Transport Research Laboratory
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Trials on segregation set-back at side roads

Annex 4 Trial M4 with car drivers turning into and out of the side road

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Contents

1 Introduction

1.1 This document

This Annex presents the findings from the third in a series of test track trials (trial methodology M4) carried out by TRL to investigate segregation set-back at cycle lane crossings of side-roads.

1.2 Aims and Objectives of the trial

The purpose of this trial was to consider the possible effects on safety of reducing the distance for the end of a kerb that is segregating an on-carriageway cycle lane in advance of a junction. A 30m set-back is currently recommended by the DfT (LTN 2/08); set-back distance being the distance between the entrance to the side road[1] and the end of the cycle lane segregation.

This trial supplements earlier trials by considering different turning movements by cars at a side junction, with an approaching segregated cycle lane.

There is potentially a risk that the presence of a segregated lane may result in drivers misjudging their interaction with cyclists at a side road. This could possibly occur by not accounting for the cyclist's presence as they would if they were part of the main traffic flow, or through misinterpretation of the available information. The trial aimed to investigate drivers' and cyclists' understanding of the layout, priorities at the side road, and concerns when using the road layout.

The objectives are to understand how the kerb set-back distance affects:

- Drivers' decisions about whether to give way to cyclists;
- Vehicle paths when turning;
- Vehicle speeds;
- Drivers' perceptions of how easy it is to make turning manoeuvres;
- Perceived safety of situations encountered;
- Passing distances between cars and cycles; and
- Drivers' understanding of and attitude towards the trial facility

The trial's objectives were considered as inter-related research questions which can be categorised as qualitative and quantitative. These are given below:

1 At the point where the minor road kerb-line prior to the bend radius would bisect the give way line

Quantitative research questions:

To what extent does the different kerb set-back affect:

1. The position and driving style of drivers when undertaking the turning manoeuvres?
2. Drivers' decisions whether to turn in front of the cyclist or give way and turn behind?
3. The speed of drivers on approach to the junction?
4. The distance between the cycle and the car when they are parallel?

Qualitative research questions:

1. How does changing the kerb set-back affect road users' perceptions of safety?
2. How easily could the driver make the turn with different set-back distances?
3. How does changing the kerb set-back affect the participants' ability to judge the cyclist's speed and position, and to decide whether to pass?

To give an overall indication of public understanding and views of segregated cycle lanes and set-back distances the following qualitative research questions were also investigated:

1. What are people's views on segregated cycle lanes, their purpose and benefits?
2. What are the preferences of car drivers regarding set-back distance?
3. How well do drivers understand road layouts at junctions crossing a segregated cycle lane?

1.3 Layout of trial site

The highway layout for this trial was the same as that for the first two segregation set-back trials (M1 and M2). This layout is shown in **Figure 1**.

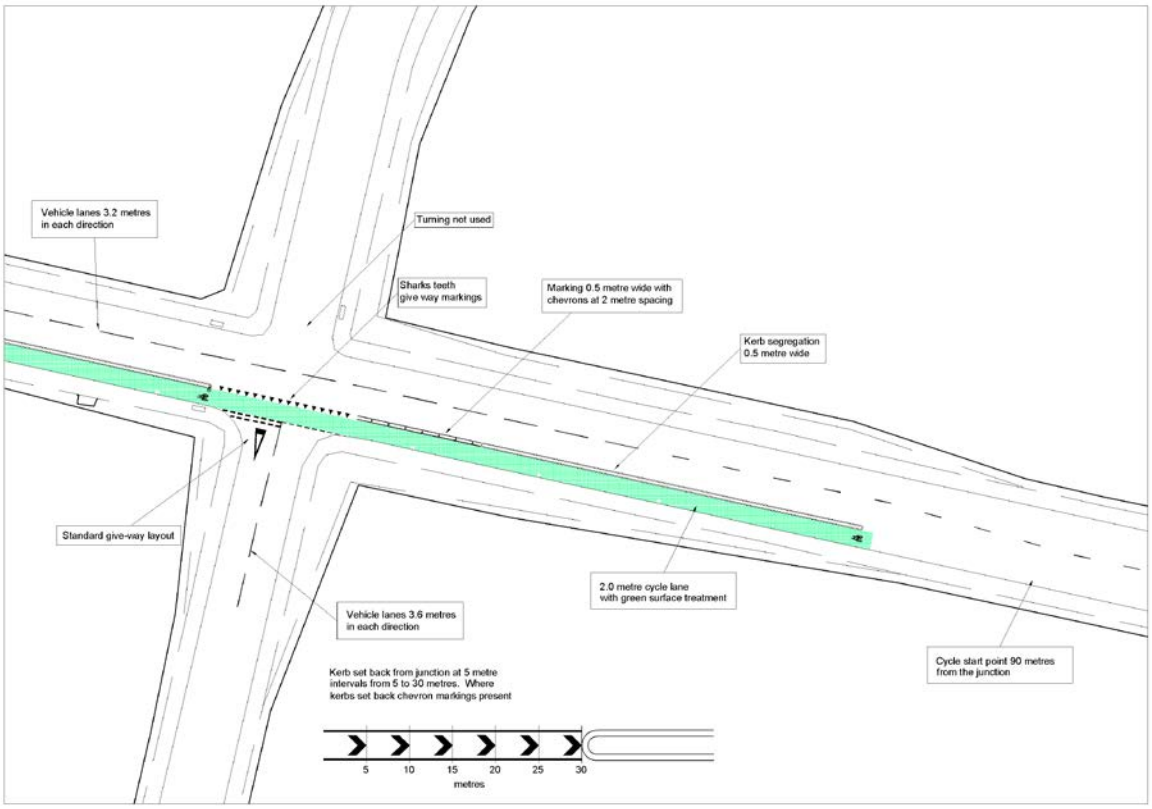

Figure 1: Segregated cycle lane layout

It comprised a cycle lane at carriageway level, intersecting with a side road. A kerb was used to separate the cycle lane from the main carriageway with a gap at the junction to allow cars to turn into or out of the side road.

The cycle lane was coloured green throughout and continued from the end of the segregation across the side road as an advisory cycle lane, additionally using triangular markings which are not an approved road marking in the UK. Similar markings are used in the Netherlands as a 'give way' marking.

The fourth arm of the junction was coned off as it was not required for this trial.

Video cameras were set up at 10 locations, covering the full area shown in the drawing. All three approaches to the junction were monitored with the main focus being close to the junction. This permitted measurements to be taken of vehicle position on the approach and when turning, and to enable the average speed of the participants to be measured over a 80 to 90 metre length ending at the junction depending on whether they were turning into, or out of, the side road respectively.

1.4 Trial location

The trial took place on the Small Roads System at TRL in Crowthorne. An overview of the trial site is shown in **Figure 2** where the junction used is indicated with a circle and an image from one of the video cameras is given in **Figure 3**.

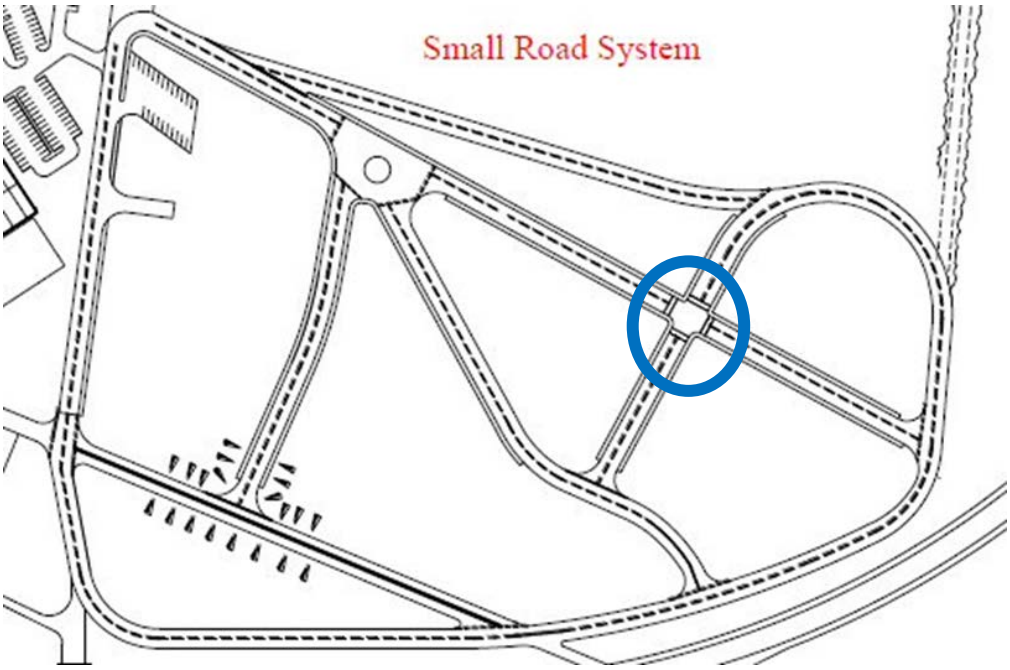

Figure 2: Trial location

Figure 3: Photo of trial location

2 The trial methodology

2.1 Trial methodological design

This trial involved members of the public as car drivers (the trial participants) and TRL staff members as cyclists. Using TRL staff cyclists made it easier to control situations on the test track, helping ensure that cyclists were correctly positioned and in the right speed range for the required scenarios, and to manage safety in compliance with TRL's responsibilities for workplace safety. The previous two trials on this facility did not involving conflicting manoeuvres, so this was the first trial in which drivers encountered cyclists that continued all the way across the junction.

Participants were split into two groups, those turning into the junction and those turning out of the junction.

The TRL cyclists only followed a single route: starting from one of three points upstream of the side road (spaced at 10m intervals) such that they could be 30, 20 or 10 metres from the side road when the car was within 5 metres of it respectively. They cycled along the segregated section of the cycle track continuing, after the end of the segregation, along the marked cycle lane across the mouth of the side road. The scenarios set up in the trial therefore comprised:

- car travelling in same direction as cyclist, then turns left into junction, whilst the cyclist continues straight on;
- car travelling in opposite direction to cyclist, then turns right into junction, whilst the cyclist continues straight on;
- car turns out of junction, right or left, whilst the cyclist travels straight on the main road (within the segregated cycle track) past the junction

In addition, situations were set up where a queue of traffic was present in the lane closest to the side road, on both sides of the side road, and car driving participants were asked to turn right into the side road, or right out of the side road.

Each participant driver took part in three sessions, with the segregation set-back distance differing between the sessions. The set-back distances were from one of two sets: 5m/15m/25m and 10m/20m/30m.

In order to reflect a range of real life situations, the trials were designed so that car drivers encountered the cyclist at different distances from the junction for each of the setback distances. The TRL cyclists adjusted their starting position and approach speed so that when the car driver was within 5 metres of the side road on the main road, or within 5m of the give way line when exiting the side road, the cyclist was at one of three set distances from the side road, these being: 10m, 20m, or 30m. Two runs at each distance were carried out per participant in each session, one with the participant turning left and the other turning right at the junction.

Immediately after each run both the participants and staff cyclists were asked to answer a few short questions on their decisions, ease of use and perceived safety of the situation experienced. These provided immediate feedback on individual situations. After completing the trial, all participants were asked to fill out a questionnaire to ascertain their overall thoughts, any preferences and also the degree of their understanding of the situations they had experienced.

Video analysis was used to examine the behaviour and actions of the car drivers and cyclists in each of the experimentally controlled situations described above. This record allowed the timing of vehicle associated events, such as the drivers' decisions to turn. To assist this a grid was placed on the approach to the side road and filmed when the trial was not being conducted. This was subsequently used to calibrate the analysis of the video recording of the run. The grid was used to record the lateral position (distance from the kerb edge) of the vehicle's front wheel at known distances from the start of the side road. Distances from the side road were marked with one metre spacing, and the distance from the kerb was recorded to the nearest half metre.

2.2 Limitations to methodology

The situations presented to the participants were necessarily lacking some aspects of realism. However, the relative judgements of the presented situations were based upon consistent circumstances. Thus the participants' assessments provided a clear insight into driver preferences.

For any kind of trial participants in such an experiment are:

- aware they are being studied;
- likely to drive more carefully than they would on the road;
- less likely to be engaged in any other distracting tasks (e.g. using mobile phone, adjusting radio etc.);
- not under time pressures.

Furthermore, in this particular trial:

- interactions were between single vehicles and single cyclists, this simplifies the decision making process and making it easier for either party to stop without concern of conflicts with a following vehicle or cyclist;
- there were no following vehicles putting pressure on the drivers to make progress;
- no opposing traffic flow to limit turning movements into the side road;
- speeds were relatively low at all times, with average speeds between 9 and 15 mph.

It should also be noted that this trial did not consider features such as bus stops, on-street parking, loading/drop-off zones or pedestrian crossings which would often be present in real-life situations and would affect driver behaviour.

Nevertheless, such experiments provide good insights into relative behaviour and can therefore be used to investigate the comparative (although not absolute) safety of altering designs and measures.

2.3 Participant and vehicle quantity, composition and type design

A total of 90 drivers completed questionnaires after the trial. Of these, 57% were men and 43% women.

A range of age groups was included, as seen in Figure 4, however young drivers under 25 were excluded from the trial for insurance reasons, and those aged 55-64 were over represented.

