%	26%

Figure 7 shows the position of 1st entry (left) and position of last exit (right) of the 6 participants using LBS1 in section 2 of junction 1. It can be seen that all participants returned to LBS2 in a timely manner with signs indicating closure of LBS1 in section 3.

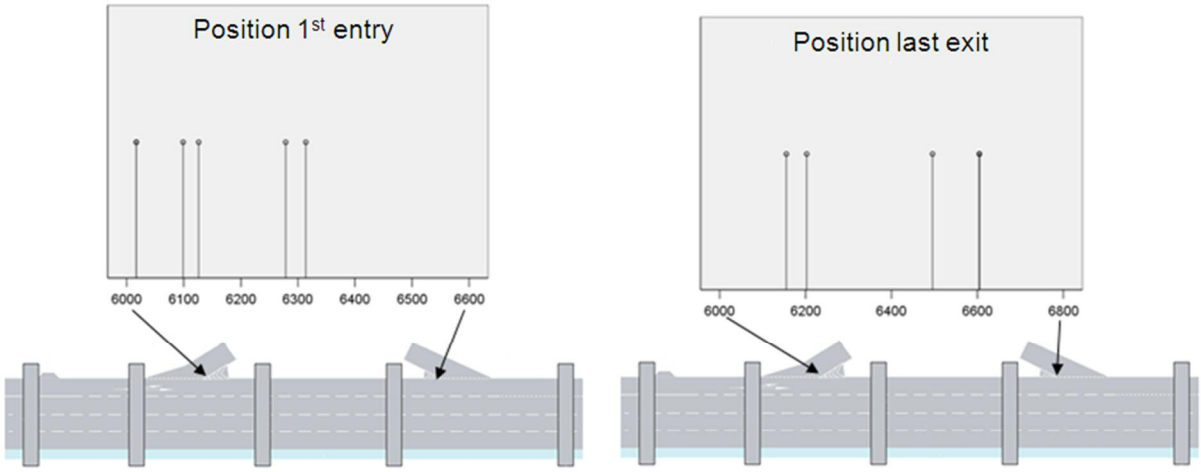


Figure 7: Position first entry and last exit LBS1 section 2 (Junction 1, route 1)

3.2.4 Junction 2

Junction 2 was similar to junction 1, but differed in the amount of traffic which was heavier than in junction 1. As per junction 1, LBS1 was closed for traffic in all sections except for section 2. In section 1, none of the participants illegitimately made use of LBS1. Only one participant failed to return to LBS2 in section 3 after driving in LBS1 throughout section 2. This participant stayed in LBS1 for only a short period of time in section 4 before finally changing lanes into LBS2.

Table 6 shows the percentage lane use in Junction 2 for the Younger and Older participants. As also observed for junction 1, Older drivers tended to use LBS2 and LBS3 and to a lesser extent LBS4.

Table 6: Percentage lane use Junction 2 (Route 1) by age category

	LBS1	LBS2	LBS3	LBS4
Young	0.7%	25%	37%	35%
Old	0.9%	42%	41%	12%
Total	0.8%	33%	39%	24%

The positions of first entry and last exit into LBS1 in section 2 of the six participants who did make use of LBS1 within junction 2 are displayed in Figure 8. It can be seen that if participants decided to use LBS1 in section 2, participants did so at the start of the section. As for junction 1, all participants returned to LBS2 timely in advance of the lane closure in section 3 as indicated by gantry signs.

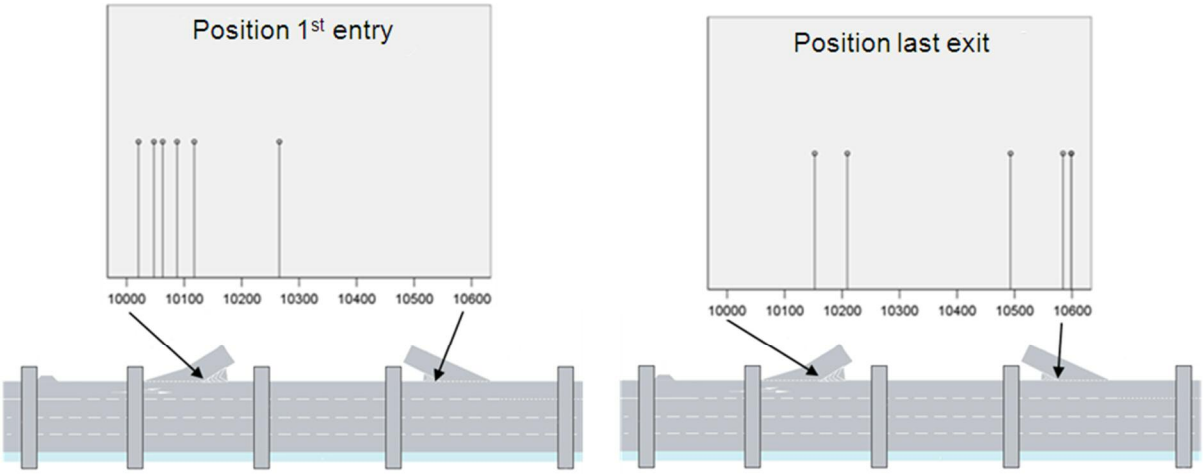


Figure 8: Position first entry and last exit LBS1 section 2 (Junction 2, route 1)

3.2.5 Junction 3

At junction 3, participants were asked to leave and rejoin the motorway. With the exception of section 2, LBS1 was closed for traffic. Of particular interest at this junction was: 1) the position relative to the exit datum point at which participants choose to enter LBS1 at diverge, and 2) the position at which participants rejoined the motorway in LBS2.

Figure 9 (left) shows the positions where participants entered LBS1 before exiting the motorway. It can be seen that the vast majority entered LBS1 close to the exit datum point (the start of the exit slip road). Only one (Older) participant crossed the solid white line to enter LBS1 which, at that point (± 700 metres in advance of the exit datum point), was closed to traffic.

Figure 9 (right) shows the positions where participants entered LBS2 after rejoining the motorway as LBS1 was closed for traffic in sections 3 and 4. It can be soon that the vast majority of participants entered LBS2 almost immediately upon re-entrance. 23 out of 96 participants (24%) stayed in LBS1 beyond the end of the on-slip but entered LBS2 in time and did not illegitimately make use of LBS1.

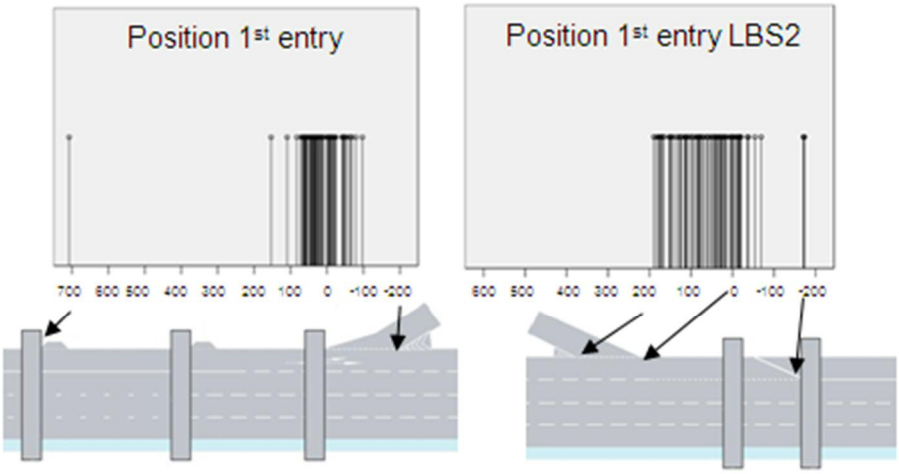


Figure 9: Position of first entry into LBS1 before leaving the motorway at Junction 3 (left); Position of first entry into LBS2 after re-entering the motorway (right)

3.2.6 Junction 4

In junction 4, LBS1 was open to traffic in section 2, after which the hard shoulder running scheme ended as indicated by blank gantry signs. In section 1, none of the participants illegitimately drove in LBS1. With LBS1 open to traffic in section 2, 8 out of 96 participants (see also Table 4) chose to use LBS1. All 8 participants correctly moved from LBS1 into LBS2 on approach to section 3. 2 Participants entered LBS1 from LBS2 in section 3, before reverting again to LBS2 in section 4.

3.2.7 Junction 5

LBS1 within junctions was always open with the exception of Junction 5 where Part Time TJR applied. This allowed for the evaluation whether participants were conditioned into using LBS1 within junctions and then chose to use it when it was closed. However, as already indicated, none of the participants drove in LBS1 in section 2 (see also Table 4). In fact, LBS1was not used throughout junction 5 at all.

3.2.8 Junction 6

Junction 6 was again configured as a FT TJR junction with LBS1 open to traffic within the junction. As in junction 3, participants were asked to leave and rejoin the motorway at this junction. The vast majority entered LBS1 close to the exit datum point (P24 in Figure 10); however four participants entered LBS1 prior to the lane becoming open. This number of participants, even though small, could suggest that the blank gantries might attract drivers into LBS1.

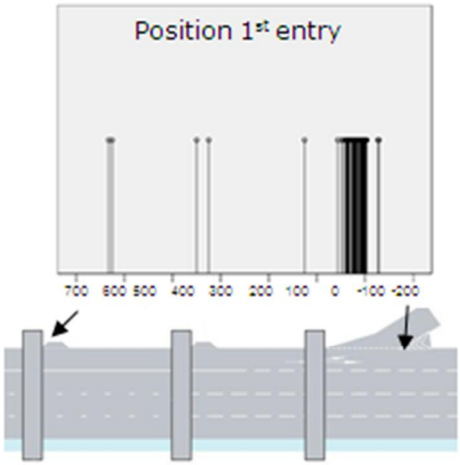


Figure 10: Position of first entry into LBS1 before leaving the motorway at Junction 6 (Route 1)

In line with previous studies (Diels et al., 2009ab), Older drivers tended to re-enter the motorway at slightly lower speeds than Younger drivers (see Figure 11), although the difference failed to reach statistical significance (P>.05).

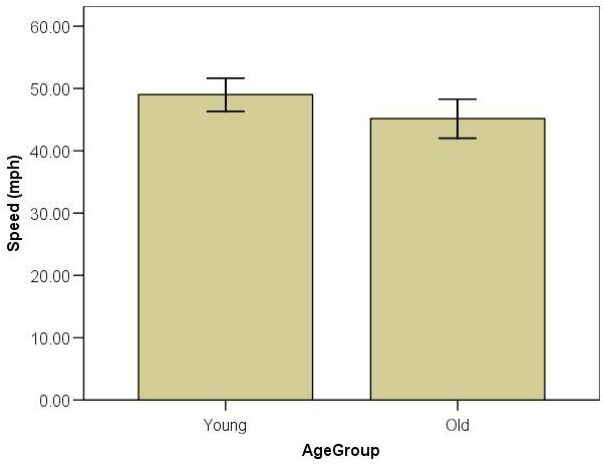


Figure 11: Mean speed (mph) upon re-entering the motorway (Junction 6, route 1) as a function of age category

3.3 Driving behaviour – Route 2

3.3.1 Lead in

As for Route 1, all participants started their drive in LBS2. Unlike Route 1, however, LBS1 was open to traffic in Route 2. Table 7 shows the percentage lane use in the lead in section for the Younger and Older participants as well as the total across both groups. Generally, most drivers did not use LBS1 even though it was open; most drivers remained in LBS2 (7.7% LBS1, LBS2 66.1%). In line with the findings in Route 1, Older drivers were less likely to use the faster lanes (LBS3, LBS4) when compared to the Younger drivers. Also, Younger drivers drove again faster than Older drivers and this difference was found to be statistically significant ($t(93) = 3.46$, $p < .01$).

Table 7: Percentage lane use lead-in section (Route 2) by age category

	LBS1	LBS2	LBS3	LBS4
Younger	7.8%	58.4%	16.5%	17.3%
Older	7.5%	74.2%	10.4%	5.8%
Total	7.7%	66.1	13.5%	11.7%

3.3.2 Overview of lane use within Junction 1-6

To provide an overview of the use of the additional capacity provided by opening of LBS1 within the FT TJR scheme, Table 8 shows the percentage use for LBS1-4 for each of the 6 junctions.