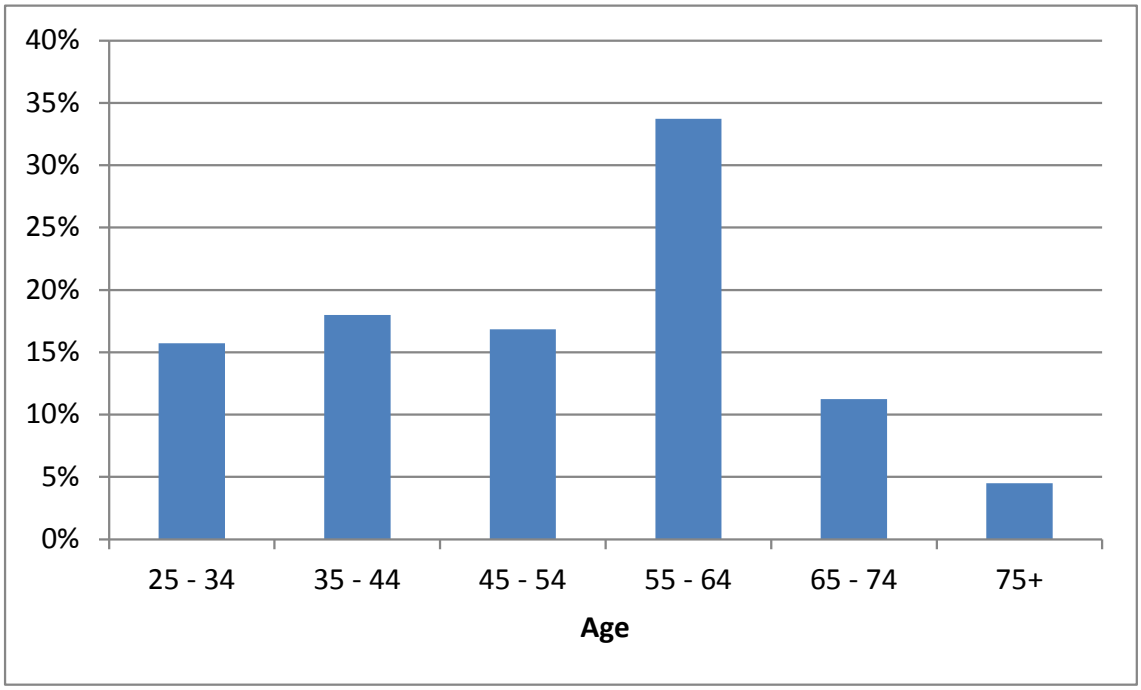

Figure 4: Age profile of participants

Figure 5 shows that more than half of the drivers never cycled (59%), and only 5% cycled three times a week or more often, these broadly match access to bicycle (43%, using the assumption those without access to a bicycle never cycle) and cycling frequency of greater than 3 times per week (8%) statistics[2]. Those who did cycle tended to use a bicycle most often for leisure journeys (83%).

[2] http://www.ctc.org.uk/resources/ctc-cycling-statistics

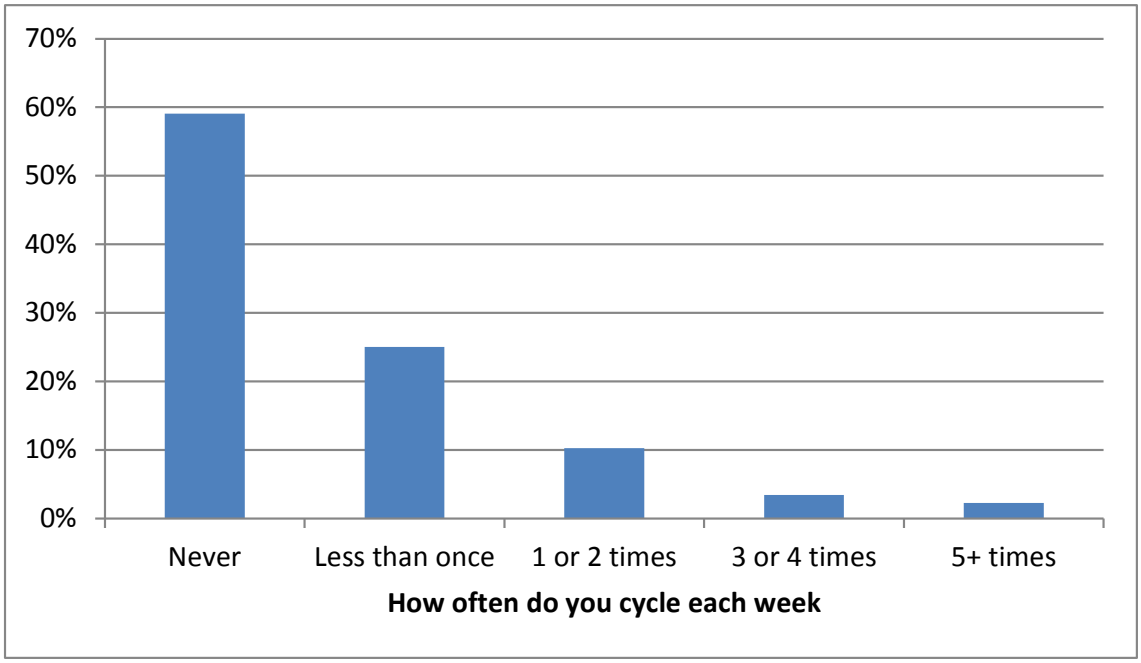

Figure 5: How frequently participants cycle

Half of those who cycled usually travelled on the road – either in traffic or in cycle lanes on the road - and a third usually cycled on separate cycle paths.

3 Video analysis and trackside questionnaires

3.1 Introduction

There were four routes travelled by the car drivers, right into the side road, left into the side road, right out of the side road and left out of the side road. In addition some right turn manoeuvres were carried out with a queue of traffic on the lane closest to the side road. The situations with a queue of traffic are dealt with separately from the other right turn manoeuvres and hence there are six different scenarios types in total. The results for each route are examined individually.

3.1.1 Cautions and caveats

The queue of traffic was only present on days three and four of the trial and was only experienced by the participants who were in group 1 (those who experienced setback distances of 5m, 15m and 25m) on those days.

Hence, all data for group 1 for the non-queue routes was collected over two days and all data for group 2 (10m, 20m and 30m setback) was gathered from trials held over four days.

Since they were only collected over two days rather than four, the data for group 1 trials (5m, 15m and 25m setback) were collected from fewer runs and participants; which meant that sample sizes were therefore approximately half of those for group 2. For this reason, the results for groups 1 and 2 trails have been largely displayed in separate figures.

3.1.2 Distance definitions

A grid system was overlaid onto video displays. This was used to record the lateral positions of the car and cyclists on their approach to the side road. All lateral distances were started (0 metres) at the kerb line on the vehicles' approach, i.e. the inside kerb on the main road for those turning into the side road.

The distance with respect to the side road was started (0 metres) at the distance where any probability of conflicts was expected to start increasing. These are defined in Figure 6 and Table 1.

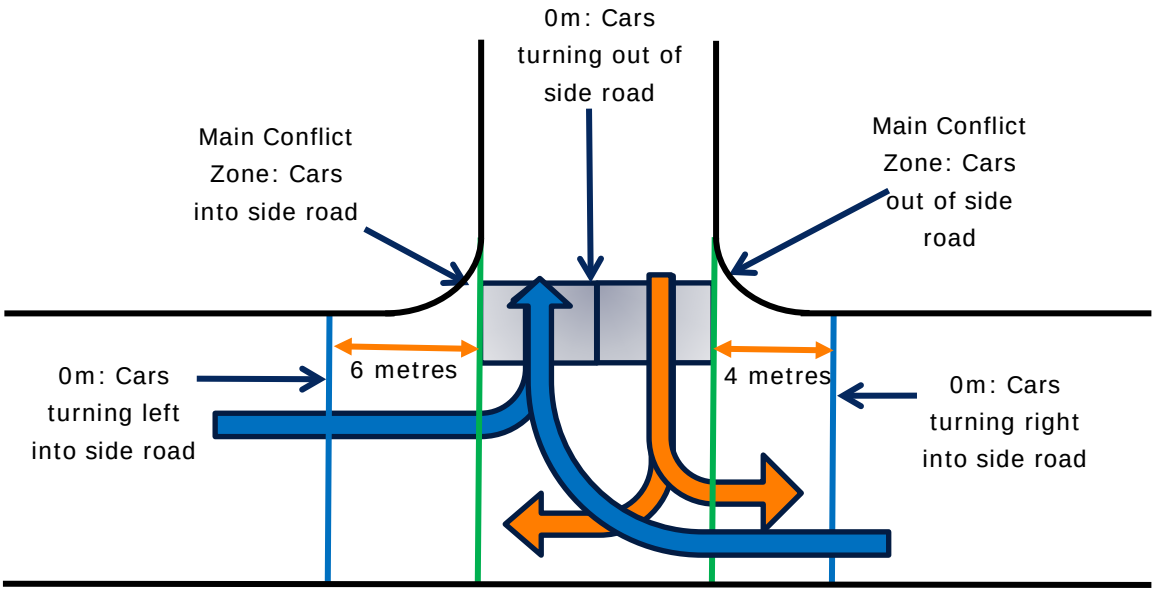

Figure 6: 0 metres distances from side road definitions

Table 1: Definitions of '0 metres' distances from side road

Manoeuvre	'0 metres'
Left into side road	6 metres before the projected kerb line of the side road
Right into side road	4 metres before the projected kerb line of the side road
Left out of side road	At the give way line
Right out of side road	At the give way line

3.2 Car Path

Drivers adapt the path they utilise to enter a side road depending on its geometry. If wide angles (i.e. a large kerb radius) are available it offers the opportunity for drivers to sweep into the side road by also using a large turning radius. However, drivers can be required to turn more sharply into the side road with an acute kerb angle into side road. Reducing the setback of a cycle lane effectively reduces the side road's kerb radius. It would therefore be expected that the drivers' path into the side road could be affected by the cycle lane segregation set-back.

3.2.1 Into Side Road

Any path deviations with different segregation set-back distance would be expected to be most evident for vehicles turning into the side road, as they passed closest to the physical segregation, i.e. they used the side-road lane nearest to the kerb segregation. The average paths that were observed are shown in Figure 7 and Figure 8.

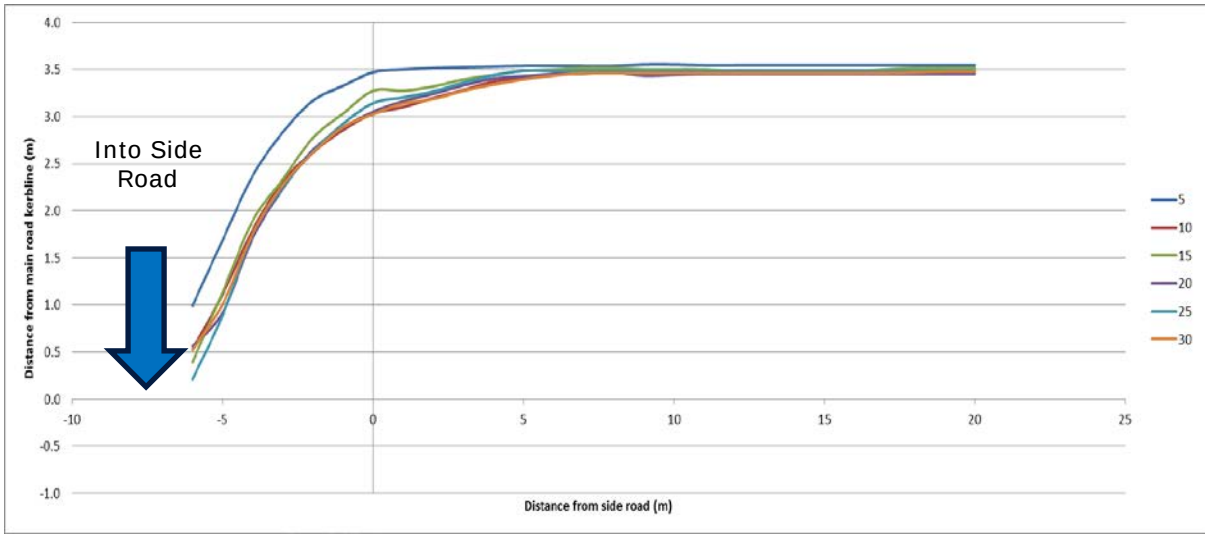

Figure 7: Average car path into side road: Turning left

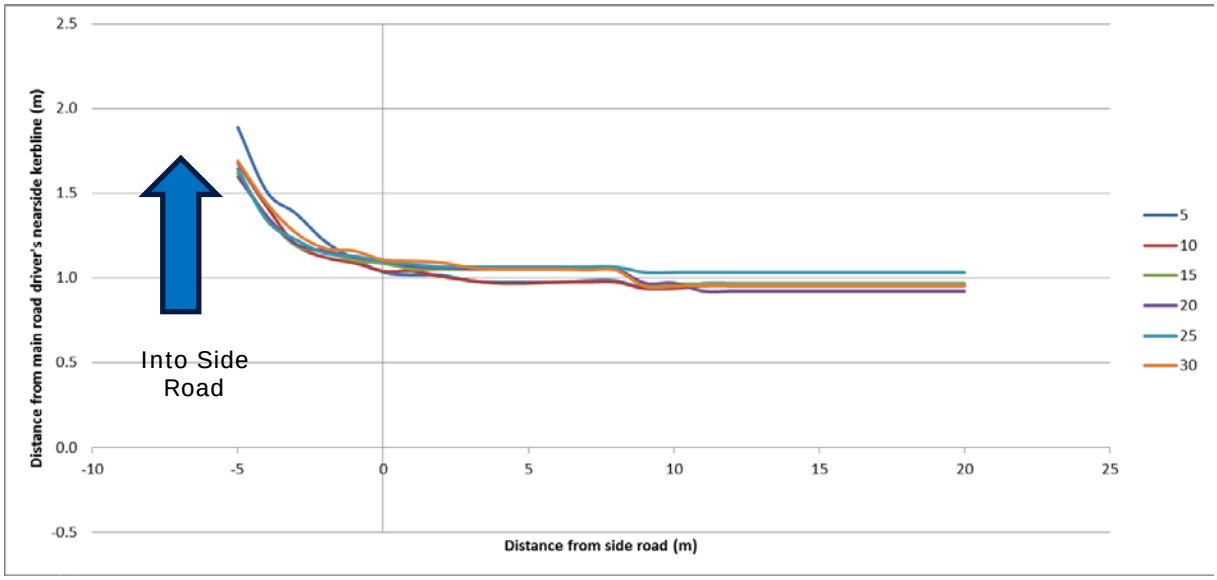

Figure 8: Average car path into side road: Turning right

The segregation set-back distance had little to no effect on car paths for set-back distances between 30 and 10 metres. It should be noted that the average paths for the 5, 15 and 25 metre setbacks were for a different group of participants to those experiencing the other setbacks; however participants were randomly allocated to the groups, and no group bias was evident in the form of systematic differences in observed and analysed behaviour. Also, the average paths for the 15 and 25 metre setbacks were only observed on Days 1 and 2 of the trial. However, there is evidence that the participants used higher speeds on Day 1, so this may have affected the vehicle paths at these setback distances: the average speed for cars turning left into the side road was 14.1 mph on Day 1, but between 11.4 and 11.5 on Days 2, 3 and 4.