Table 8: Percentage use of LBS1-4 in each junction

Junction	LBS1	LBS2	LBS3	LBS4
1	18%	34%	23%	24%
2	20%	43%	21%	15%
3	66%	29%	2%	2%
4	8%	47%	26%	19%
5	5%	33%	40%	20%
6	2%	22%	54%	22%

As expected, the percentage use of LBS1 in junction 3 was considerably higher compared to the other junctions as participants were asked to leave and rejoin the motorway at this junction. Percentage use of LBS1 in junction 4, on the other hand, was low. This was because in this non-TJR junction participants were unable to drive in LBS1 in section 2 (within-junction section) and failed to make use of the additional capacity in section 3 and 4 despite LBS1 being open to traffic. This suggests that drivers are less likely to use LBS1 after leaving it. Finally, note further that the percentage use of LBS1 in junction 6 was much lower since LBS1 was closed to traffic in this junction. The overall percentage use of LBS1 in full-time TJR junctions without any lane closures (i.e. average percentage use of junction 1 and 2) was 19%, similar to that found for the PT TJR scheme (Diels et al., 2009a).

3.3.3 LBS1 use in Section 2 of Junctions 1-6

Table 9 shows the number of participants making use of LBS1 in section 2, as well as their percentage use. Although a direct comparison is not possible, it is of interest to compare LBS1 use with that in Route 1. It is apparent that a larger number of participants made use of LBS1 in section 2 when LBS1 was open in section 1, 3, and 4 as was the case in Route 2.

Table 9: Number of participants (n) who used LBS1 in sections 2, Route 1 (including mean percentage of time spent in LBS1 for those participants)

LBS1 usage sections 2	Junction 1	Junction 2	Junction 5	Junction 6
n	31	27	14	7
Percentage use	82%	77%	43%	37%

3.3.4 Junction 1

Junction 1 was the first junction where participants encountered FT TJR with LBS1 open to traffic throughout. As already shown in Table 8, a substantial number of drivers (regardless of age) took advantage of the increase in capacity presented by LBS1 being open.

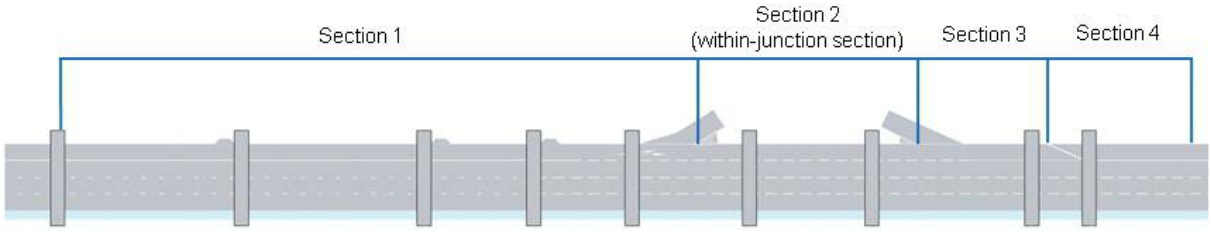
As also found for Route 1, a difference in pattern of lane choice between age groups was observed (Table 10) whereby Older drivers spent more time in LBS2 than younger drivers and vice versa for LBS4. None of the differences however reached statistical significance ($p > .05$).

Table 10: Percentage lane use in Junction 1 (Route 2) by age category

	LBS1	LBS2	LBS3	LBS4
Younger	18%	30%	24%	29%
Older	18%	39%	22%	19%
Total	18%	34%	23%	24%

Table 11 shows the percentage use for each of the four sections within junction 1 for participants who drove in LBS1 in at least one of the four sections. It can be seen that only 2 participants drove in LBS1 in all four sections. 24 participants made use of LBS1 in section 1, with the majority continuing to use LBS1 in section 2. 10 participants moved into LBS1 in section 2, with a considerable number of participants leaving LBS1 upon entering section 3. A further 8 participants moved into LBS1 only upon entering section 4. The results seem to suggest that participants are less likely to make use of LBS1 in section 3, the section that coincides with traffic merging onto the motorway, whereas beyond this point (section4), LBS1 use increased again.

Table 11: Percentage use LBS1 per section Junction 1 (Route 2)



Pp	Section 1	Section 2	Section 3	Section 4
1	100	100	100	100
2	100	100	100	100
3	100	100	94	60
4	100	100	0	0
5	100	70	23	79
6	86	99	0	0
7	72	46	0	61
8	72	0	0	0
9	60	100	100	68
10	57	100	100	14
11	55	83	0	0
12	48	0	0	51
13	44	83	0	0
14	36	0	0	0
15	26	98	64	43
16	25	58	0	0
17	23	0	0	0
18	21	100	100	55
19	7	92	0	0
20	6	100	100	65
21	5	91	0	89
22	2	100	100	100
23	1	100	100	80
24	0	83	0	69
25	0	89	100	100
26	0	79	100	100
27	0	74	100	100
28	0	72	100	100
29	0	70	0	29
30	0	68	100	100
31	0	55	0	0
32	0	50	60	100
33	0	48	0	62
34	0	47	32	100
35	0	0	100	100
36	0	0	100	100
37	0	0	0	73
38	0	0	0	64
39	0	0	0	39
40	0	0	0	30
41	0	0	0	28
42	0	0	0	26
43	0	0	0	15
44	0	0	0	14
45	0	0	0	11

3.3.5 Junction 2

The layout of Junction 2 was identical to Junction 1 and was the second FT TJR junction with LBS1 open throughout. Table 12 displays the mean time spent in each lane for all participants and by age category. Clearly, LBS2 was the most popular lane with participants using it 43% of the time, regardless of age category. Use of the other three lanes was fairly evenly spread.

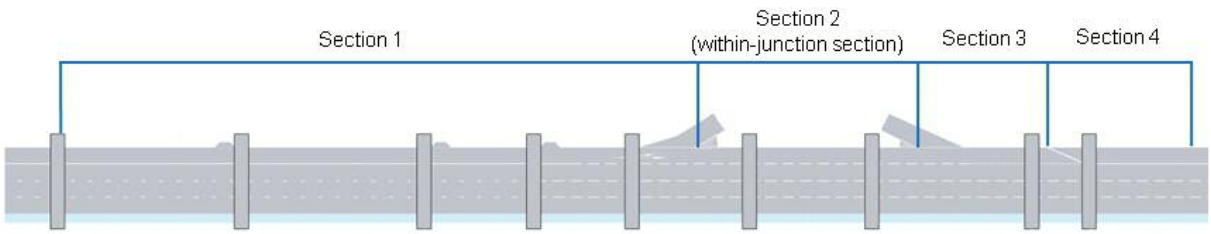
Table 12 shows the percentage use for each of the four sections within junction 2 for participants who drove in LBS1 in at least one of the four sections. It shows the increase in LBS1 use in comparison to junction 1. It further reflects participants' tendency to leave LBS1 on approach to section 2 and 3, likely due to diverging and merging traffic. Again, as for junction1, a considerable proportion of participants entered and moved back into LBS1 in section 4. This suggests that drivers are less likely to make use of LBS1 in sections 2 and 3.

Table 12: Percentage lane use in Junction 2 (Route 2) by age category

	LBS1	LBS2	LBS3	LBS4
Younger	17%	43%	20%	20%
Older	23%	43%	22%	9%
Total	20%	43%	20%	15%

Table 13 shows the percentage use for each of the four sections within junction 2 for participants who drove in LBS1 in at least one of the four sections. It can be seen that only 2 participants drove in LBS1 in all four sections. 42 participants made use of LBS1 in section 1, with the 24 continuing to use LBS1 in section 2. 10 participants moved into LBS1 in section 2, and 20 participants left LBS1 upon entering section 3. As observed in junction 1, the results seem to suggest that participants are less likely to make use of LBS1 in section 3, the section that coincides with traffic merging onto the motorway, whereas beyond this point (section4), LBS1 use increased again.

Table 13: Percentage use LBS1 per section Junction 2 (Route 2)



Pp	Section 1	Section 2	Section 3	Section 4
1	100	100	100	100
2	100	100	100	100
3	100	100	0	45
4	100	100	0	0
5	100	95	0	0
6	100	77	0	27
7	100	58	0	27
8	96	0	0	0
9	85	100	0	0
10	80	56	0	0
11	70	100	0	0
12	69	100	0	0
13	69	0	0	20
14	66	73	0	23
15	60	92	100	100
16	60	64	0	0
17	58	0	0	0
18	57	0	0	0
19	56	0	0	27
20	53	0	0	25
21	53	0	0	0
22	51	91	0	58
23	49	78	0	0
24	47	54	100	64
25	46	0	0	0
26	45	0	0	10
27	44	0	0	92
28	37	52	100	100
29	35	0	0	0
30	33	88	0	49
31	30	0	0	0
32	27	0	0	24
33	26	0	0	32
34	24	42	0	0
35	18	0	0	31
36	13	16	0	0
37	12	0	0	0
38	4	0	0	6
39	3	0	0	52
40	2	100	100	32
41	2	0	0	0
42	1	80	0	0
43	0	88	0	0
44	0	82	0	0
45	0	76	0	0
46	0	28	100	58
47	0	0	100	100
48	0	0	0	86
49	0	0	0	82
50	0	0	0	41
51	0	0	0	40
52	0	0	0	37
53	0	0	0	28
54	0	0	0	13
55	0	0	0	12
56	0	0	0	10
57	0	0	0	4
58	0	0	0	4
59	0	0	0	0
60	0	0	0	0

3.3.6 Junction 3

The layout of Junction 3 was the same as for Junction 1 and Junction 2; again, LBS1 was open throughout. However, in junction 3, participants were required to exit and rejoin the motorway. As for Route 1 when participants were required to exit and rejoin the motorway, of particular interest at this junction was: 1) the position relative to the exit datum point at which participants choose to enter LBS1 at diverge, and 2) the position at which participants rejoined the motorway in LBS2.

Figure 12 displays the points at which participants entered LBS1 (those who entered more than 800m in advance of the exit datum point are not displayed). It can be seen

that, overall, participants entered LBS1 in good time to conveniently leave the motorway. It also displays the point at which participants rejoined LBS2 after rejoining the motorway (note, LBS1 was open to traffic in sections 3 and 4, therefore there was no need to depart LBS1 for LBS2, however, 35 participants chose to change lanes within 200 metres of the end of the on-slip).

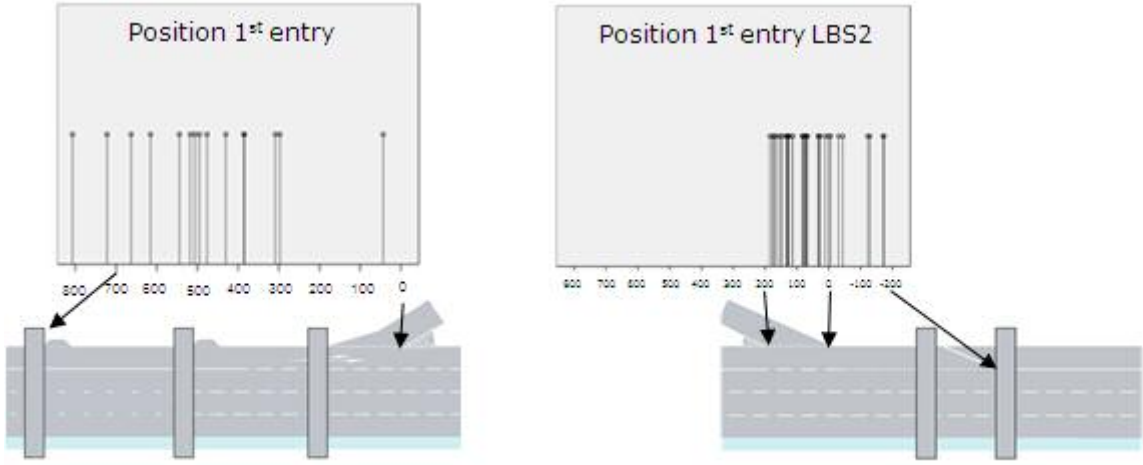


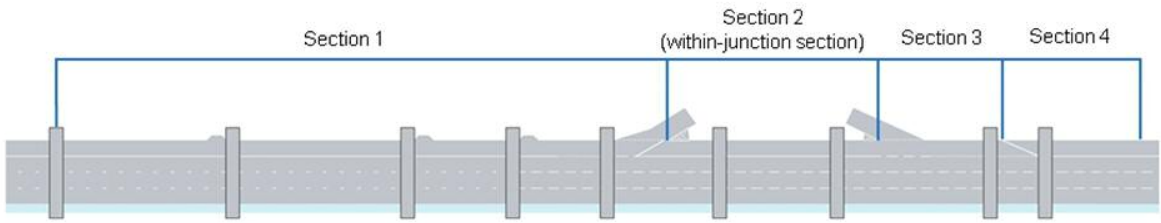
Figure 12: Positions of first entry into LBS1 before leaving the motorway at Junction 3, and first entry into LBS2 on rejoining the motorway (Route 2)

As for junction 3 in route 1, Older drivers tended to rejoin the motorway at slightly lower speeds (mean = 37mph, SD=9.9mph) compared to Younger drivers (mean=39mph, SD=11.5mph), although the difference were small and not statistically significant (p>.05).