The deviation in path when drivers turned left into the side road with a 5 metre segregation setback was statistically significant compared with a 10 metre setback. T-tests showed that the deviation in path was statistically significant (at the 95% confidence level) from 5 metres to -2 metres on the approach: where -6 metres was the projected kerb line of the side road. The path with a 5 metre setback resulted in an

average driver approaching the cycle lane at a more acute angle, maintaining their distance from the cycle lane for longer, and remaining out of the cycle lane for longer.

The path also appeared to be slightly different when car drivers turned right into the side road with a 5 metre setback. However, this difference was only statistically significant at -3 and -5 metres.

3.2.2 Out of Side Road

The path taken by drivers for vehicles turning left out of the side road would not be expected to vary with segregation set-back distance as they do not encounter the kerb separation variations. However, it might have been expected to have an effect on those turning right out of the side road, as they passed near to the end of the cycle lane affected (See Figure 9). The average paths used are shown in Figure 10 and Figure 11 below.

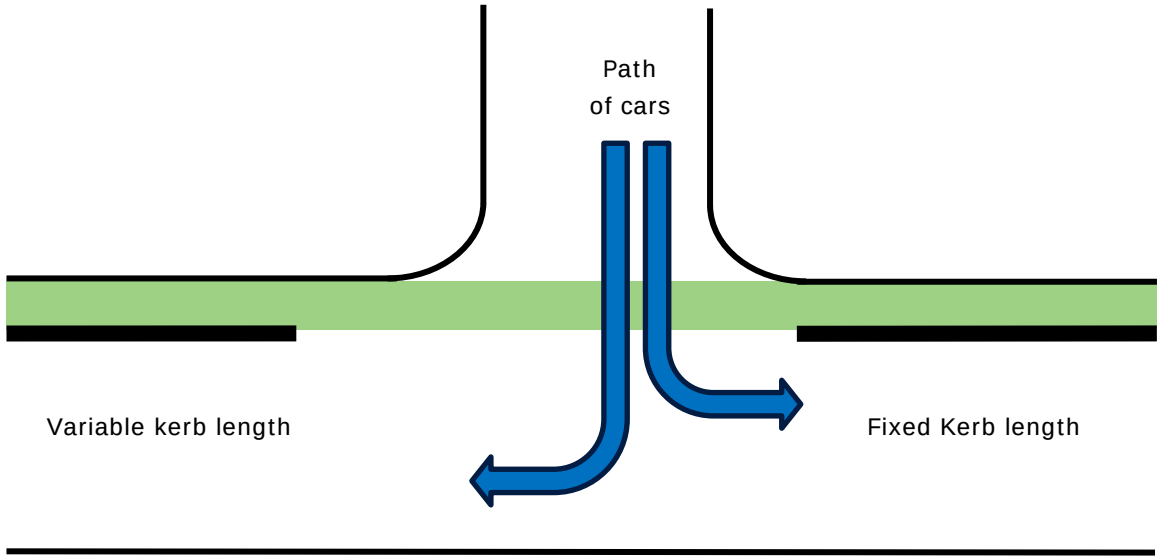

Figure 9: Car movements out of side road

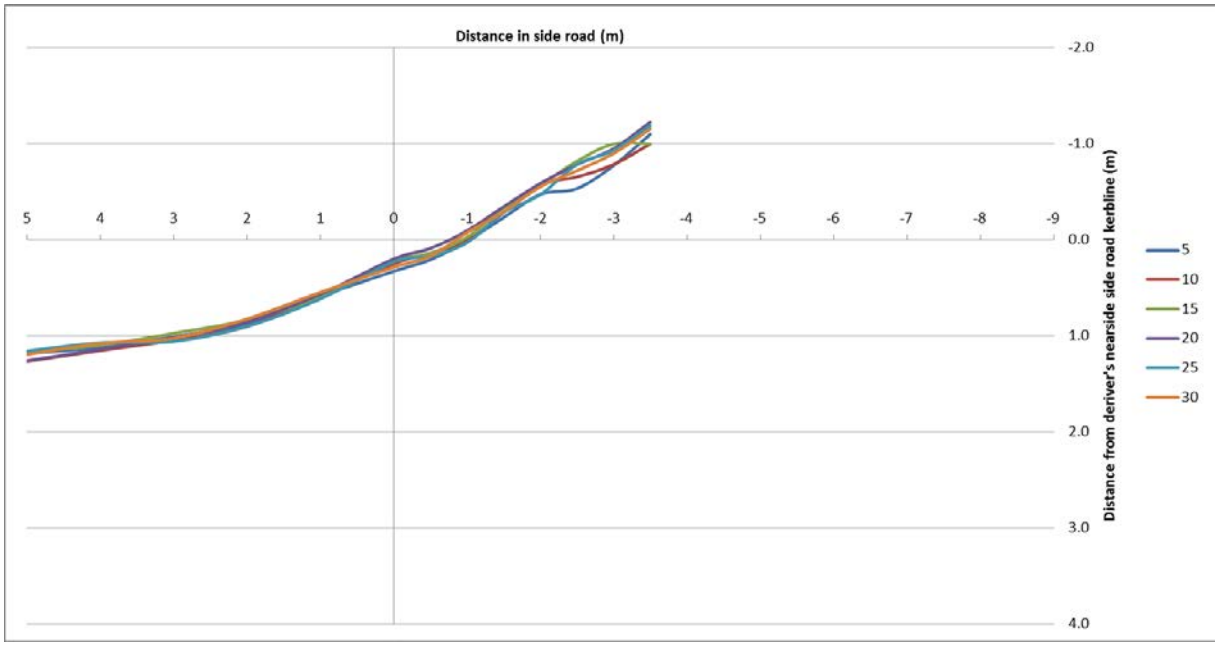

Figure 10: Average car path out of side road: Turning left

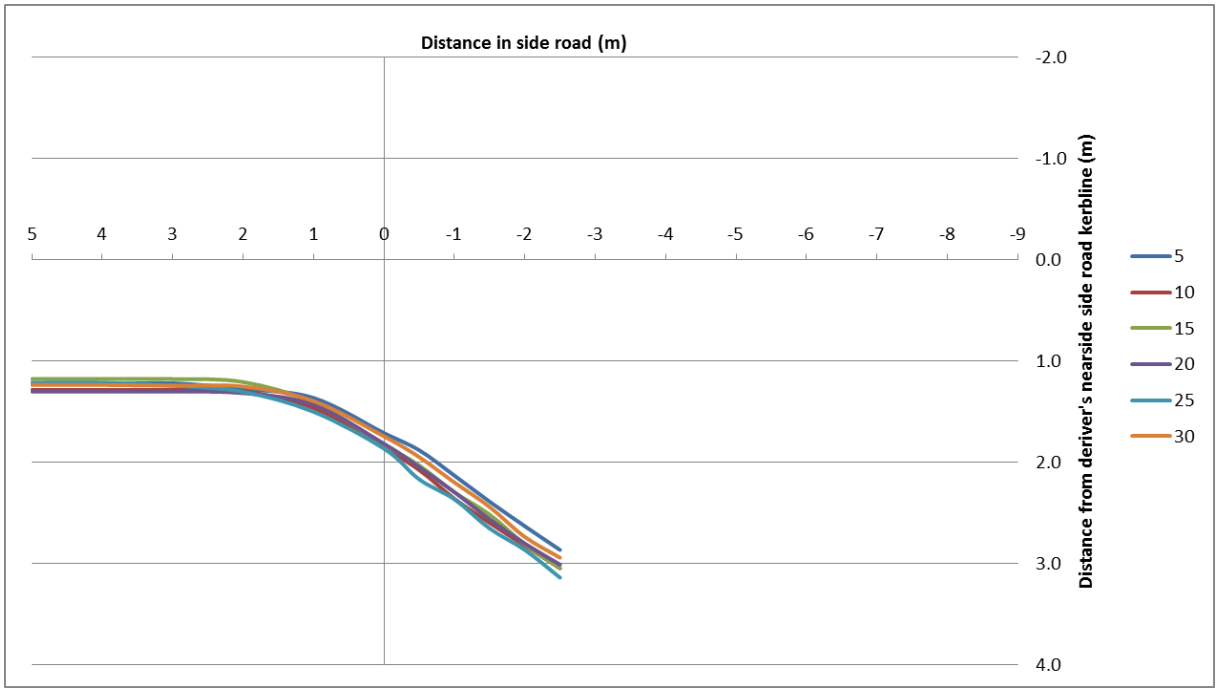

Figure 11: Average car path out of side road: Turning right

The segregation set-back distance had no observable effect on the average path of the vehicles out of the side road when turning left. However, there was a small (0.1 to 0.2 metre) but statistically significant effect (at the 95% confidence level) on the vehicles' paths when turning right onto the main road, with a 5 metre compared to a 10 metre setback, from the give way line until 2 metres into the main road (i.e. across the width

of the cycle lane). This resulted in drivers using a more acute angle when exiting across the cycle lane.

3.3 Distance from the kerb and car speed

The average speed of the car drivers was measured by recording the time they started from 90 metres before entering the side road until they reached the conflict area with the cyclist: i.e. crossed into the cycle lane. Similarly, for cars exiting the side road they were timed over the 80 metres before they reached the give way line.

The main effect that segregation set-back distance might be expected to have on car speed would be because it potentially affects drivers' paths, which in turn affect their speed. The observed relationship between path and speed is shown in Figure 12 and Figure 13 for cars turning into the side toad. This shows distance from the driver's nearside kerb and the effect on speed.

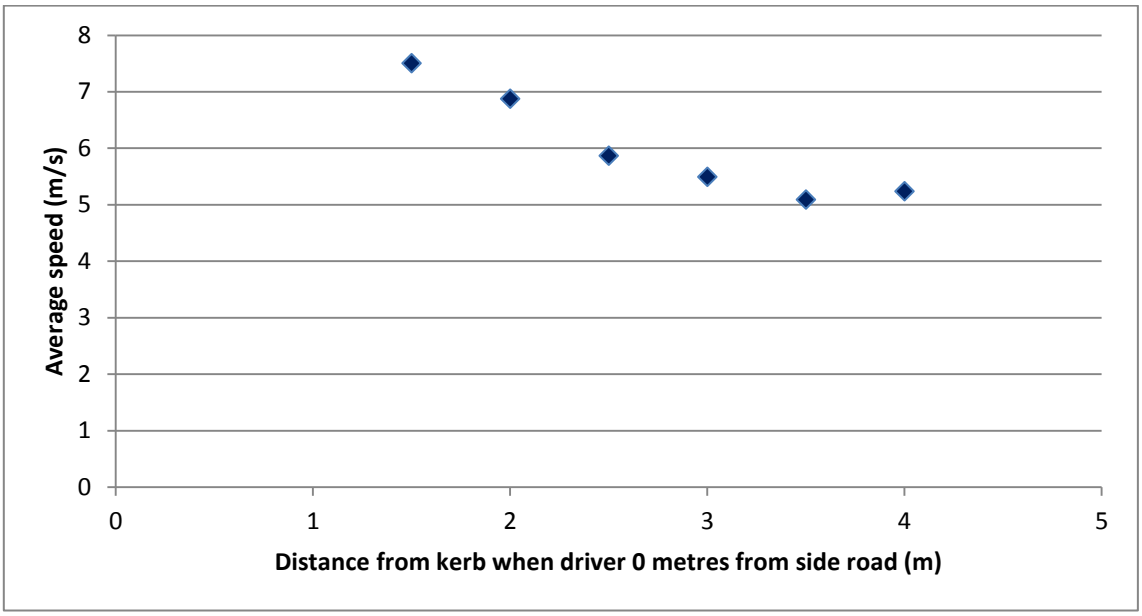

Figure 12: Average car speed and distance from kerb: Turning left into side road

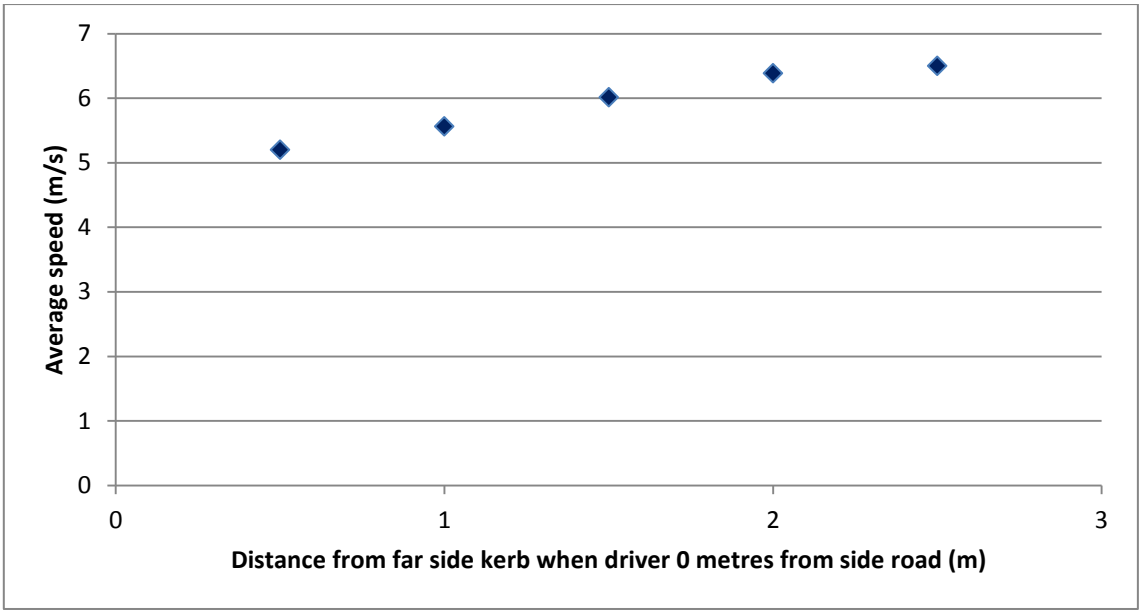

Figure 13: Average car speed and distance from kerb: Turning right into side road

These graphs show that drivers' associated average speed increased as the approach path used got closer to the nearside kerb when turning left into the side road. Conversely, it increased the farther from the kerb when turning right into the side road. That is, if they used a large radius turning circle to enter the side road, then their average speed was greater.

One implication for left turners is that, should a driver use a small radius turn, then not only will they encroach into the cycle lane later, and at an improved angle for seeing the cyclists, they will also do so at a lower speed.

The displayed differences in speed according to distance from the driver's nearside kerb were statistically significant in all cases where the sample sizes were greater than 10.

No such variations in distance from the kerb and speed were present for vehicles turning out of the side road. The maximum difference in average speed across all distances from the kerb, and turning movements out of the side road, was 0.8 mph.

Having established existing relationships between a driver's approach path and their speed, and assessed whether path varied with setback distance of the cycle lane, the next step was to consider what conclusions can be drawn on the effect of setback distance on approach speed.

3.3.1 Into Side Road

The analysis of driver's paths concluded that the only variation in path occurred with a 5 metre set-back when the driver turned left into the side road. The distributions of observed distances from the driver's nearside to the kerb when at the 0 metres reference point of the side road with a 5 and 10 metre setback are shown in Figures Figure 14 and Figure 15.

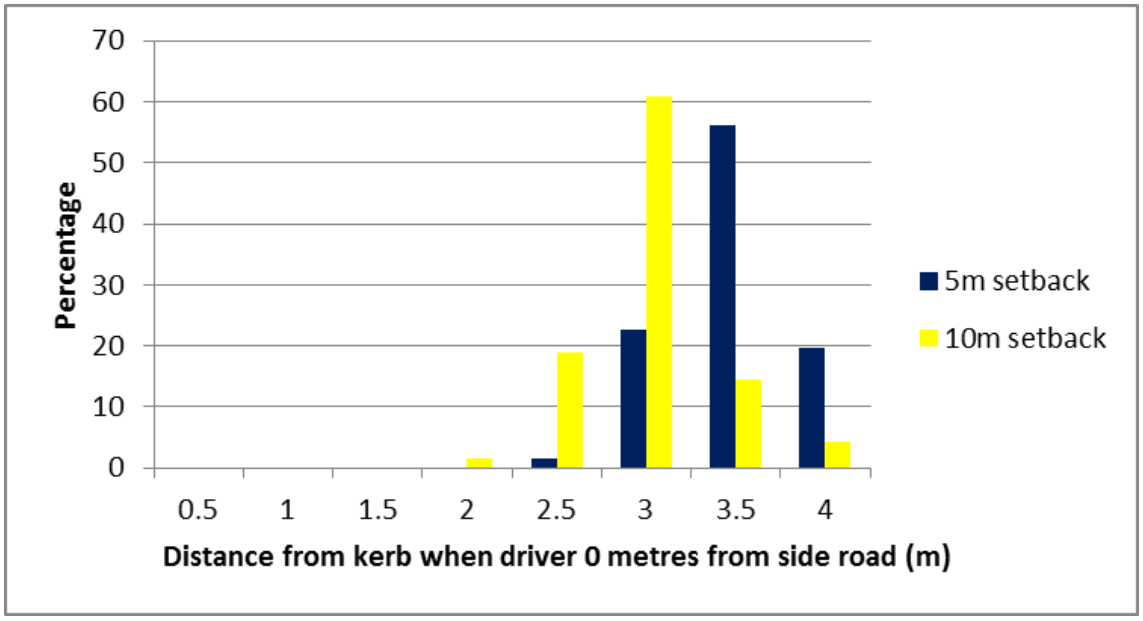

Figure 14: Distances from nearside kerb when car reached the side road (0 metres): Turning left

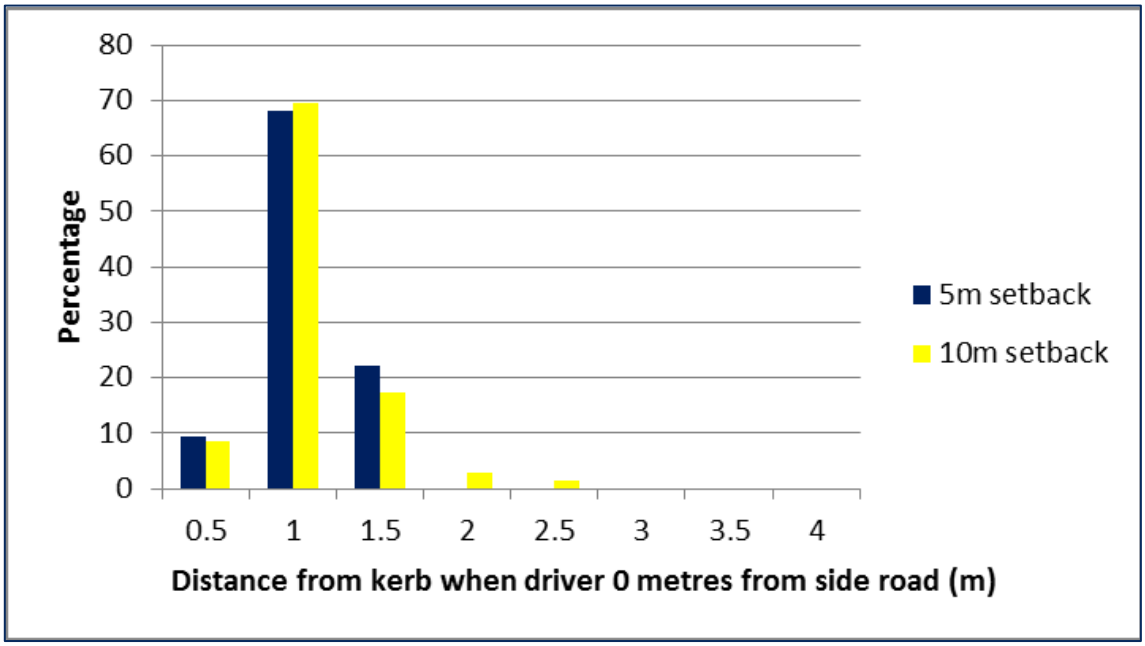

Figure 15: Distances from nearside kerb when car reached the side road (0 metres): Turning right

When turning left into the side road distances from the kerb with a 5 metre set-back were significantly greater than with a 10 metre set-back: i.e. the percentage whose distance was at least 3.5 metres was significantly greater. However, the set-back had no effect for those turning right.

The derived relationships imply that the average speed of drivers turning left into the side road will be less with a 5 metre setback than with a 10 metre setback.

The measured average speeds over the 90m run were 11.6 mph with a 5 metre setback and 12.4 mph with a 10 metre setback. This difference was weakly significant (i.e.

significant at the 90% confidence level), however because speed is averaged over 90m the change in speed at the junction will be understated.

The average approach speed was 12.8 mph with both the 5 metre and the 10 metre setback for drivers turning right into the side road. This is in agreement with the observed lack of variation in path used into the side road.

3.3.2 Out of Side Road

The analysis of driver's paths concluded that there was no discernible effect of driver path on speed out of the side road. The distributions of distances from the driver's nearside to the kerb when at the 0 metres reference point (the give way line) of the side road with a 5 and 10 metre setback are shown in Figure 16 and Figure 17.

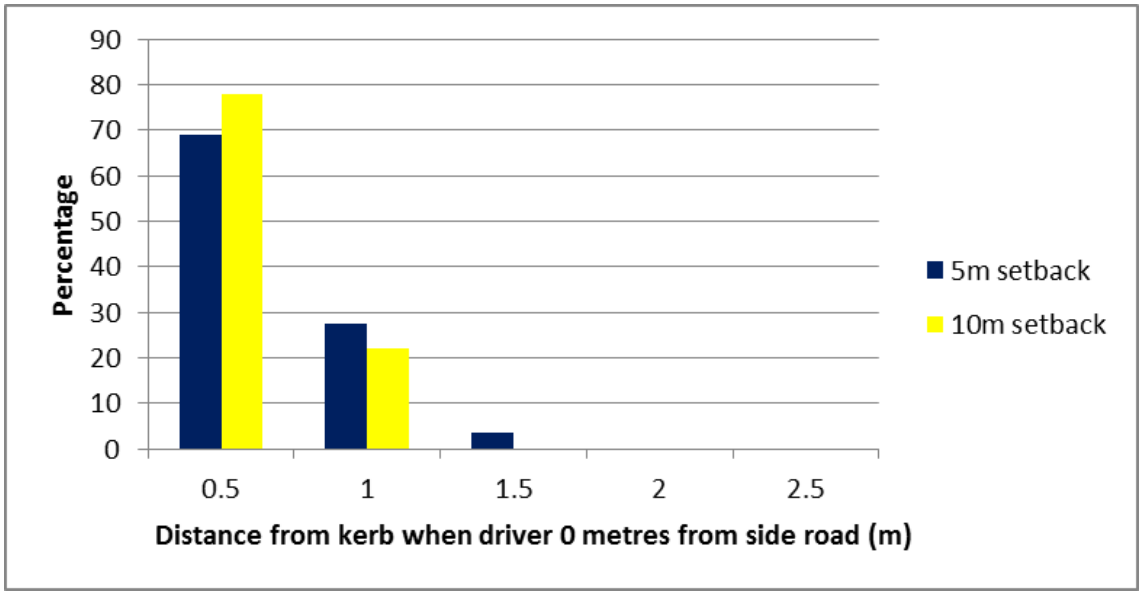

Figure 16: Distances from nearside kerb when car reached the main road (0 metres): Turning left

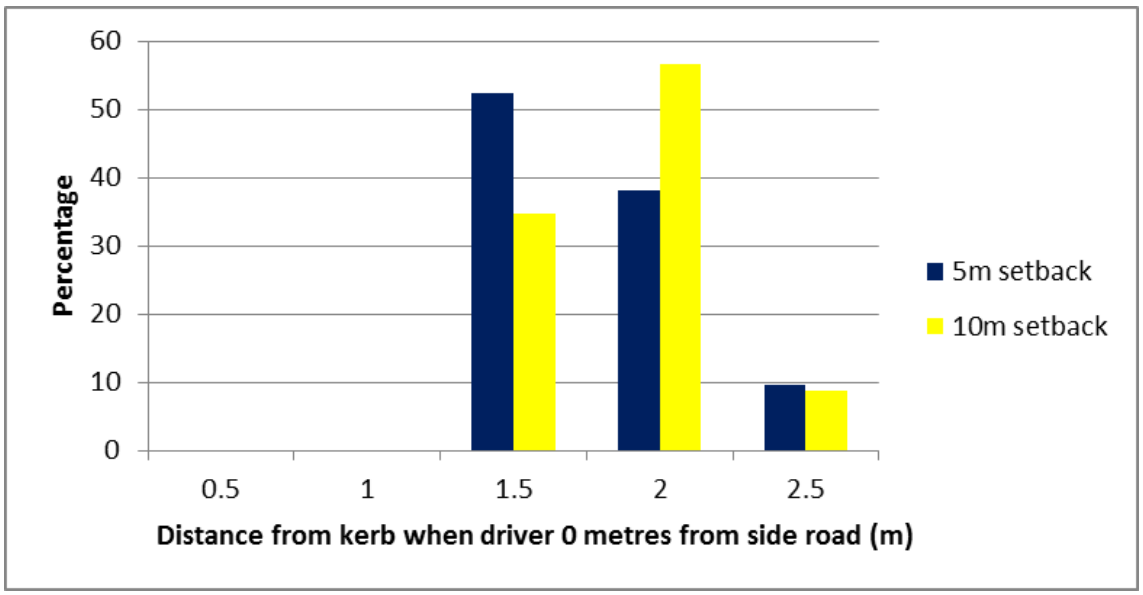

Figure 17: Distances from nearside kerb when car reached the main road (0 metres): Turning right

When turning left out of the side road, the distribution of distances from the kerb with a 5 metre setback were practically the same as those with a 10 metre setback. However, when turning right, the 5m setback resulted in a higher percentage of drivers being closer to the kerb at the main road: 1.5 metres rather than 2.0 metres.

From this, it would be expected that drivers turning right out of the side road would have been closer to perpendicular with respect to the main road with a 5 metre setback. Such a road position may be considered desirable for cyclist visibility. This deviation in distance from the kerb was also associated with a small, but statistically significant effect (at the 95% confidence level), on the vehicles' paths when joining the main road.