3.3.7 Junction 4

Junction 4 was the non-TJR junction and allowed for the evaluation of participants' response to a non-TJR junction after having encountered several FT TJR junctions at this point. LBS1 was closed within the junction (section 2), and open elsewhere. As can be seen in Table 14, 4 participants (4%) drove in LBS1 in section 2, despite the overhead gantries indicating it was closed for use. It can be seen that 3 out of 4 participants, all of which were in the Older driver category, drove in LBS1 for a significant proportion of the time (> 45%). All four non-compliant participants had left LBS1 by section 4 (where it was legal to use the lane). This might indicate a lack of confidence in which lanes are open for traffic.

Table 14: Percentage use LBS1 per section Junction 4 (Route 2)

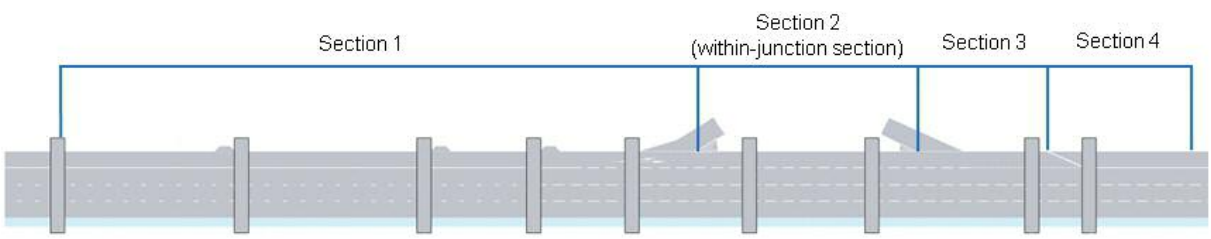


Pp	Section 1	Section 2	Section 3	Section 4
1	88	0	0	97
2	88	0	100	100
3	87	9	0	0
4	86	100	61	0
5	71	0	0	76
6	64	0	0	0
7	59	45	0	0
8	51	0	0	0
9	48	0	26	91
10	34	0	0	0
11	34	0	100	36
12	28	0	0	0
13	28	0	0	0
14	27	0	0	0
15	17	0	0	0
16	12	0	0	0
17	10	0	0	0
18	9	0	0	0
19	6	0	0	0
20	0	74	0	0
21	0	0	69	100
22	0	0	0	96
23	0	0	0	92
24	0	0	0	80
25	0	0	0	67
26	0	0	0	57

3.3.8 Junction 5

LBS1 was closed in section 4 of Junction 5. As shown in Table 15, no driver entered LBS1 in section 4, in accordance with the information displayed on the overhead gantries. When compared to junction 1 and 2, the proportion of participants driving in LBS1 in section 1 appears to be low. One possible explanation is that in the preceding junction 4, LBS1 was closed in section 2 forcing participants into LBS2. As observed before, once out of LBS1, drivers tend to be less inclined to revert to LBS1. LBS1 usage in junction 5 may be relatively low as a consequence of LBS1 closure in the preceding junction 4.

Table 15: Percentage use LBS1 per section Junction 5 (Route 2)



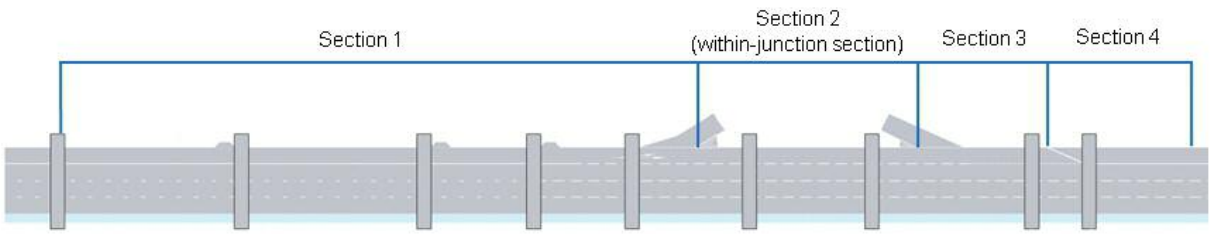
Pp	Section 1	Section 2	Section 3	Section 4
1	100	27	0	0
2	100	25	0	0
3	82	0	0	0
4	69	41	0	0
5	63	39	0	0
6	56	0	0	0
7	53	29	0	0
8	51	25	0	0
9	50	96	0	0
10	39	0	0	0
11	38	0	0	0
12	31	0	0	0
13	31	0	0	0
14	29	34	0	0
15	28	0	0	0
16	25	26	0	0
17	9	0	0	0
18	4	90	0	0
19	1	38	0	0

20	1	0	0	0
21	0	75	88	0
22	0	45	0	0
23	0	6	0	0

3.3.9 Junction 6

Finally, within Junction 6, LBS1 was closed, except within the junction and the merge area (sections 2 and 3). From Table 16 we can see that the vast majority adhered to the lane closure with only one participant briefly driving in LBS1. Section 2 was only used by seven participants. 2 participants drove in LBS1 in section 3 but subsequently changed into LBS2 in response to the red cross above LBS1.

Table 16: Percentage use LBS1 per section Junction 6 (Route 2)



Pp	Section 1	Section 2	Section 3	Section 4
1	3	28	0	0
2	0	78	65	0
3	0	55	0	0
4	0	37	0	0
5	0	34	6	0
6	0	16	0	0
7	0	8	0	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0

3.4 Questionnaire

3.4.1 C1 - Attitude towards TJR

Following the two drives, participants were asked to rate their level of agreement with six statements (*a-f*) related to Through Junction Running (refer to Appendix C). Figure 3 shows the mean level agreement to each of the six statements (1=strongly disagree; 5=strongly agree). Overall, there was no difference in confidence between older and younger participants. This is in contrast to what was found for PT TJR, where older participants tended to be less confident in the PT TJR scheme compared to that of younger participants. A Mann-Whitney test was performed on each of the six statements which showed no statistical difference between Older and Younger participants. Since there was no significant main effect of age, in the below, each of the statements are discussed for the Younger and Older participants combined.

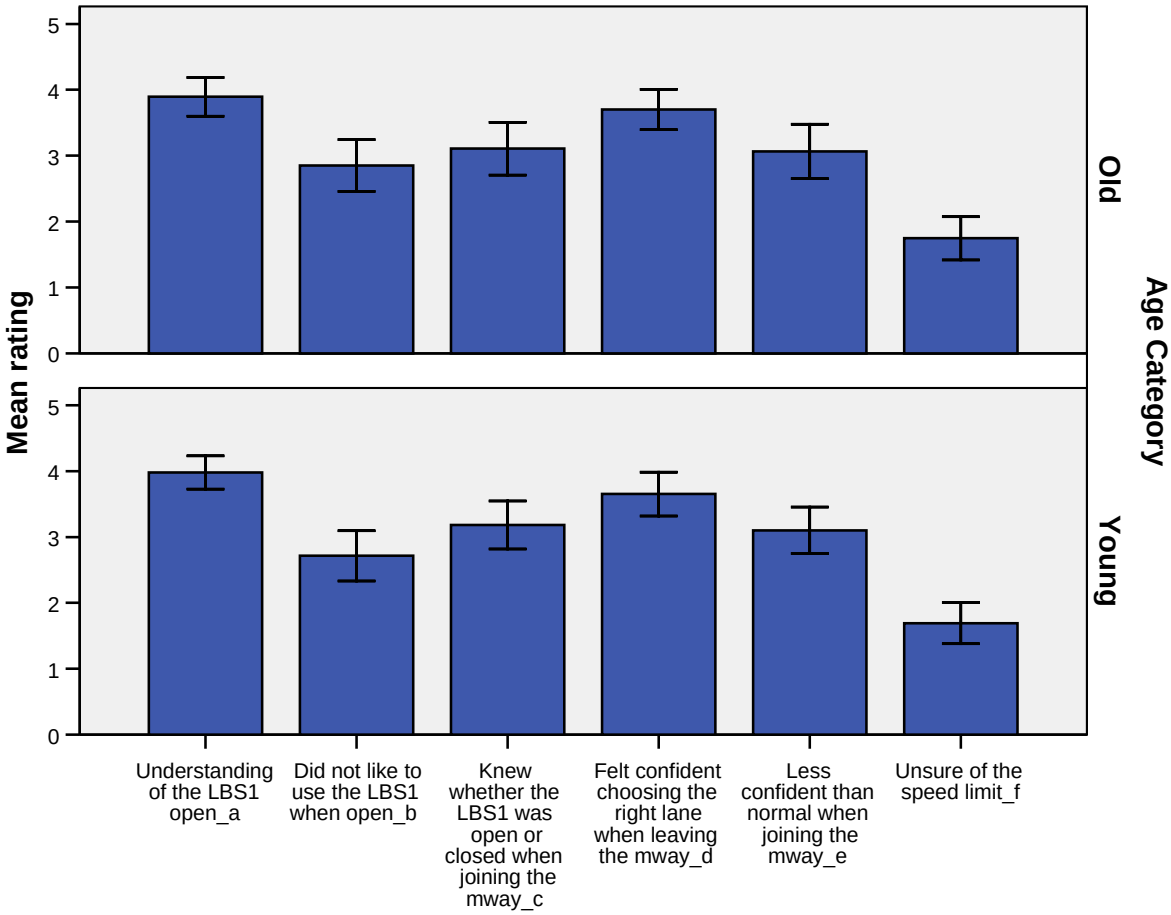


Figure 13: (C1) Mean level of agreement with regard to TJR statements. Error bars indicate the 95% Confidence Interval (95% CI) (n=47). 1=strongly disagree; 5=strongly agree

The mean rating related to statement *a* (*"I found it easy to understand when the hard shoulder was open as a normal running lane")* was 4, and suggests that participants were clear whether it was allowed to use LBS1 as a normal running lane. This result mirrored the findings of the PT TJR study.

The mean rating related to statement *b* (*"I did not like to use the hard shoulder when it was open as a normal running lane")* was 2.8, identifying a weak dislike of the use of LBS1. Again, a similar result (2.9) was found in the PT TJR study.

Statement *c* ("*I knew whether the hard shoulder was open or closed as a normal running lane when joining the motorway*") revealed a mean rating of 3.2 which suggested a very slight agreement with the statement, indicating that participants were not completely clear as to the status of LBS1 upon rejoining the motorway. The same score was obtained in the PT TJR study.

The mean rating for statement *d* ("*I felt confident choosing the right lane when trying to leave the motorway*") was 3.7, which suggests that participants were relatively confident as to whether they were in the correct lane. A similar rating was reported in the PT TJR study.

The mean rating of 3.1 was related to statement *e* ("*I was less confident than I would normally when joining the motorway*") suggesting participants were slightly less confident than normal. A similar result (3.5) was obtained in the PT TJR study.

In the last statement *f* ("*I was unsure of the speed limit that applied through the drive*") a rating of 1.7 was reported. The same score was also found in the PT TJR study, suggesting that overall it was clear to participants what the specific speed limit was.

Overall, the results are in line with the PT TJR study and suggests that in both TJR schemes participants express a slight dislike of using the hard shoulder as a running lane, and tend to be less confident when rejoining the motorway. It should be noted that the comparison with joining the motorway normally (non-TJR) should be interpreted with care considering that the current study did not include non-TJR drives.

Unlike the PT TJR study, the current study showed no effects of age category. In particular, in the PT TJR study, older participants were considerably less enthusiastic using the hard shoulder as a normal running lane. The current finding suggests that in a Full Time TJR scheme, older drivers may be less reluctant to use to use the hard shoulder.

3.4.2 C2 - Effectiveness of TJR features

Question C2 asked participants to rate how effective different road features (i.e. line markings, road signs and gantry information) were in informing them as to which lanes were available. Figure 4 illustrates the mean effectiveness ratings for each of the three road features (0=ineffective; 10=very effective). It can be seen that gantry information was rated most effective, followed by road signs, with line markings deemed to be the least effective. The same trend was observed in the PT TJR study. Wilcoxon signed ranks tests showed gantry information to be significant more effective than both line markings and road signs ($p<0.05$).

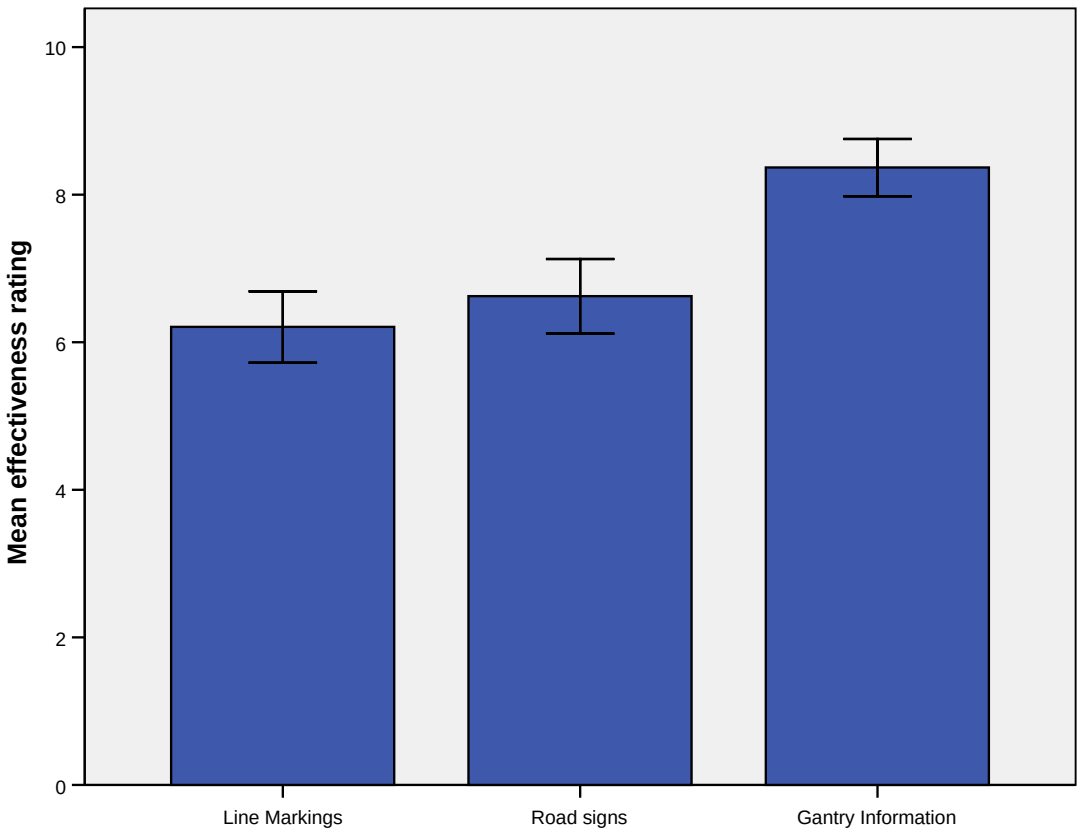


Figure 14: (C2) Mean effectiveness rating of different road features in indicating availability of lanes (95% CI)

3.4.3 C3 - Permitted lanes and speed

Question C3 asked participants in what lanes they were permitted to drive when the VSL gantry signs were blank and no further information was given. 17 out of 96 (17.7 %) of participants (12 of which were in the older category), incorrectly stated it was permitted to drive in LBS1. A similar result was obtained in the with the PT TJR study (13 out of 69 (18.8%), 11 older participants). These results suggest that the absence of gantry information results in confusion as to the lane status of the hard shoulder, and in particular for older drivers. Note however that this finding is not specific to TJR but HSR in general.

There was no difference found between age groups in terms of confidence rating as to the correctness of their answer. Overall participants were very confident that their response to question C3 was correct (Mean=8.12; SD=2.2) based on their responses using a scale in which 0 represented feeling *very unconfident* and 10 represented feeling *very confident*.

Table 3 shows the frequency distribution of answers to the question what the speed limit was for cars on this road with all signs on the gantry blank. 6 participants incorrectly answered that the speed limit was 60 mph, with 5 of this number being members of the older group. Similar results were obtained in the PT TJR study with the vast majority indicating the correct speed limit.

Table 17: Number of participants indicating speed limit with blank gantry (C3)

	40	50	60	70	No limit
n	0	0	6	90	0

3.4.4 C4 - Permitted lanes (i)

Question C4 asked participants what lanes they were permitted to drive in when the VSL gantry signs indicated a VSL of 60mph, a red cross above LBS1, and no further information displayed on the VMS sign (Appendix C.1, picture 2). The correct answer in this instance was LBS2, 3 & 4 which 93 participants accurately reported. Table 18 shows that only three participants gave incorrect answers. Two older participants incorrectly answered that all four lanes were permitted to drive, and one younger participant believed LBS1, 2 & 3 to be the correct answer. Participants were very confident in their answer to this question with a mean of 9.1 (SD=1.9). When asked the speed limit, all but four participants (two older and two younger) correctly indicated the speed limit to be 60mph. Again, these findings are in line with the PT TJR study indicating that both lane status and speed limit was clear to the vast majority of participants.

Table 18: Number of participants indicating the lanes permitted to drive in when VSL gantry signs display a red cross above LBS1

	LBS2,3 & 4	LBS1,2,3 & 4	LBS1,2 & 3
n	93	2	1

3.4.5 C5 – Permitted lanes (ii)

This question asked participants to identify the lanes in which they were legitimately permitted to drive when staying on the motorway and continuing on the M42, the gantry VMS signs were all blank. Under these conditions, drivers are allowed to use all four lanes. Table 19 shows the number of participants incorrectly indicating not being permitted to use LBS1-4. A majority of participants correctly understood what lanes were available and were confident in the answer given (Mean=8.5; SD=2.0).

However, 23 out of 96 participants (24%) incorrectly stated that they were not allowed to use LBS1 to continue on the motorway. This suggests that a high proportion of participants were not clear whether or not they were allowed to use LBS1. In respect of the previous PT TJR study, the percentage was significantly lower (15.9%), with 11 participants incorrectly answering this question. Note that in the PT TJR scheme, however, an additional VMS sign was mounted on the gantry to indicate the status of LBS1.

Table 19: Number of responses from participants incorrectly indicating not being permitted to use LBS1-4

	LBS1	LBS2	LBS3	LBS4
n	23	1	1	0

3.4.6 C6 – Permitted lanes (iii)

This question refers to the same road and sign layout as described in question C5; participants were asked which lane they could legitimately use to leave the motorway.

The vast majority identified the correct lane as LBS1, with a high mean confidence level of 8.2 (SD=2.2).

However 19 participants (20%) answered this question incorrectly (Table 20). 10 participants stated that LBS1 & LBS2 could both be used to exit the motorway; within this response 8 were from the older driver category. Three (two older) participants indicated that only lane LBS2 could be used as the exiting lane. Furthermore four participants (three older) incorrectly answered LBS2, 3 and 4, and two participants (one older and one younger) suggested that all four lanes could be used to exit the motorway. Overall 14 participants in the older group answered incorrectly, indicating there potentially is slight confusion over which lane to use to legitimately exit with dynamic use of the hard shoulder. In contrast, in the PT TJR study which included the additional VMS sign to indicate the status of LBS1, with 12%, the proportion of participants providing an incorrect answer was lower.

Table 20: Number of participants incorrectly indicating lanes used to exit the motorway

	LBS1 & 2	LBS2	LBS2, 3 & 4	LBS1, 2, 3 & 4
n	10	3	4	2

3.4.7 C7 – Permitted actions (i)

Question C7 asked participants what to do when encountering a gantry showing a red cross above LBS1, a VSL of 60mph above LBS2-4 and a miscellaneous informatory sign indicating LBS1 to be closed. Participants were allowed to select multiple options that they thought were applicable under these conditions. The different options and the number of participants selecting each of the options are showing in Table 21. It was shown that all but four participants were aware that LBS1 was closed. It was also clear to the participants what the correct speed limit was, as only one participant answered this statement incorrectly. 89% participants correctly indicated that traffic could potentially merge from LBS1 showing a general awareness to the implications of LBS1 being closed. Participants were confident of the answers they had given with a mean score of 8.3 (SD=1.9).

It can be noted that similar results were found in the PT TJR study, as unlike the FT TJR trial a VMS sign was operating in the PT TJR study (Please note, that the VMS signs in the previous study were additional to the gantry and road signs indicating the status of the hard shoulder upon rejoining the motorway). Only one participant indicated that LBS1 was a normal running lane and no participant incorrectly stated the speed limit to be 70mph. Both sets of participants were comparable in terms of awareness of traffic merging from LBS1.

Table 21: Behavioural options and number of participants selecting each with gantry configured accordingly to C7

Option	Use LBS1 as a normal running lane	Use LBS2 as a normal running lane	Use LBS3 as a normal running lane	Use LBS4 as a normal running lane	Drive at 70mph	Drive at 60mph	Beware of traffic merging from LBS1
n	4	92	91	89	1	92	85

3.4.8 C8 – On-slip verge sign (i)

Question C8 asked participants to describe the meaning of the new on-slip sign indicating LBS1 to be open. All but 9 out of 96 participants correctly answered that the sign indicates LBS1 to be used a normal running lane upon entering the motorway. Participants were confident of their answer to this question with a mean of 7.4 (SD=2.3).

Examples of incorrect answers given were:

"Lanes B, C and D only"

"Three outside lanes only"

"?" (Respondent put a question mark in the box provided)

"You must give way the lane markings are irrelevant"

"The inside lane is the hard shoulder initially but then becomes a normal hard shoulder - not a running lane, (however not very clear")

3.4.9 C9 – On-slip verge sign (ii)

Question C9 was identical to C8 with the difference that the on-slip verge sign indicated LBS1 to be *closed* instead of open. Most participants understood the correct meaning of the sign, i.e. to indicate that LBS1 is closed and LBS2-4 are available as normal running lanes only. Participants were confident of their answer to this question with a mean of 7.4 (SD=2.2), reflecting a similar confidence rating to the C8.

However, 21 out of 95 (21%) participants provided answers that indicated they did not comprehend the meaning of the sign. This is a significant proportion and suggests the sign is not completely self-explanatory.

Examples of incorrect answers were as follows:

"Same as above"

"?" (two participants responded with a question mark).

"Traffic merging onto motorway"

"The lane I am joining in has a much shorter run onto the motorway than normal"

"The same as the first but with a smaller filter lane"

"You must give way twice on the first lane"

"Merging traffic to wait to join lane"

"Right of way"

3.4.10 C10 – Permitted actions (ii)

Question C10 asked participants whether they would be allowed to use LBS1 if they wanted to leave the motorway at Junction 4. Participants referred to a picture where the VSL displayed a 60mph limit across all four lanes and a VMS showed the text *"Use hard shoulder for junction 4 only"*. All but one participant correctly stated that it was allowed to use LBS1 under these conditions. A confidence level of 9.2 suggested that participants were very confident of their answers (SD=1.7). The PT TJR study's results mirrored that of the FT TJR indicating that the signs clearly conveyed the intended message.

3.4.11 C11 – Permitted action (iii)

Question C11 referred to whether participants would consider undertaking using the hard shoulder if their progress was affected by heavy, slower moving traffic. Results for this question varied with 18 participants selecting *"Definitely would not"* at one end of the scale and with nine participants stating they *"definitely would".* The mean at 5.4 reflected the differences in answers (SD=3.1). It could be noted however that the decision to undertake may not be directly affected by the hard shoulder. This may reflect general driving behaviour not specific to TJR.

3.4.12 D1 – Confidence

Question D1 asked participants how confident they feel about driving on motorways with sections where the hard shoulder could be opened as a normal running lane. On a scale from 0 (very unsure) to 10 (very confident), the mean confidence rating was 7.0 (SD=2.0) with younger drivers being slightly more confident.

3.4.13 D2 – Difference to travel

Question D2 asked participants what difference to TRAVEL they thought the use of the hard shoulder as a normal running lane might have. On a scale from 0-10 (0=much worse; 5=no change; 10 much better) the mean score of 6.8 (SD=2.1) indicated that participants believed that hard shoulder running would have a positive effect on travel. Older participants tended to be slightly more sceptical as to its benefits although this difference was found not to be significant.

3.4.14 D3 – Difference to safety

Question D3 asked participants what difference to SAFETY they thought the use of the hard shoulder as a normal running lane might have. Employing the same scale (0=much worse; 5=no change; 10 much better), the mean score of 3.7 (SD=2.0) indicated that the participants thought that hard shoulder running could compromise safety. Again older participants tended to be slightly more negative about the safety impact hard shoulder running might have. However differences were small and did not reach statistical significance.