The derived relationships imply that the average speed of drivers turning left, or right, out of the side road were unaffected by setback. This was also evident in the calculated average speeds over the run from the start point to the main road entrance: varying between 9.6 and 10.3 mph for vehicle turning left, and 9.6 and 9.8 mph for turning right, out of the side road across all setback distances. Again, the average speed measure will understate speed reduction at the junction.

3.4 Passing Distance

The (lateral) passing distance between the car and the cyclist was recorded when cars overtook the cyclist. This only occurred when cars turned left into the side road. The average distance between the car and cyclist when they passed each other are summarised in Figure 18. This is for cars that passed the cyclist between the distances of 20 metres and -5 metres, where the 0 metres reference point was 6 metres before the side road's projected kerb line.

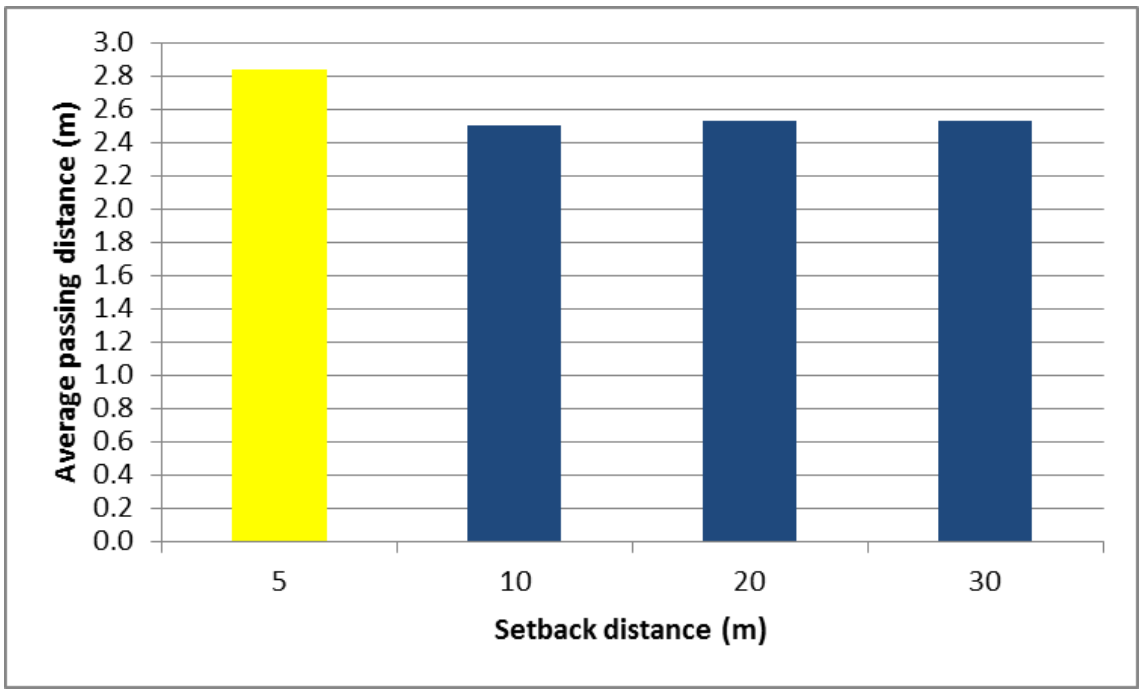

Figure 18: Average passing distance: Turning left

The averages were for the same drivers and cyclists at 10, 20 and 30 metres, but for different groups at the 5 metre setback. The drivers were randomly allocated to the groups on all four trial days. Also, tests have shown that whilst there were differences in car speeds on the first day of the trial, this was common to both groups taking part on

that day. It is therefore appropriate to consider the two groups as a treatment and control to see the effect of a 5 metre compared to a 10 metre set-back. It was found that the passing distance with a 5 metre set-back was significantly greater (at the 95% confidence level) than with a 10 metre set-back: the difference being approximately one-third of a metre.

Further, when the car and cyclists were parallel between 20 and 5 metres before the side road the average passing distance was 0.5 metres greater (3 compared to 2.5 metres) with a 5 metre setback.

3.5 Driver Decisions

Drivers approached, or exited, a side road. In all cases there was a cyclist approaching on the main road that could conflict with the driver's vehicle. The distance between the cycle and the car was varied by modifying the starting positions of the cyclists and requesting that they try to reach a given marked point (either 10, 20 or 30 metres) before the start of the associated main conflict zone when the car reached the 5 metres before the start of the main conflict zone (see Figure 19). The cyclists then continued straight across the side road.

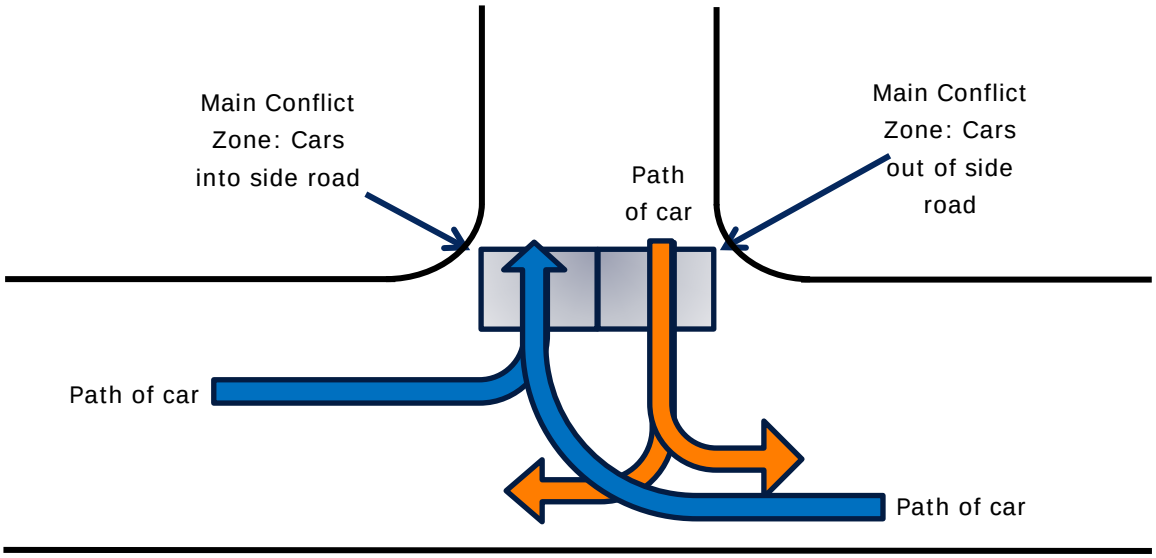

Figure 19: Conflict Zones

The driver therefore encountered a range of conditions at the side road. In each case they had to decide whether to pass in front of the cyclist. The alternative was to wait for the cyclist to reach and clear the conflict zone before entering themselves, and so pass behind the cyclist.

Drivers always experienced a cyclist on their nearside when approaching the side road and turning left into it. Also, similarly there was a cyclist approaching the side road in the opposite direction when they approached to turn right into the side road. In both cases they had to make a decision to either enter the side road in front of the cyclist, or behind them. Furthermore, they were asked to report whether they had changed their initial decision during their approach to the side road. Figure 20 and Figure 21 shows their decisions and whether they had changed them.

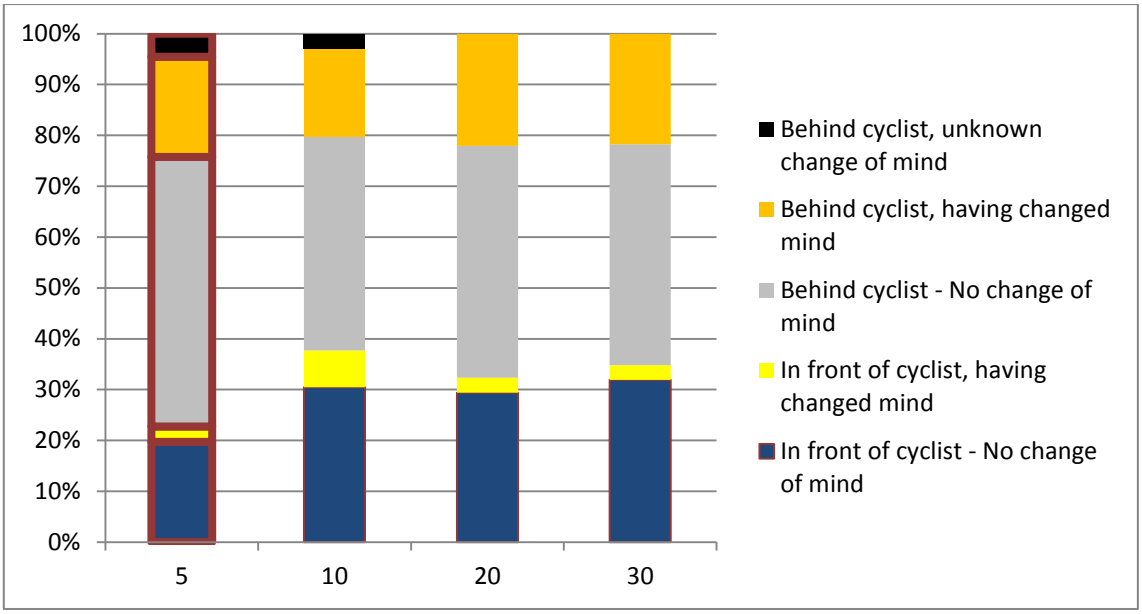

Figure 20 Driver decision when turning left into junction (bold outline indicates a different group of drivers)

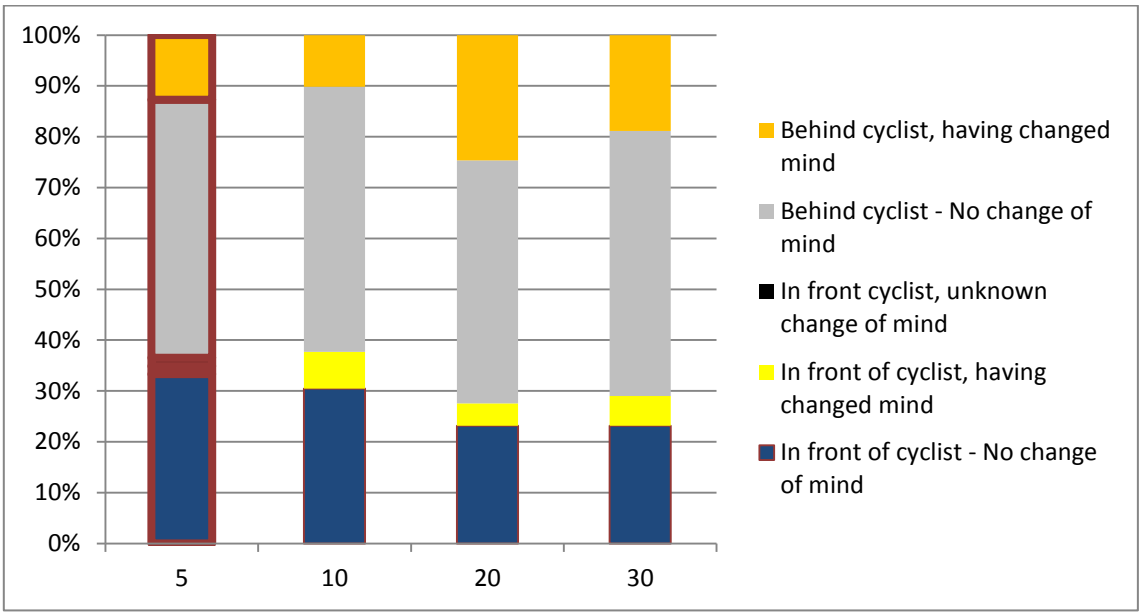

Figure 21 Driver decision when turning right into junction (bold outline indicates a different group of drivers)

Significantly more drivers (approximately 15%) chose to turn behind the cyclists with a 5 metre setback when turning left. This was probably a result of them reducing their speed. Also, more drivers (approximately 10%) also chose to turn behind the cyclists with a 20 and 30 metre setback than with shorter setbacks, however this difference was not statistically different.

Clearly, such decisions will be influenced by the distance of the cyclists from the side road when the car driver is at the side road: i.e. if close they should give way irrespective of setback, and if far away from the side road then the car driver would be

expected to go in front of them. The trial was designed so that each driver should have encountered a situation where the cyclist was 10 metres, 20 metres and 30 metres from the side road when the driver was at the side road. However, driver speed variation did result in some variation in the achieved distances – see **Figure 22** and Figure 23.