The above statements from section D of the questionnaire can be directly compared to that of PT TJR. Results were shown to be similar throughout with no or very little difference between the answers. For example the means for the question *"difference to safety"* were found to be 3.9 for PT TJR and 3.7 for FT TJR showing that participants in both studies were concerned about the safety aspect of using the hard shoulder as a dynamic lane. Participants were also well matched in terms of their confidence score concerning driving on the motorway when regions of the hard shoulder are open with only a 0.1 difference between the scores of 7.1 (PT TJR) and 7.0 (FT TJR).

3.4.15 D4 – Comments

The final question from the questionnaire gave the participants an option to write down any comments they might have from the two drives completed in the trial. The comments are included in full in Appendix D.

In the comments section at the end of the questionnaire, a variety of observations were put forward by participants. Mixed impressions of Through Junction Running were found; with several stating that using the hard shoulder as a running lane to reduce congestion was a good method, examples from participants are as follows:

> *"I have used the hard shoulder on the M40 and I think it is great".*
>
> *"I think that the use of the hard shoulder is good and would increase capacity, but it will take time for people to get used to it".*
>
> *"Once you know it our confidence and ability would increase…"*
>
> *"I found it easy to understand when I could not use the hard shoulder including at junctions. Very good information provision".*
>
> *"Routes are fine".*

However safety issues were also raised. For example:

> *"I believe it would relieve some of the congestion but people would still not use the correct lanes when not that busy".*

> *" If there were refuge areas at regular intervals this would be much safer and I would feel happier about driving on the hard shoulder as you would be less likely to hit a broken down vehicle".*

Participants overall found the general use of the hard shoulder relatively straight forward; however concerns were raised over the procedure in LBS1 when accidents occurred and the effects this would have on safety:

> *"I think using the hard shoulder would make traffic run smoother sometimes until someone breaks down then it might make that traffic dangerous trying to merge into (normally) Lane 1 when other drivers aren't paying attention".*

> *"The use of the hard shoulder worries me when it comes to emergencies and all 4 lanes are blocked. How are the emergency services especially fire engines going to get through…"*

> *"If a vehicle breaks down when the hard shoulder is open, that time interval until it can be closed is potentially very dangerous both for the stranded motorist and following drivers".*

Participants also expressed that clearer signs were needed to inform drivers of the status of the hard shoulder when rejoining the motorway:

> *"Most was ok and easy to follow. Only merging when joining from a slip road was sometimes misleading/confusing. Possibly a gantry over the slip road with directions on which lanes are open would help".*

> *"Need to be clearer about the rules for using the hard shoulder. Seems to make joining and exiting the motorway worse".*

4 General discussion

The aim of this study was to investigate drivers' responses to a simulated Full Time Through Junction Running (FT TJR) scheme under conditions of high traffic density. Participants drove two routes with Lane Below Signal 1 (LBS1) closed (Route 1) or open (Route 2) in the majority of sections. The results from Route 1 are discussed first, followed by those from Route 2. 4.3 discusses the results of the questionnaire, and 4.4 and 4.5 discuss the implications of the all the results of the study in relation to network performance and safety considerations respectively.

4.1 Route 1

In route 1, LBS1 was open within junctions 1, 2, 3, 4 and 6, and closed for the rest of the route. When considering the level of contravention, it was observed that the vast majority adhered to the signs indicating LBS1 to be closed to traffic. This suggests that the red cross displayed on the gantries was well understood and effective in preventing drivers from using LBS1 as a normal running lane. These findings are in line with previous studies that also showed the level of contravention to be very low (Diels et al., 2009ab).

It was further found that only few participants made use of the extra capacity provided by opening of LBS1 within the junctions. If participants drove in LBS1, they returned to LBS2 before the start of the on-slip, possibly to avoid any potential conflict with merging traffic. Approximately 7% of participants made use of LBS1 for some time. This is a desirable outcome as sudden lane changes in and out of LBS1 within a junction are unlikely to be advantageous in the context of road safety and traffic flow.

Leaving and rejoining the motorway when LBS1 was closed to traffic did not seem to cause any apparent difficulties for participants. This may not be surprising as with LBS1 closed as this represents the current non-TJR traffic situation on most UK motorways.

With the gantry signs turning blank in junction 4, it was observed that all participants correctly understood that LBS1 was not open to traffic and none of them illegitimately drove in LBS1, again indicating participants correctly understanding lane status on the basis of provided signs.

4.2 Route 2

In route 2, LBS1 was open for the whole route except for within junction 4 and between junctions 5 and 6. The overall percentage of LBS1 use on the approach to a FT TJR junction was 19% and mirrors the percentage use observed in the study investigating use of additional capacity within the Part Time TJR scheme (Diels et al., 2009a).

When comparing overall LBS1 use within junctions in Route 1, it is apparent that a larger number of participants made use of LBS1 within a junction when LBS1 was open in the upstream and downstream sections as was the case in Route 2. This may not be surprising as in the latter case; there is no need for participants to change lanes.

One of the main findings was that, similar to the PT TJR scheme, participants tended to use LBS1 between junctions, but changed into LBS2 on their approach to the junction, even though LBS1 remained open to traffic. This suggests that participants are less inclined to use LBS1 within junctions. In addition, participants were also less likely to make use of LBS1 in the section that coincides with traffic merging onto the motorway, whereas beyond this point, LBS1 use increased again.

The finding that drivers are less likely to make use of LBS1 within the junction and in the merge area was also observed in the previous Part Time TJR study. This was initially ascribed to participants' reluctance to cross the solid white line that crosses LBS1 and delineates the offside of the diverge. However, within the FT TJR scheme the solid white line is absent. The fact that a similar pattern is observed in both FT and PT TJR studies

suggest that participants are more reluctant to make use of LBS1 within the junctions. This might be because drivers want to avoid potential conflicts with merging traffic. It is also possible that participants were unfamiliar with Through Junction Running and it would be of interest to consider their behaviour over time. It is likely that once accustomed to the new traffic situation provided by TJR, a higher LBS1 usage within junctions would be observed.

Junction 4 was configured as a non-TJR junction. Four Older participants used LBS1 within this junction despite the road markings and signals indicating that it was closed to traffic. All other participants drove in LBS1, indicating that for most participants it was clear that LBS1 was closed to traffic. As for route 1, this suggests that the red cross displayed on the gantries was well understood and effective in preventing drivers from using LBS1. Similarly, in junction 5 and 6, participants did not make inappropriate, or illegal, use of LBS1.

It is of interest to note that in junction 5, the percentage use of LBS1 in section 1 was considerably lower compared to junction 1 and 2 in which this section was also open to traffic. One possible explanation for this is that, in general, participants are less inclined to revert to LBS1 once they have left this lane. Thus, the closure of LBS1 within junction 4 forced participants to leave LBS1. Although LBS1 was opened again in the following sections, relatively few participants returned into LBS1. As such, LBS1 closure (within a junction in this case), appears to have a knock-on effect further downstream and illustrates the advantage of Full Time TJR in that drivers are more likely to make use of the additional capacity in LBS1 in subsequent sections.

4.3 Questionnaire

Overall, the results of the questionnaire were largely in line with those obtained in the Part Time TJR study (Diels et al., 2009a). Participants reported to be clear whether it was allowed to use LBS1 as a normal running lane; reported a weak dislike of the use of LBS1; tended to feel slightly less confident than normal; where clear as to the current speed limit. It is of interest to note that similar to the PT TJR study, participants were not completely clear as to the status of LBS1 upon entering the motorway. This suggests that current signs employed on the on-slip may not be fully comprehended and alternative designs may be considered.

4.4 Network performance interpretation

To maximise network performance, any effects that would reduce capacity should be minimised. Ideally, there should be a balanced use of the available lanes and no unnecessary lane changing.

FT TJR is a less complex version of PT TJR. The permanent conversion of the hard shoulder to a running lane within a junction means that less complicated signalling is required within the junction, and that the road markings are less confusing than for PT TJR.

The primary aim of FT TJR is to increase hard shoulder utilisation on the upstream link, by allowing through traffic to use LBS1 on the approach to a junction. FT TJR also provides additional capacity through a junction, but this is often not necessary. It is rare that the section though a junction is a cause of flow breakdown. This is particularly the case when the upstream or downstream links do not have HSR; these links will have a lower capacity than the through-junction section.

If LBS1 is not available on the upstream and downstream sections, then there is unlikely to be any advantage in drivers using LBS1 through a junction, as they will be forced to return to LBS2 for the next link. Indeed, if many drivers chose to use LBS1 within a junction in these circumstances, the additional lane changing would result in a loss of

capacity. The simulator trial has shown that this is unlikely to be an issue, as very few drivers use LBS1 within a junction if LBS1 was closed in the upstream section.

If LBS1 is open to traffic on both of the upstream and downstream sections at a junction, then TJR will provide a capacity benefit in those sections, especially when little traffic leaves or joins at the junction. Traffic will be able to use LBS1 in the upstream section, even if it is not leaving the motorway. This will increase the available roadspace in the upstream section for through traffic. During periods of high flow, this will result in a reduction in congestion. The simulator trial has suggested that 19% of through traffic would use LBS1 on the approach to a junction with TJR, which would result in a more balanced lane utilisation than when LBS1 is closed through a junction.

TJR has the potential to cause additional congestion at merge areas, whether or not LBS1 is available further downstream. If flows in LBS1 though a junction are high, this could cause problems for merging traffic, resulting in additional braking and weaving in the merge area (and also further downstream). These additional conflicts would reduce the capacity. However, the simulator trial has shown that there is unlikely to be a significant drop in capacity. The majority of drivers in LBS1 through a junction chose to move out into LBS2 prior to the merge area, thereby allowing merging traffic to join the motorway more easily. This pattern of lane changing will cause less congestion than if all lane changing manoeuvres were carried out further downstream.

The simulator trial has provided information on the effects of FT TJR with medium to high flow levels. At very high flow levels, with associated flow breakdown and queuing, traffic behaviour might change. Drivers will be tempted to use LBS1 within the junction, as they might perceive a short-term gain. However, the additional lane changing required immediately downstream would result in a loss of capacity overall, and therefore additional congestion. It would be beneficial to retain traffic in three lanes through the junction, but the permanent conversion of LBS1 to a running lane makes this more difficult.

4.5 Safety interpretation

A simulator study can provide useful indications of potential safety issues arising from the use of TJR based on driver behaviour. This section considers those issues that may need to be addressed in the future design of TJR layouts and signalling from the point of view of safety.

Overall, the findings suggest that safety standards are unlikely to be compromised by the use of TJR.

There are, however, potential safety issues related to lane changing. As discussed in section 4.4, certain FT TJR scenarios (i.e. when LBS1 is closed on upstream and downstream links) may lead to increased lane changing.

It is of some concern from the results of the questionnaire that participants were relatively unsure whether they were permitted to use LBS1 when no information was displayed on the gantries. There is also some confusion about which lanes are permitted to be used to exit from the motorway. These misunderstandings are likely to increase driver stress and may have safety implications.

Participants also thought that hard shoulder running might reduce safety. However, it must be recognised that the participants were relatively unfamiliar with the various configurations, and that in practice drivers would become much more familiar with what they were permitted and not permitted to do as their experience increased over time.

5 Conclusions

- Driving behaviour indicated that the majority of participants understood and complied with the regulations of FT TJR
- A significant proportion chose to use the additional network capacity provided by FT TJR. However, participants tended to move out of LBS1 as they approached merge areas
- The signs indicating the status of the motorway on the on-slip verge were not well understood by all participants. However, behaviour in the simulated conditions indicated compliance
- The results of this study were largely positive indicating a good understanding and use of the scheme without compromising road safety

Acknowledgements

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Glossary of terms and abbreviations

ERA: Emergency Refuge Area

FT TJR: Full Time Through Junction Running

HS: Hard Shoulder

HSR: Hard Shoulder Running

LBS1: Lane Below Signal 1 (The Hard Shoulder)

LBS2: Lane Below Signal 2

LBS3: Lane Below Signal 3

LBS4: Lane Below Signal 4

PT TJR: Part Time Through Junction Running

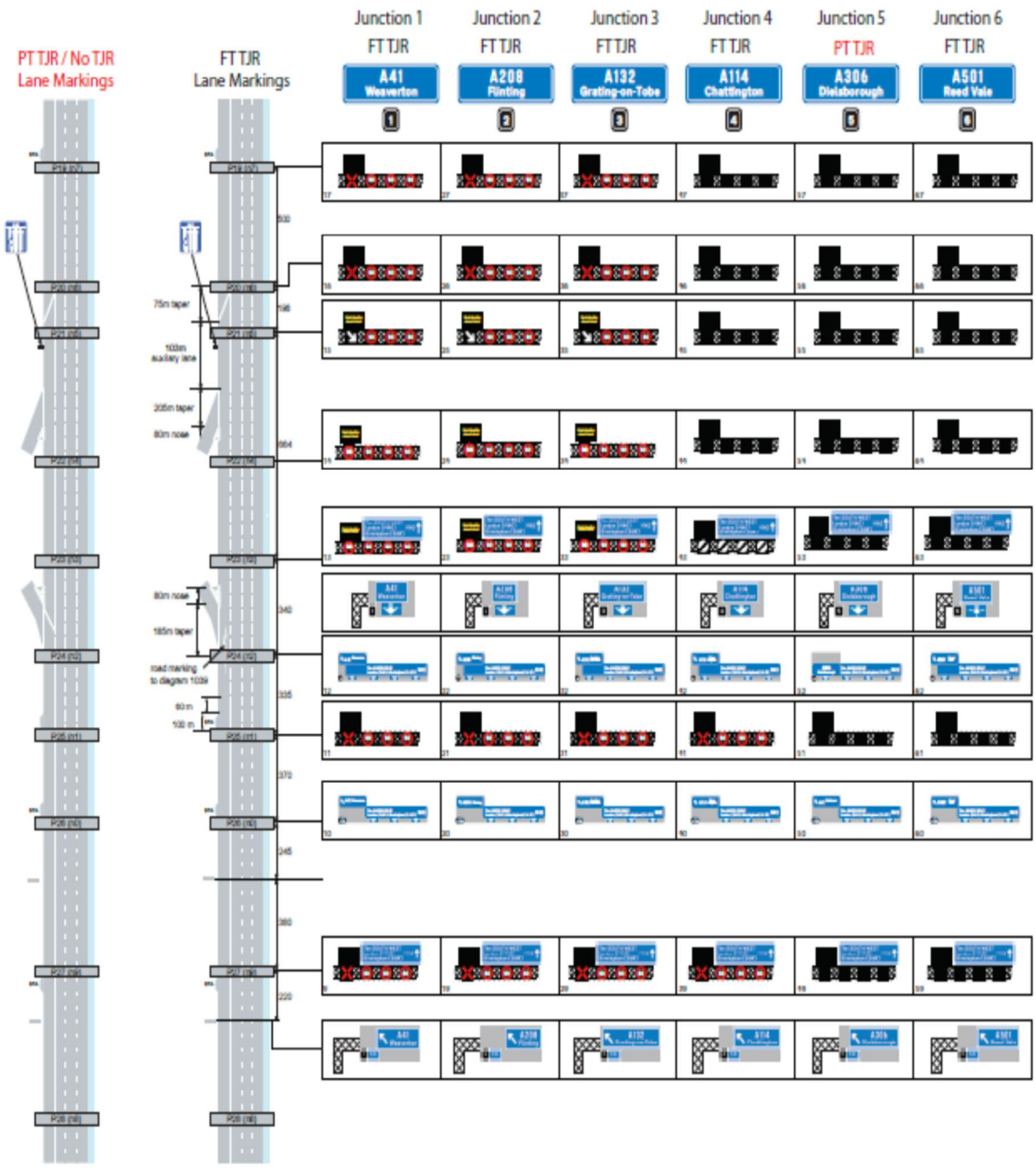
TJR: Through Junction Running

TO: Traffic Officer

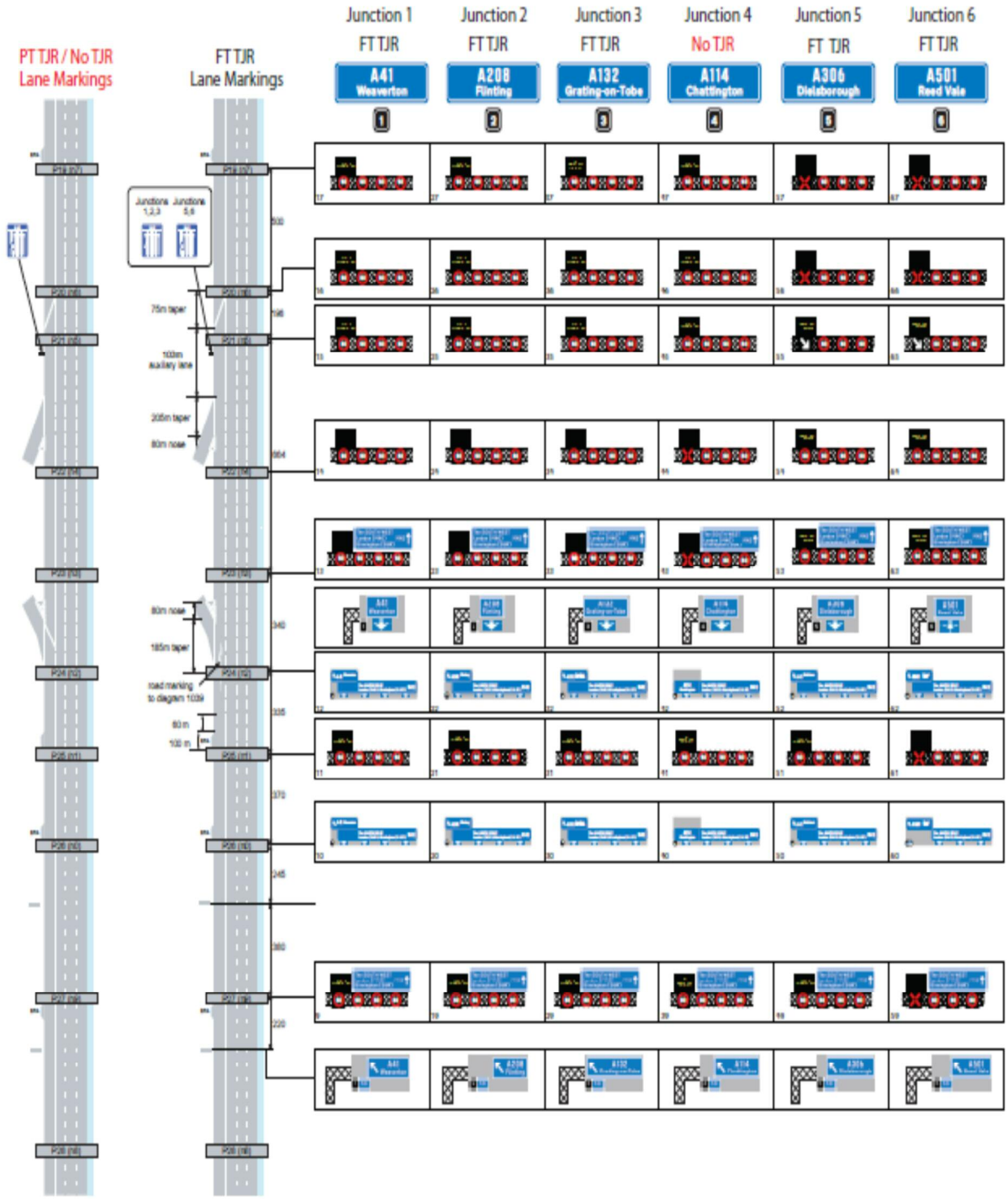
VMS: Variable Message Sign

VSL: Variable Speed Limit

Appendix A Route 1 overview



Appendix B Route 2 overview



Appendix C Questionnaire

To be completed by TRL	
Participant Number: _____	Date of Trial: _____/_____/_____

Driving Simulator Study

SECTION A
DRIVER PROFILE

Note:

- All information on this form is confidential.
- It will be stored securely at TRL.
- No information will be used by other projects at TRL.
- No individuals will be identified.

A1.	Name		
A2.	What was your age at your last birthday?		
A3.	Are you Male or Female (tick)?		
Male		*Female*	
A4.	How many years have you held a full driving licence?		
A5.	Approximately how many miles have you driven in the last year?		
A6.	What type of vehicle(s) do you drive (tick all those that apply)?		
		Motorcycle	
		Car	
		Light Goods Vehicle	
		Heavy Goods Vehicle	

SECTION B YOUR DRIVING										
(Please circle the number that you feel is most appropriate)										
B1. In general, do you enjoy driving?										
Completely dislike driving										*Thoroughly enjoy driving*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
B2. On how many days do you drive in a typical week?										
	Never									*Everyday*
	0	*1*	*2*	*3*	*4*	*5*	*6*	*7*		
B3. How confident do you feel when driving?										
Very unconfident										*Very confident*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
B4. How confident do you feel when driving on motorways?										
Very unconfident										*Very confident*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

SECTION C					
C1. Following your experience of the motorway scheme in the two drives, please rate your level of agreement with the listed statements by placing a tick in one of the boxes to the right of each statement					
	Strongly disagree				*Strongly agree*
a. I found it easy to understand when the hard shoulder was open as a normal running lane.					
b. I did not like to use the hard shoulder when it was open as a normal running lane.					
c. I knew whether the hard shoulder was open or closed as a normal running lane when joining the motorway.					
d. I felt confident choosing the right lane when trying to leave the motorway.					
e. I was less confident than I would normally be when joining the motorway.					
f. I was unsure of the speed limit that applied through the drive.					

C2. The lanes that were available as normal running lanes changed dynamically through the two drives.

Please rate how effective you felt different road features were in informing you as to which lanes were available.

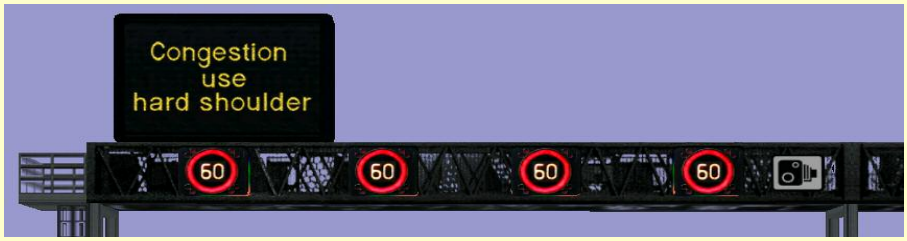
a. Line markings? E.g.

Very ineffective										*Very effective*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

b. Road signs? E.g.

Very ineffective										*Very effective*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

c. Gantry information? E.g.



Very ineffective										*Very effective*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

C3.	Referring to PICTURE 1									
a.	In which lanes are cars permitted to drive? ***(Please circle all those that you think apply).***									
Lanes:										
			A	*B*	*C*	*D*				
b.	How confident are you that your answer to C3a is correct?									
Very unconfident										*Very confident*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
c.	What is the speed limit for cars on this road? ***(Please circle the one that you think applies).***									
Speed limit (mph)										
	40	*50*	*60*	*70*	*No limit*					
C4.	Referring to PICTURE 2									
a.	In which lanes are cars permitted to drive? ***(Please circle all those that you think apply).***									
Lanes:										
			A	*B*	*C*	*D*				
b.	How confident are you that your answer to C4a is correct?									
Very unconfident										*Very confident*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
c.	What is the speed limit for cars on this road? ***(Please circle the one that you think applies).***									
Speed limit (mph)										
	40	*50*	*60*	*70*	*No limit*					

C5.	Referring to PICTURE 3
a.	Imagine you are staying on the motorway and continuing on the M42. In which lanes could you legitimately drive to stay on the M42? ***(Please circle all those that you think apply).***

Lanes:

	A	*B*	*C*	*D*

b.	How confident are you that your answer to C5a is correct?

Very unconfident										*Very confident*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

C6.	Referring to PICTURE 3
a.	Imagine you are leaving the motorway. In which lane(s) could you legitimately drive to exit at this junction? ***(Please circle all those that you think apply).***

Lanes:

	A	*B*	*C*	*D*

b.	How confident are you that your answer to C6a is correct?