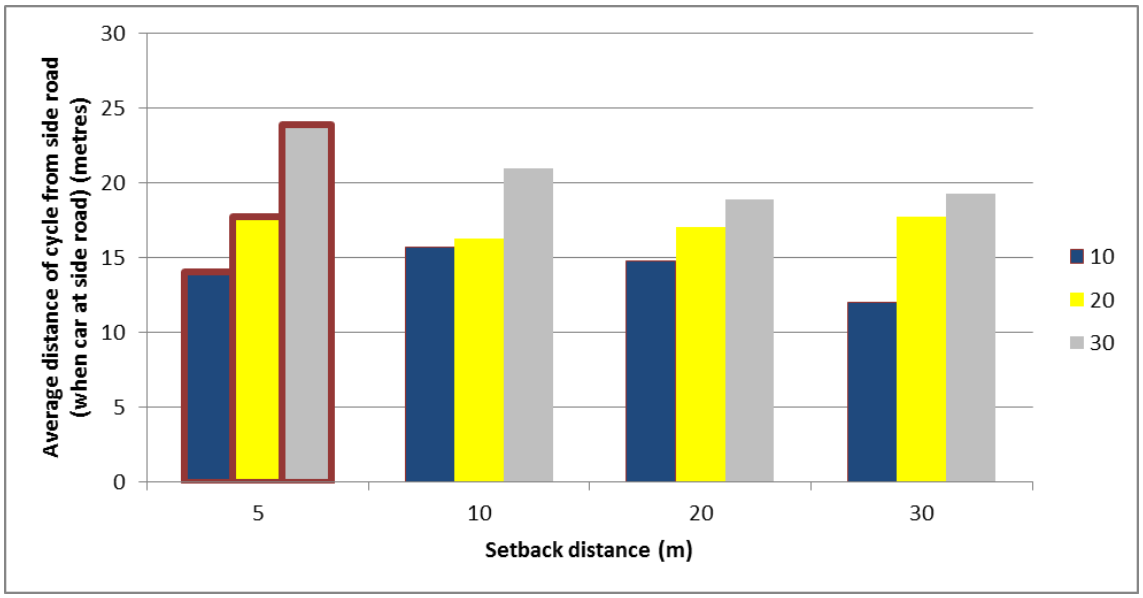

Figure 22: Average distance of cycle from side road (when car at side road and turning left) for different planned distances from the side road (Red outline indicates a different group of drivers)

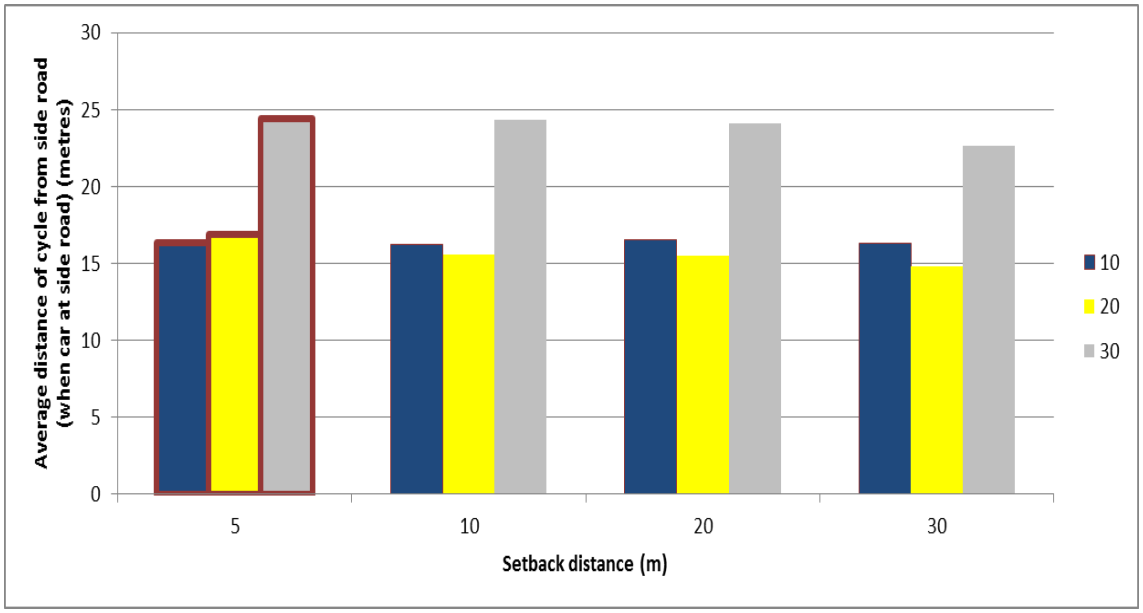

Figure 23: Average distance of cycle from side road (when car at side road and turning right) for different planned distances from the side road (Red outline indicates a different group of drivers)

In reality the observed distances did not appear to vary to the planned extent, although an increasing range was achieved. These values were affected by not being able to include in the calculation car drivers who held back away from the side road and let the cyclists through.

The main result was that little variation of the average observed distances for a planned distance occurred across the different setbacks.

As there was no relationship between setback distance and differences between planned and achieved distances from the side road, it was valid to consider the effect of the setback distance in isolation from the achieved distance of the cyclists from the side road in the above analysis.

Finally, the decisions of drivers turning left into the side road for different set-back distances and for different planned distances of the cyclist from the side road are shown in Figure 24.

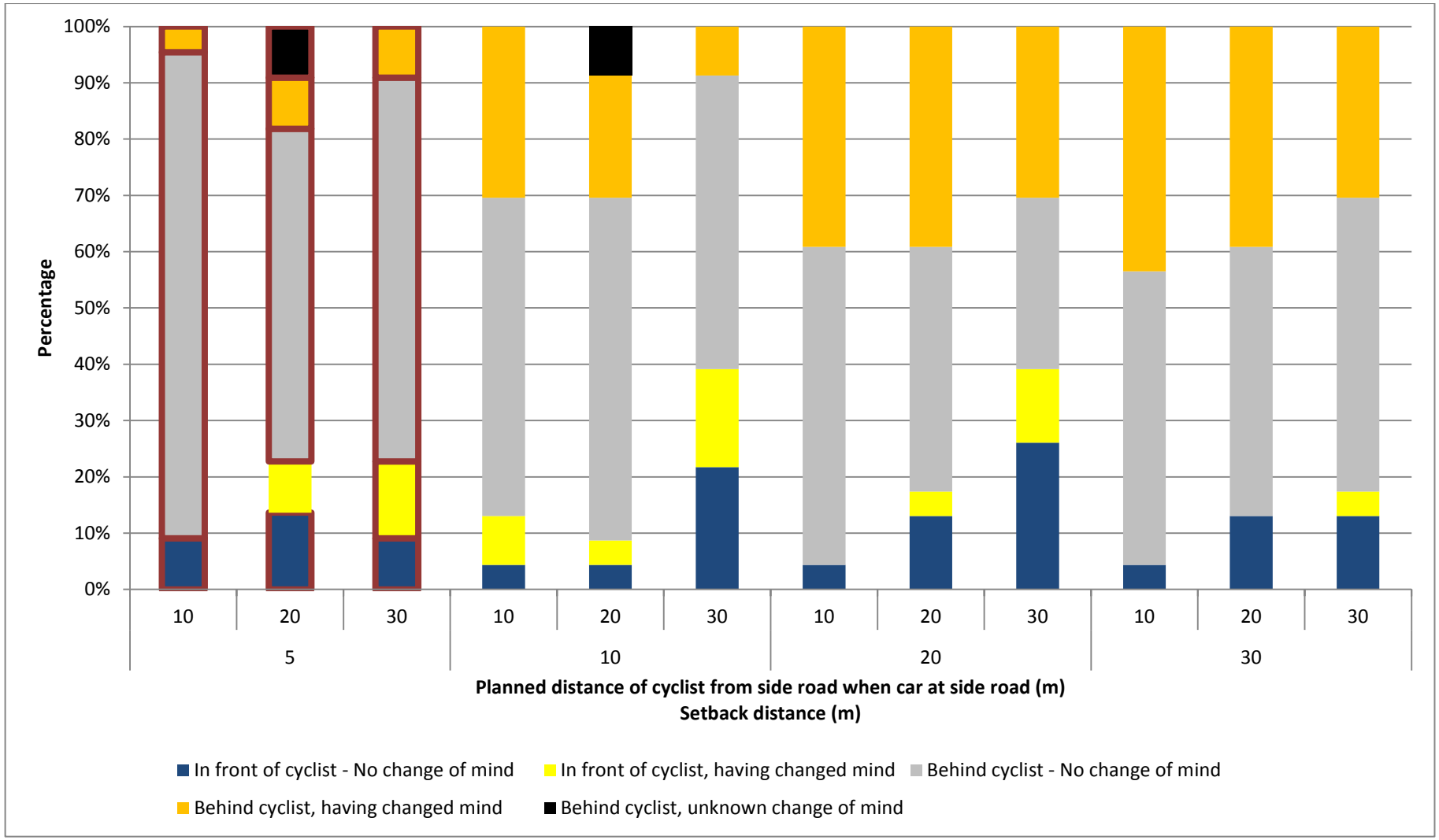

Figure 24 Driver decision according to set-back distance and planned distance of cyclists from side road for drivers turning left into side road (bold outline indicates a different group of drivers)

Generally, as expected, the percentage of drivers who decided to go in front of the cyclist increased with the planned distance of the cyclist from the side road when the driver reached the side road.

Drivers were more likely (an increase of 4%) to have changed their mind before turning in front of the cyclist with a 10 metre set-back: although this was not statistically significant.

In contrast, the drivers were less likely (a decrease of 4%) to have changed their mind before turning behind the cyclist with a 10 metre set-back: although this was not statistically significant.

These findings weakly imply that drivers when making a difficult decision at a 10 metre set-back are more likely to pass in front of the cyclist.

3.5.1 Out of Side Road

Drivers always experienced a cyclist approaching the side road from their right when arriving at the give way marking before entering the main road. They had to make a decision as to whether to exit the side road in front of the cyclist, or behind them. Furthermore, they were asked to report whether they had changed their initial decision during their approach to the main road. Figure 25 and Figure 26 shows their decisions and whether they had changed them.

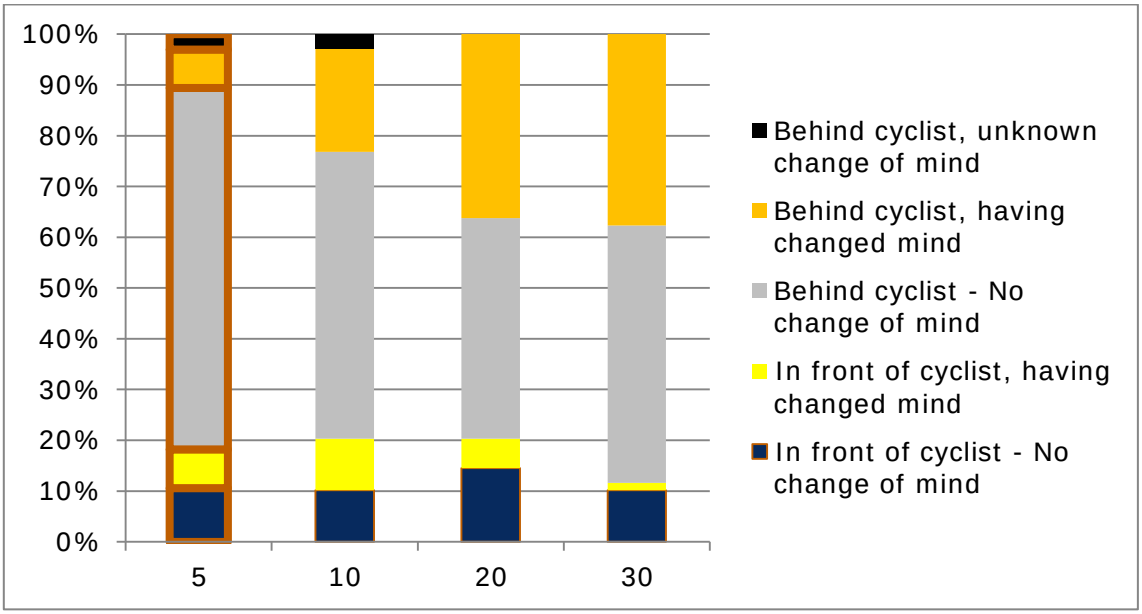

Figure 25 Driver decision when turning left out of side road (bold outline indicates a different group of drivers)

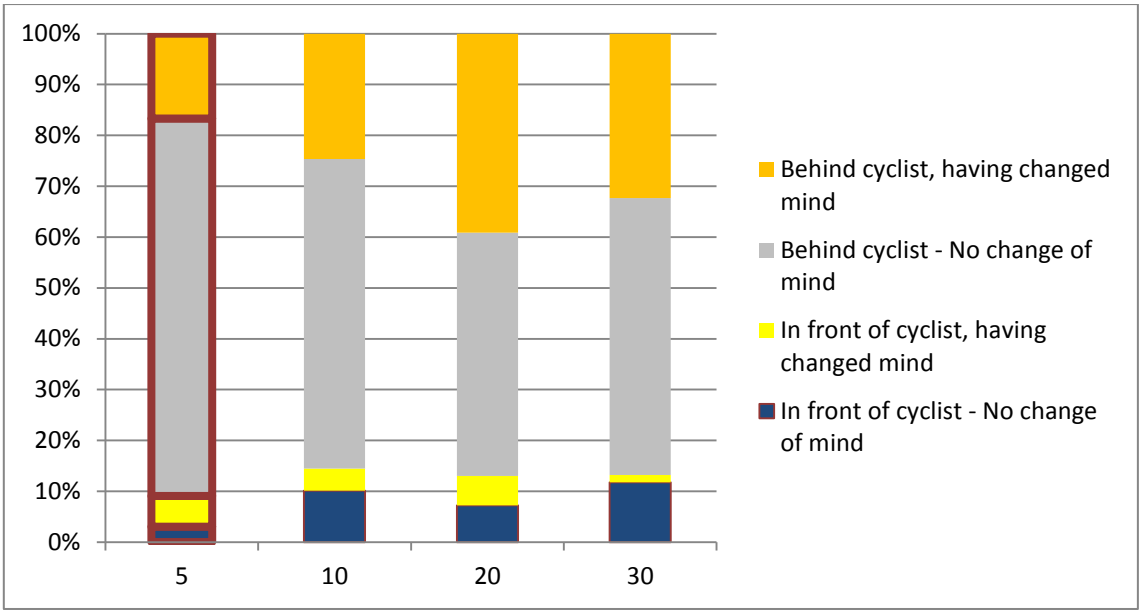

Figure 26 Driver decision when turning left out of side road (bold outline indicates a different group of drivers)

Approximately the same percentage of drivers decided to turn in front of the cyclists with all set-backs for a given manoeuvre out of the side road: 10% turning right and 20% turning left[3]. There was a relationship between set-back distance and the percentage of drivers who chose to wait for the cyclist after changing their mind. Fewer changed their mind as the set-back distance decreased:

- the percentage significantly decreased (at the 95% confidence level) between the 20 and 10 metres setback distances,
- the percentage significantly decreasing (at the 95% confidence level for those turning left and at the 90% confidence level for those turning right) between 10 and 5 metres setback distances.