Very unconfident										*Very confident*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

C7.	Referring to PICTURE 4
a.	When driving on the motorway, you come across a gantry showing this information. What should you do? ***(Please tick all those that you think apply).***

Use lane A as a normal running lane	
Use lane B as a normal running lane	
Use lane C as a normal running lane	
Use lane D as a normal running lane	
Drive at 70mph	
Drive at 60mph	
Beware of traffic merging from lane A	

b.	How confident are you that your answers to C7a are correct?									
Very unconfident										*Very confident*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
C8.	Referring to PICTURE 5									
a.	When joining the motorway, you come across a sign showing this information. Please describe what this sign means in terms of the lanes that are used as normal running lanes?									
b.	How confident are you that your answer to C8a is correct?									
Very unconfident										*Very confident*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
C9.	Referring to PICTURE 6									
a.	When joining the motorway, you come across a sign showing this information. Please describe what this sign means in terms of the lanes that are used as normal running lanes?									
b.	How confident are you that your answers to C9a are correct?									
Very unconfident										*Very confident*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

C10.	Referring to PICTURE 7									
a.	If you wanted to leave the motorway at junction 4, would you be allowed to use the lane marked 'A'?									
				Yes				*No*		
b.	How confident are you that your answer to C10a is correct?									
Very unconfident										*Very confident*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
C11.	If the hard shoulder within a junction was open and your progress on the remaining lanes would be hampered by heavy traffic, would you consider undertaking the slower moving traffic using the hard shoulder?									
Definitely would not										*Definitely would*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	

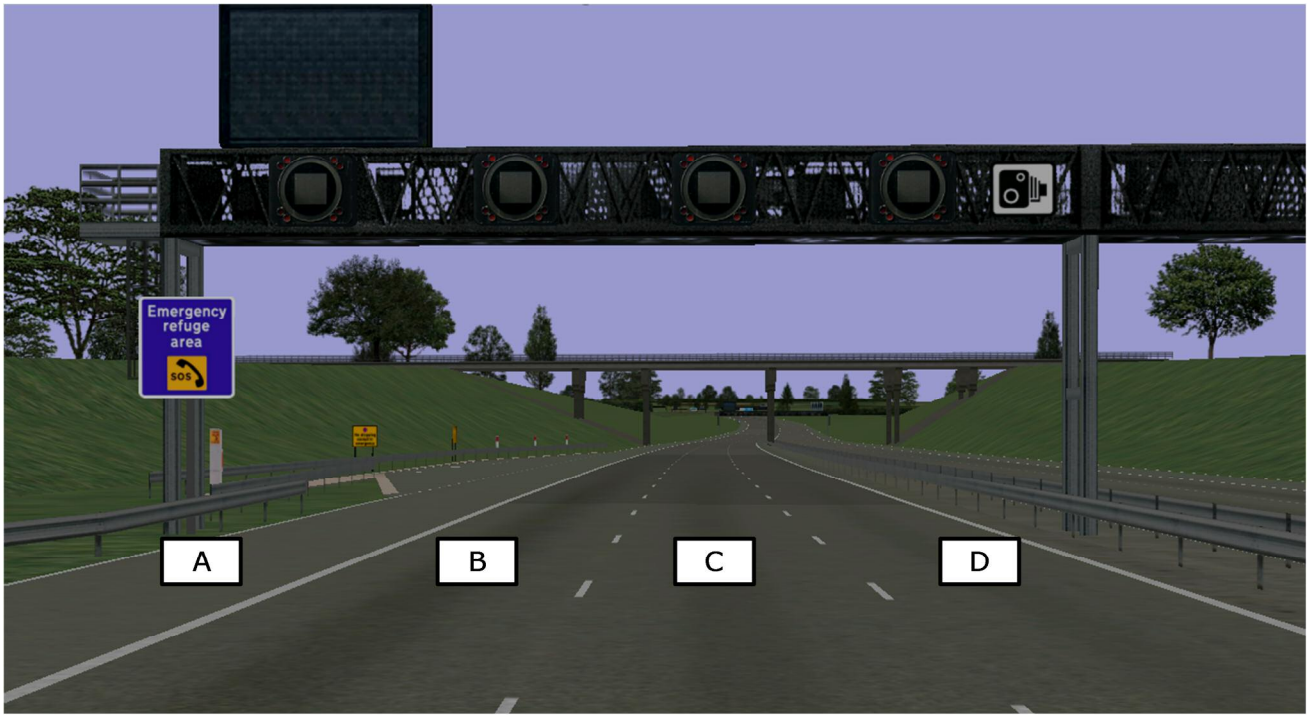
SECTION D GENERAL COMMENTS										
D1.	How confident would you feel about driving on motorways with sections where the hard shoulder could be opened as a normal running lane?									
Very unsure										*Very confident*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
D2.	What difference to **TRAVEL** do you think use of the hard shoulder as a normal running lane might have?									
Much worse					*No change*					*Much better*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
D3.	What difference to **SAFETY** do you think use of the hard shoulder as a normal running lane might have?									
Much worse					*No change*					*Much better*
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
D4.	Please give us any general comments you have about driving on the simulated routes									

End of Questionnaire

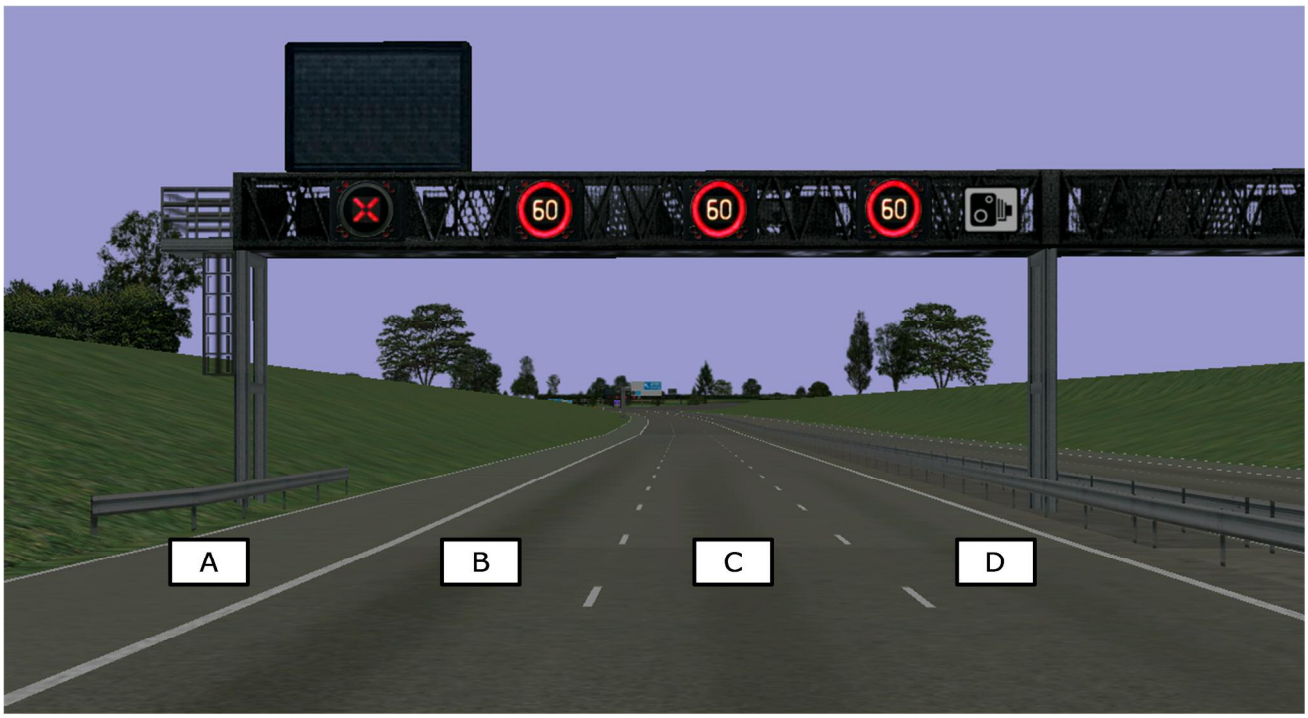
Thank you very much for your participation in this study.

C.1 Accompanying pictures for reference

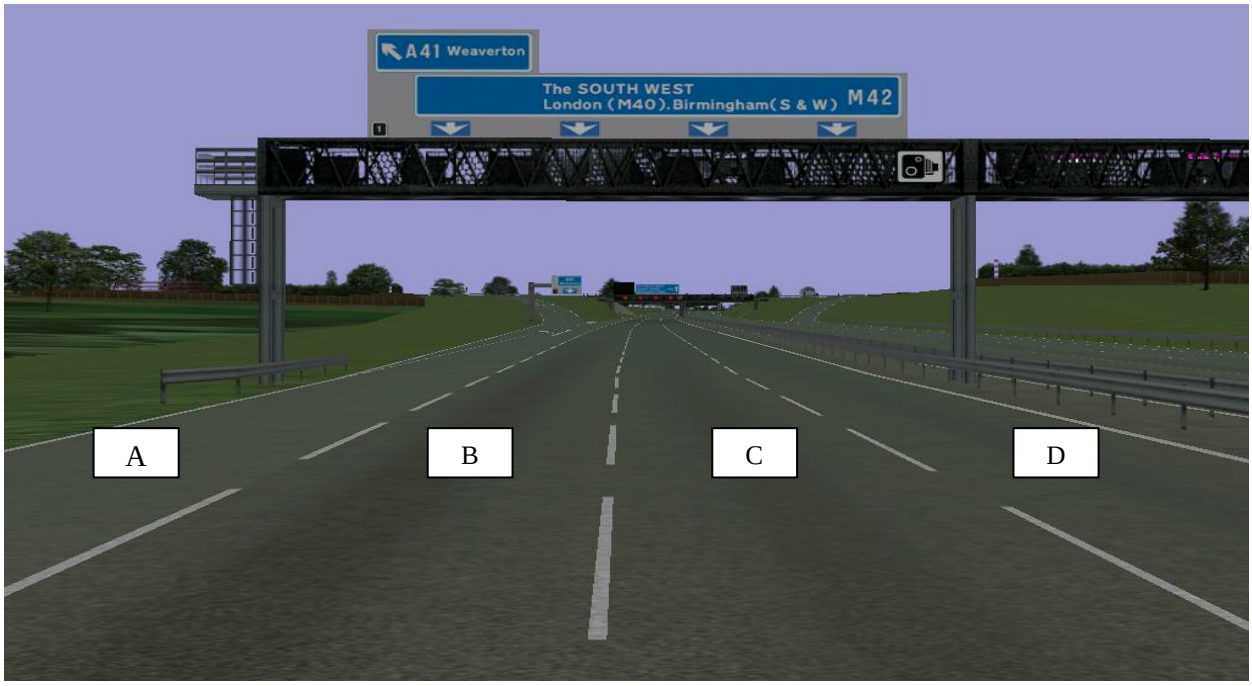
Picture 1



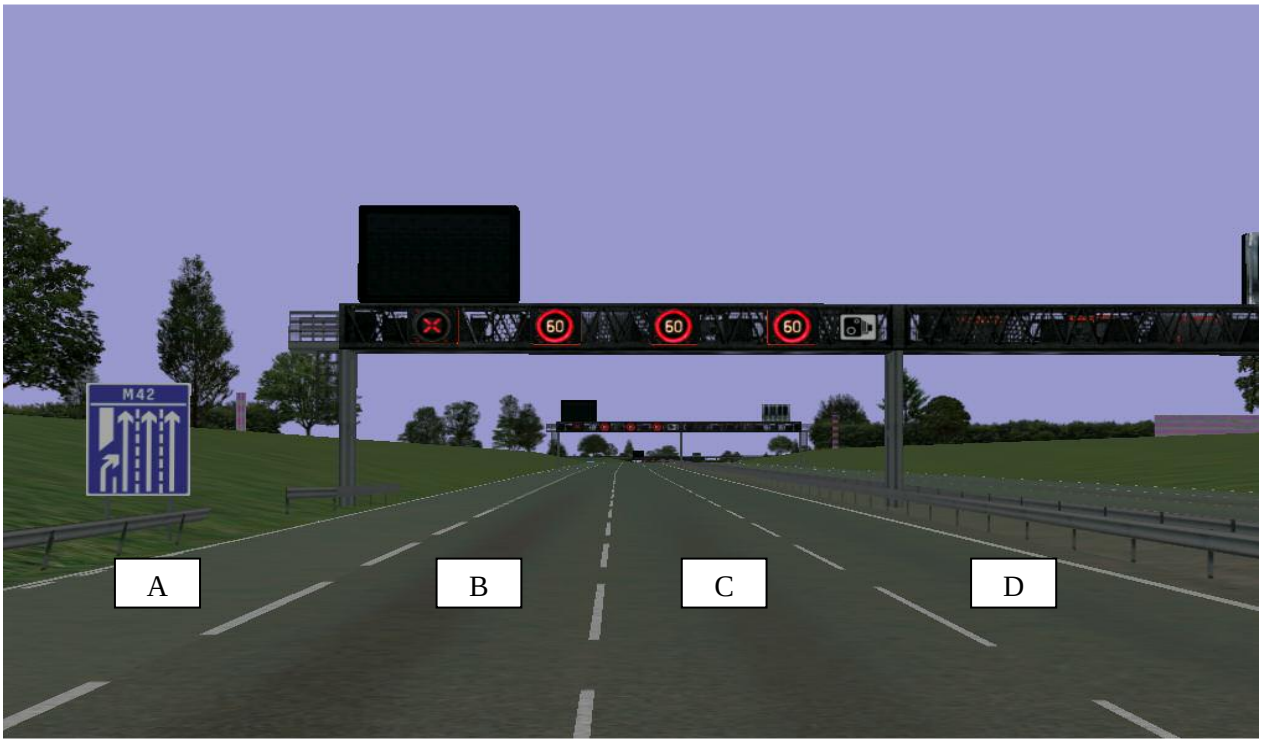
Picture 2



Picture 3



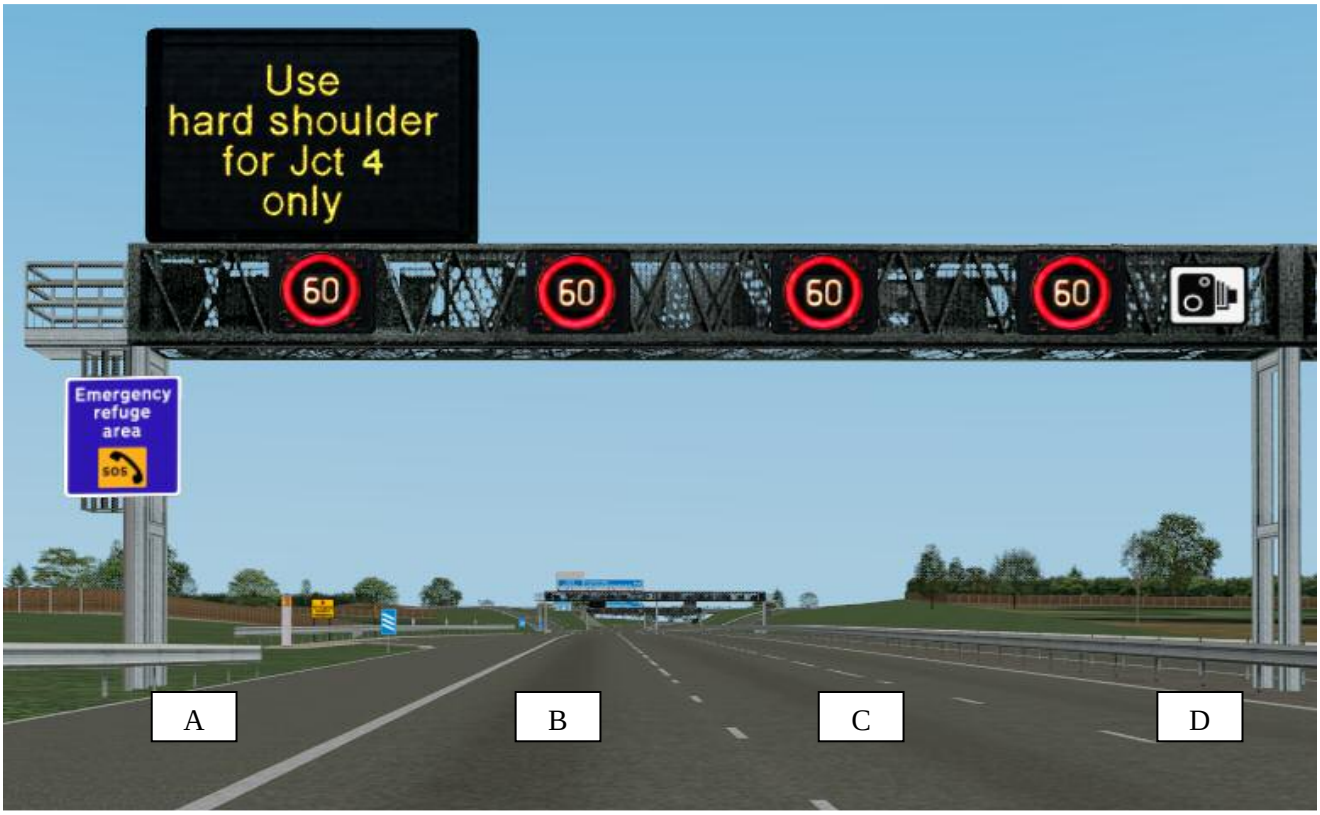
Picture 4



Picture 5

Picture 6

Picture 7


Use
hard shoulder
for Jct 4
only
60
60
60
60
Emergency
refuge
area
SOS
A
B
C
D

Appendix D Participants' general comments

Hard to change lanes because gaps in traffic seemed smaller than reality. Also lots of undertaking and erratic driving.
Hard shoulder closed ahead sign - was unsure if this meant for emergencies also.
Image is very jerky on the exit and the entry. Traffic behaved very strangely. Vehicle periodically seemed to over-rev as if it had slipped down a gear and needed to be put back into 5th.
It gave you a different approach to driving on the motorway.
I would be very fearful of increased accidents if the use of hard shoulders was intermittent.
When the hard shoulder was open I found it very easy to follow which lanes should be driven in (first drive). On the second drive however, I found it more difficult to fully understand which lanes were permitted - especially when exiting the motorway. i had to rely on the lane markings a lot more when this was the case.
Some dramatic speeds in use by other vehicles, and some very sharp positional adjustments, but otherwise pretty realistic (despite being overtaken by 2 succeeding royal blue MGB's and audi A3's with identical french registration plates!)
The only bit that makes you feel a funny is top of the hill.
Although i understand the need for an additional lane on motorways in high traffic density i do not support using the hard shoulder unless the following was introduced: 1. More stop offs on the motorway for rest or convenience stops. 2 Clearer definition of traffic rules on using the hard shoulder. 3 Lower speed limit on the hard shoulder (at least 10-20 miles less).
(Participant forgot back page)
Simulation had plenty of bad drivers.
Routes are fine, would like to see the traffic coming on your right or left a lot lighter. Very hard to see.
A little bit nerve racking! Cautious to make manoeuvres that i would probably make on a real road due to the lightness of steering on the simulator and the danger of oversteer. I feel that i don't drive as confidently as i would in a "real" car.
Cars seem to come up from behind much quicker than in real motorway driving. This may be because you can't see them a long way back.
Once you know it our confidence and ability would increase (less hesitating therefore braking and traffic queues).
Seems to be small numbers of lorries which does not seem realistic for M42
If there were refuge areas at regular intervals this would be much safer and i would feel happier about driving on the hard shoulder as you would be less likely to hit a broken down vehicle. Some running lanes finished abruptly which caused me to break hard and possible accident could have ensured.
When looking in the door mirror it is hard to tell if there is a car present. The other cars dodge in and out in an erratic way. The car feels very underpowered if you have to brake. The brakes don't feel as if they are slowing you down.
Hard shoulder use for 'junction exit' in congestion is a good idea. Hard shoulder use at entry point, bad idea as merging would be a nightmare. In general hard shoulder usage would enable the competitive, hasty or irresponsible driver to take more risks and increase the potential for accidents, in a world that's all about 'me'. Hard shoulder usage in congestion would only change 3 lanes of congestion to 4 lanes of congestion with no area for breakdown or emergency vehicles.
The road was never congested enough for me to feel I needed to use the hard shoulder
I think using the hard shoulder would make traffic run smoother sometimes until someone breaks down then it might make that traffic dangerous trying to merge into (normally) Lane 1 when other drivers aren't paying attention, could be worse

There was greater congestion where the hard shoulder closed at each point on the drives - this could lead to more accidents
At times its too confusing. If you open up hard shoulder people want to undertake but know they shouldn't so it causes rash decisions by drivers. If there is confusion more choice of accidents
Gantry signs are by far the most helpful way of telling you which lanes are open for use and at what speeds. Using the hard shoulder as a running lane can cause issues if it closes mid-way through a section and traffic has to merge with the normal running lanes
If the hard shoulder is to be used. 1. Signage must be very clear when it is and IS NOT in use. 2.Frequent changes between sections of motorway that do/do not have the hard shoulder available/not available would add to congestion, cause traffic 'waves' and could make motorways more dangerous
Make it more clear when merging into the hard shoulder of a junction
Traffic moves very erratic
One is much more aware of what one should be doing and so there is a tendency to over compensate. The steering on the car, other than in a straight line was wayward - to say the least - though whether this was deliberate or not I cannot tell. Difficult to get used to the somewhat erratic and quick movements of the other vehicles
Most was ok and easy to follow. Only merging when joining from a slip road was sometimes misleading/confusing. Possibly a gantry over the slip road with directions on which lanes are open would help
i have used the hard shoulder on the M40 and I think it is great
I think opening the hard shoulder before junctions, confuses the issue and when re-joining the main carriageway, it becomes more dangerous by opening it you are delaying re-entry to the motorway, which can be dangerous
With heavy traffic and many cars undertaking then this is not normal traffic conditions and required lots of concentration
Clear, simple signs are very important. I would not use the hard shoulder unless gantry sign operating. Also, one cannot assume that there will NOT be an obstruction or broken down vehicle there.
Sudden traffic movement is a bit un-nerving. Steering around bends or to overtake is 'sharp'. It all feels different to driving a 'normal car' on 'normal roads' - but much better than it used to be
I believe it would relieve some of the congestion but people would still not use the correct lanes when not that busy
Think use of hard shoulder does have safety issues but probably does improve flow. Oversigning could also impact confusion when speed restrictions apply. I think more accidents would be caused by merging from the hard shoulder lane - the traffic would also build up at these points on the motorway
I would not normally undertake traffic on a motorway but found I was doing so on the simulator
The use of the hard shoulder worries me when it comes to emergencies and all 4 lanes are blocked. How are the emergency services especially fire engines going to get through. The use also confuses drivers who don't like to use it, this results in a lot of undertaking especially of lane B drivers. I think it can be helpful in very heavy traffic but not at all times. As for picture 6 I think this would cause many accidents and confusion for many drivers
If a vehicle breaks down when the hard shoulder is open, that time interval until it can be closed is potentially very dangerous both for the stranded motorist and following drivers. The 60mph signs on the overhead gantries could just as easily be read as indicating 50mph
When the hard shoulder is open for traffic the signs need to be clear and frequent as unsure drivers could get confused and cause accidents

I did feel it a bit odd on the last drive and 1st turn off junction. I felt I was in the correct lane until the junction arrived and then the hard shoulder turned into a lane so I had to cut across quickly. If there was warning of this, I either missed it or passed it with a coach on my inside !!
The other cars were driven worse than in reality. Until quite recently I drove 30-40 K miles/year mainly on motorways (for my last job). Opening the hard shoulder promotes confusion and encourages general misuse of the main carriageway. Joining the motorway is made positively dangerous
Did not really notice when the hard shoulder was open for use
It's fun and I want to see the traffic flying
Much harder than a real motorway
Need to be clearer about the rules for using the hard shoulder. Seems to make joining and exiting the motorway worse
Felt strange having cars under and overtake. when doing speed limit it felt very vulnerable. The use of a green lane may indeed help traffic flow of traffic and perhaps encourage people to choose their cars bearing in mind the CO2 emissions
I think much longer needs to be given for drivers to rejoin the main carriageway from the junctions - if the hard shoulder is open it was a ridiculously short merge and even with it closed it still seems iffy in busy traffic. When busy merging there isn't always time to see the signs explaining which it is.
If cars/vehicles stuck to the left lane and only used the other lanes to overtake, congestion would be reduced without the need of a fourth lane.
I found it easy to understand when I could not use the hard shoulder including at junctions. Very good information provision
It is like driving in half light, vehicles, especially motorbikes, do not have lights. driving conditions are very extreme.
Found controlling the car when moving off motorway and back again a bit difficult
Very different to normal driving
As shown on the simulator, a lot of drivers would see the open hard shoulder as a fast undertaking lane - very dangerous. The gantry speed limits should be supported by 'stay in lane' signs, but the general rule of using left lanes when they are clear should apply
Signs were clear - helps when hard shoulder is either always open or always closed.
Too many signs, very confusing.
Vehicles come out of feed ins without warning and fast.
I wouldn’t think people using the motorway would really care if the hard shoulder was open or not if there was traffic they would just use it and cause more accidents.
I don’t like the fact that there was a lot of undertaking taking place mostly I think because of the lower speed limits. I did not like the introduction of the green lane - thought this caused more problems and would probably cause more accidents. I did not enjoy using the hard shoulder as a running lane - again thought this would cause more accidents - ok maybe when VERY heavy traffic jams.
1) Coming off the motorway and going around island quite difficult for brain. 2) Joining motorway hard due to limited visibility of traffic on slow lane.