The trial was designed so that each driver should have encountered a situation where the cyclist was 10 metres, 20 metres and 30 metres from the side road when the driver was at the side road. However, driver speed variation did result in some variation in the achieved distances, see Figure 27 and Figure 28.

[3] except for turning left out of the side road with a 30 metre setback, where only approximately 10% chose to turn in front of the cyclist (significant at the 90% confidence level)

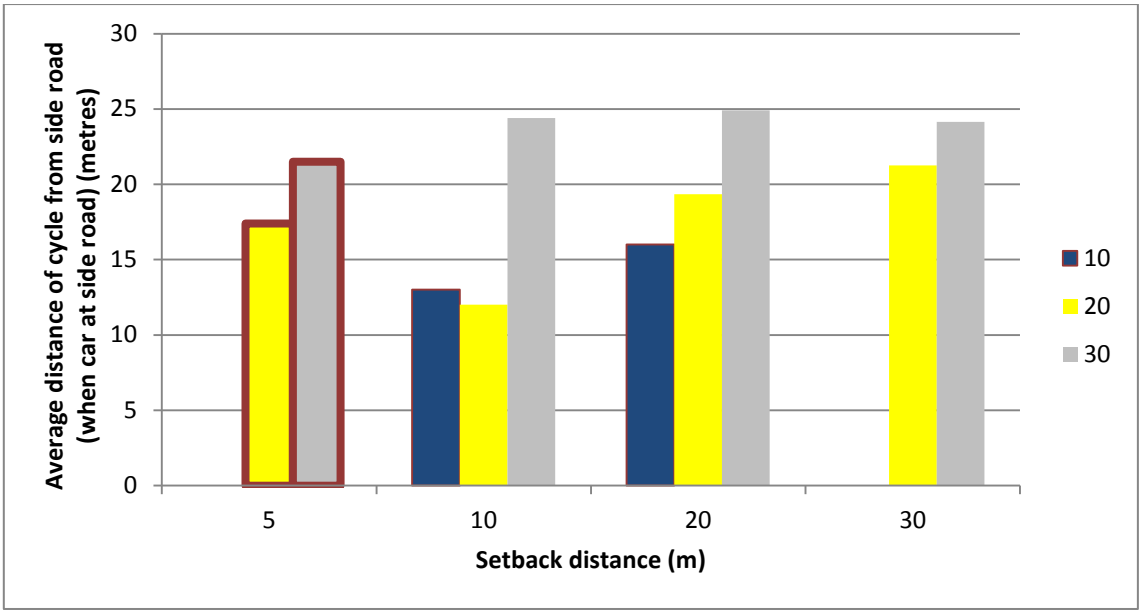

Figure 27 When turning left out of the junction: average distance of cycle from side road (when car at side road) for different planned distances from the side road (bold outline indicates a different group of drivers)

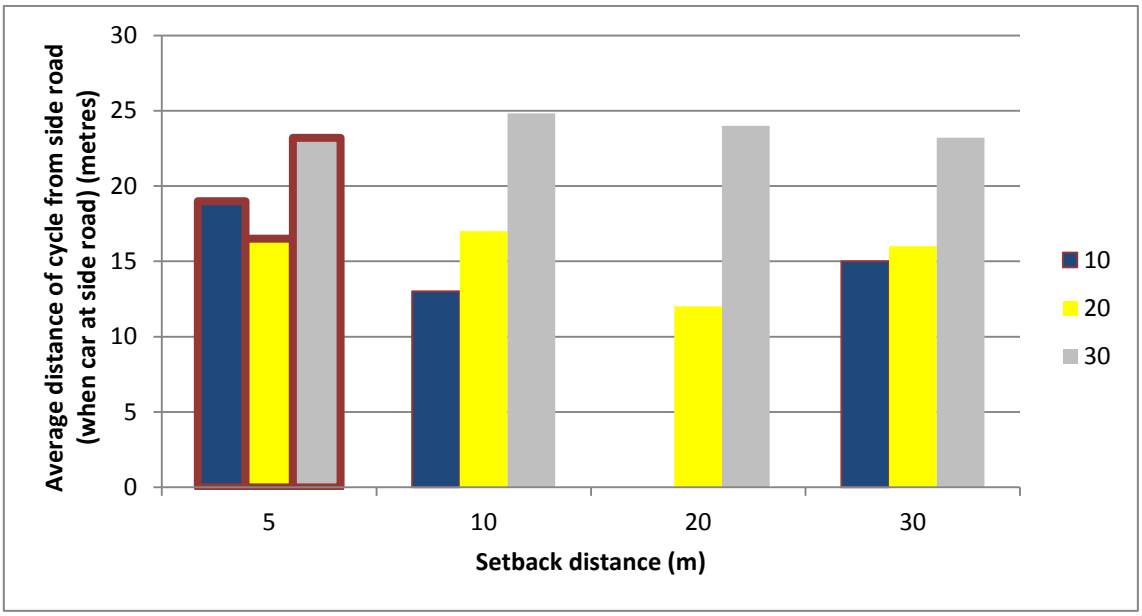

Figure 28 When turning right out of the junction: average distance of cycle from side road (when car at side road) for different planned distances from the side road (bold outline indicates a different group of drivers)

For turning into the side road, the observed distances did not vary to the planned extent, although generally an increasing range was achieved. However, there was little systematic variation of the average observed distances for a planned distance across the different setbacks. As there was no relationship between setback distance and differences between planned and achieved distances from the side road, it was valid to consider the effect of the setback distance in isolation from the achieved distance of the cyclists from the side road in the above analysis.

3.6 Waiting to exit side road on cycle lane

Drivers approached, and then exited, from the side road. There was always a cyclist approaching and no other vehicles on the road. The time drivers waited on the cycle lane was recorded in the trial, which is the time when their front wheels passed over the give way line until their rear wheels passed over the far side of the cycle lane. These times are summarised in Figure 29 and Figure 30.

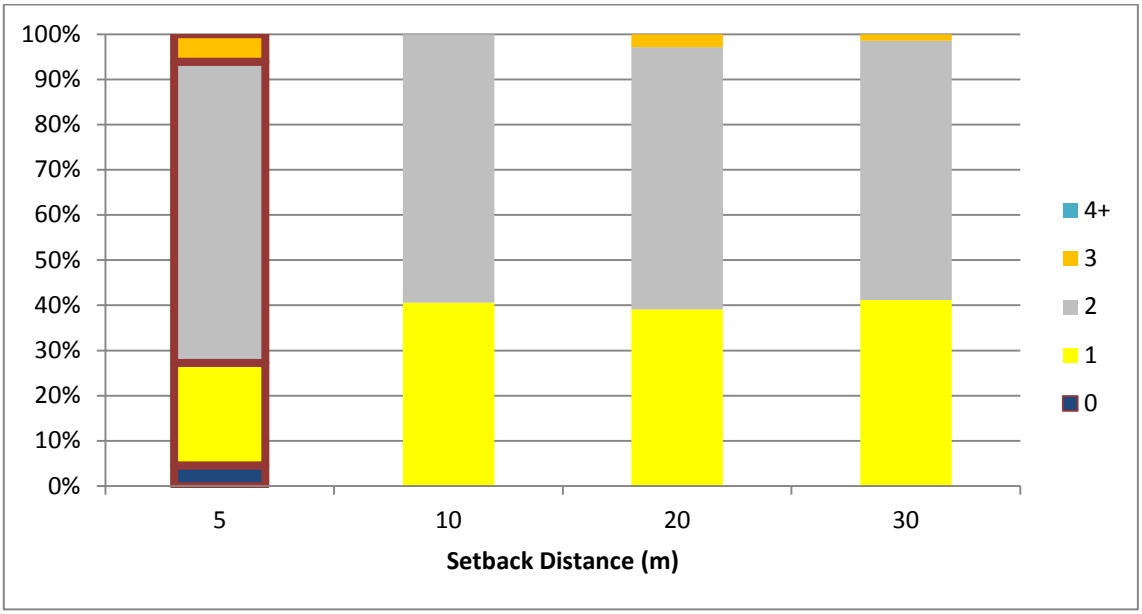

Figure 29 Turning left out of junction: time car on cycle lane (bold outline indicates a different group of drivers)

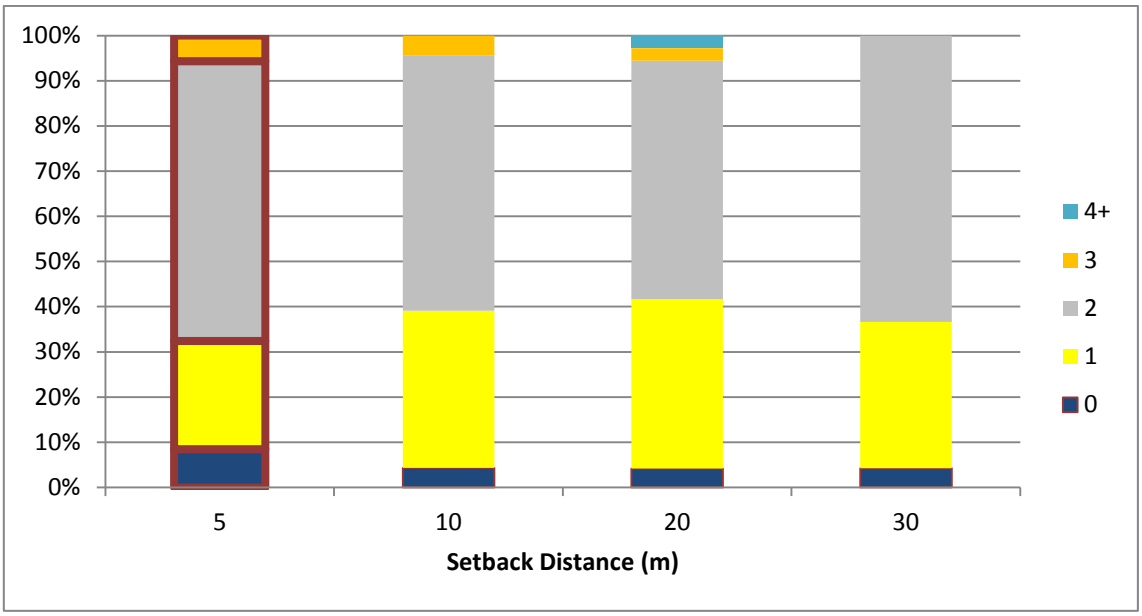

Figure 30 Turning right out of junction: time car on cycle lane (bold outline indicates a different group of drivers)

Very few drivers spent longer than 2 seconds to cross the cycle lane. Also, only 0.7% of those turning right out of the side road took longer than 3 seconds, and none took longer than 3 seconds when turning left out of the side road.

3.7 Drivers' Perceived Safety

Drivers were asked to rate the safety of the situation that occurred near/at the side road, after each time they had either turned in, or out, of it. The proffered scale was 1 being very unsafe through to 10 being very safe. This section considers changes in their perceived safety.

Drivers always experienced a cyclist near the side road when they turned into it. Also, for each set-back distance they encountered situations when the cyclist was far from the side road (approximately 30 metres), closer to the side road (approximately 20 metres), and close to the side road (approximately 10 metres). Their perceived safety would be expected to be based upon the ease of making their decision to go in front, or behind, the cyclist combined with the situation occurring subsequent to that decision.

3.7.1 Into Side Road

An exploratory analysis of the data revealed that two participants considered all encountered situations to be much less safe than their counterparts. This distorted the comparative safety scores. However, removing the second day's data from the analysis removed this issue. Figure 31 and Figure 32 shows the participants average safety score for different set-backs, for turning left and turning right respectively, for the remaining three days of the trial.

The analysis implies that the safety scores for setback distances of 10 metres and greater do not significantly vary. However, drivers considered that the situations experienced with a 5 metre setback were slightly less safe: 0.7 on the safety scale out of 10, which was significant at the 95% confidence level.

Further tests were performed to take account of the scores being based on the assessments of two different groups of drivers. This involved considering the difference in safety scores either between the 5 and 15 metre setbacks, or the 10 and 20 metre setbacks, depending on those experienced by the driver. This was limited to the drivers taking part in the first two days of the trial, as those on the other days experienced a different situation with a 15 metre setback.

The analysis indicates that whilst the drivers considered the 10 and 20 metre setbacks to be as safe (average variation in the safety score being 0.02), they did consider the 5 metre setback to be slightly less safe than the 15 metre setback: average variation in the safety score being 0.2. However, these variations were not statistically significant.

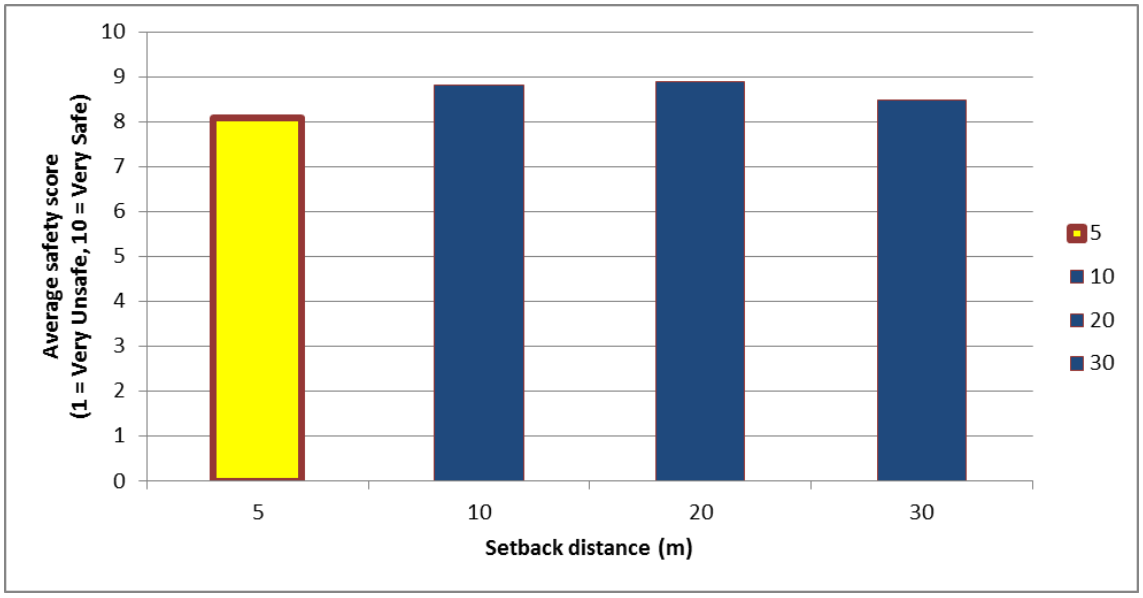

Figure 31: Average driver safety scores: turning left into side road (Red outline indicates a different group of drivers)

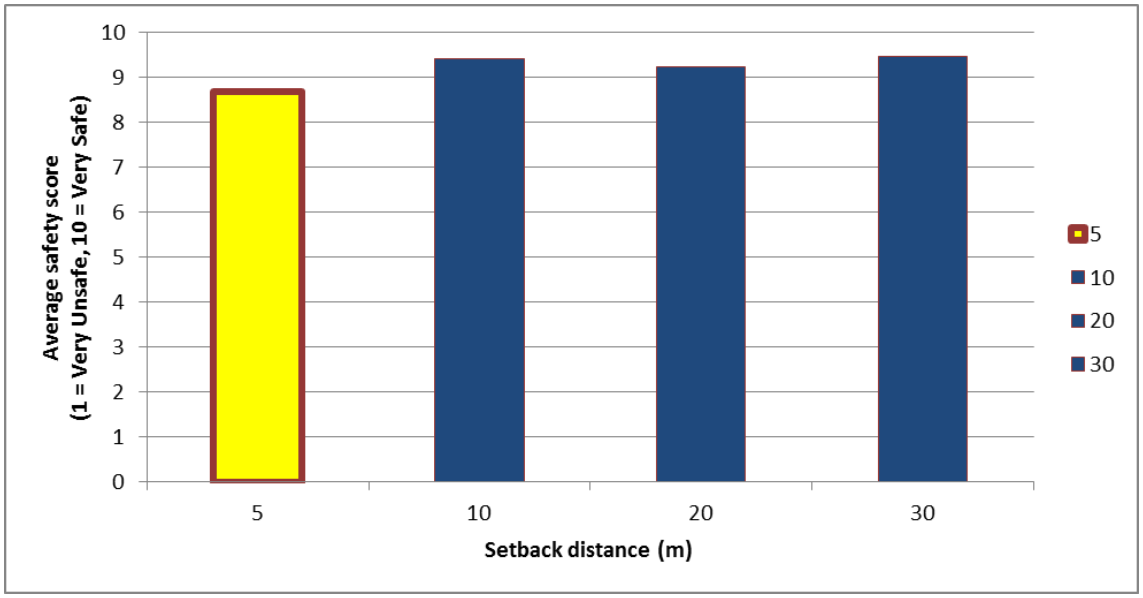

Figure 32: Average driver safety scores turning right into side road (Red outline indicates a different group of drivers)

3.7.2 Out of Side Road

The participants' average safety score for different setbacks when turning out of the side road are summarised in Figure 33 and Figure 34. The analysis implies that the safety scores for setback distances of 10 metres and greater did not significantly vary. However, drivers considered that the situations experienced with a 5 metre setback were very slightly less safe: 0.2 to 0.3 on the safety scale out of 10, which was not statistically significant.

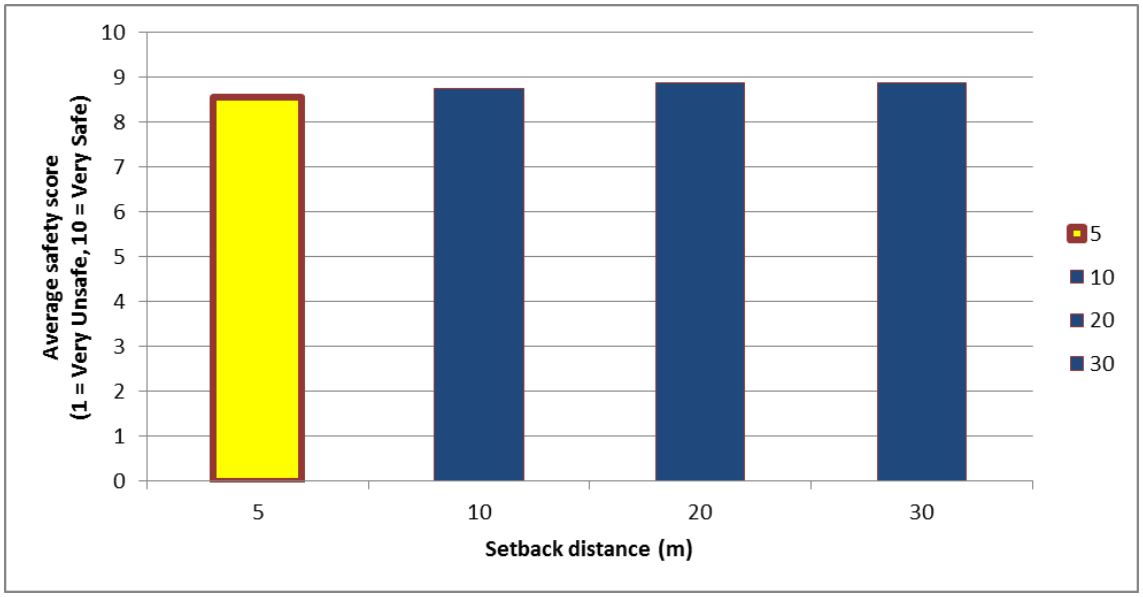

Figure 33: Average driver safety scores: turning left out of side road (Red outline indicates a different group of drivers)

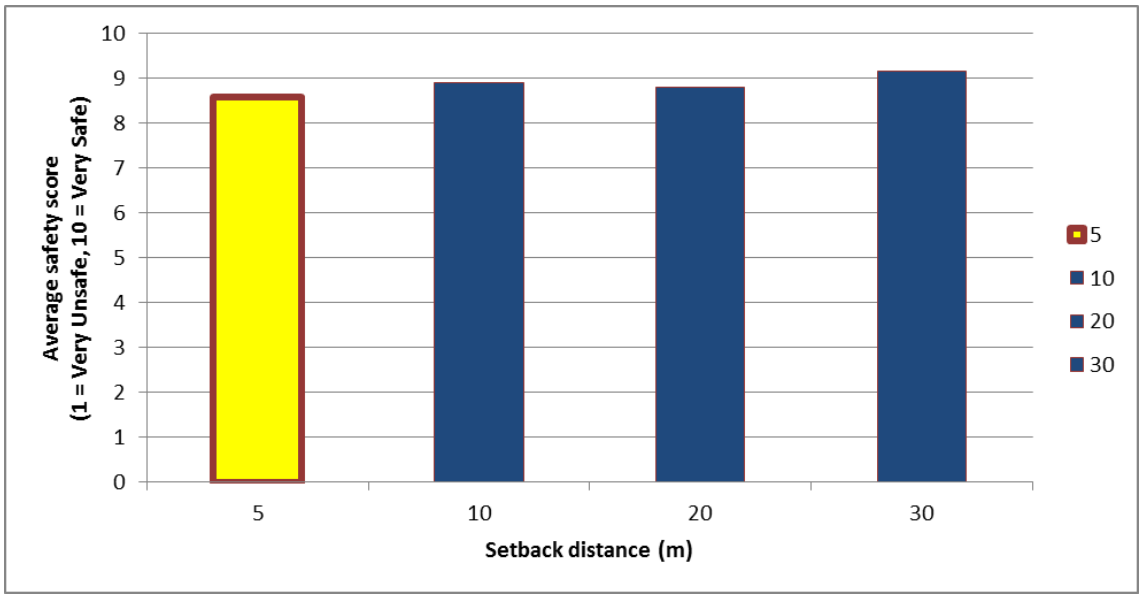

Figure 34: Average driver safety scores turning right out of side road (Red outline indicates a different group of drivers)

3.8 Drivers' turning with a queue present

Two groups on each of the final two days of the trial were asked to turn right into, or out of, the side road with a traffic queue present on the main road, see Figure 35. This was to observe what, if any, behavioural changes occurred when driver views of the cyclist were limited.

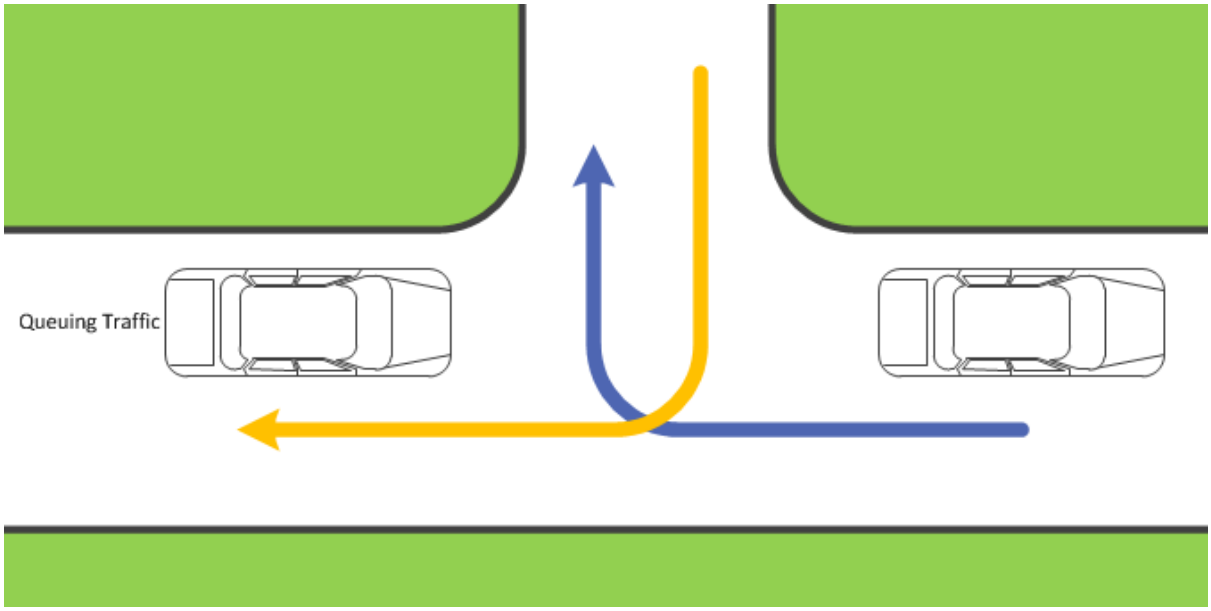

Figure 35: Traffic queues and turning movements

3.8.1 Paths

The average paths chosen by drivers turning right into, and out of, the side road when a traffic queue was present on the main road are shown in Figure 36 and Figure 37.

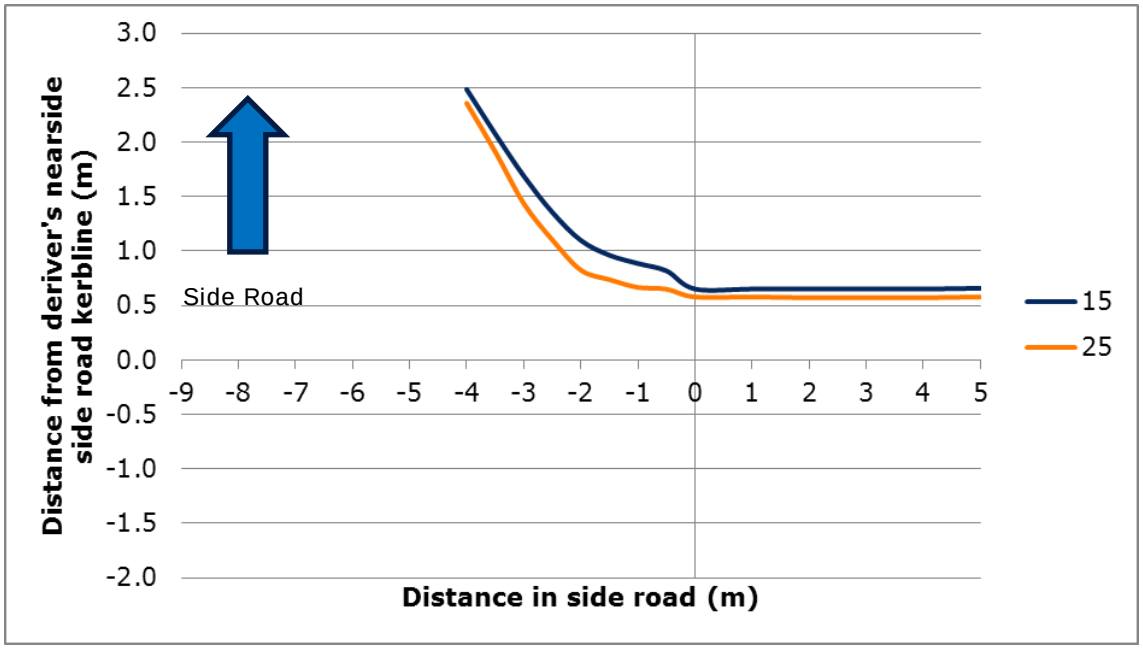

Figure 36: Average car path into side road: Turning right

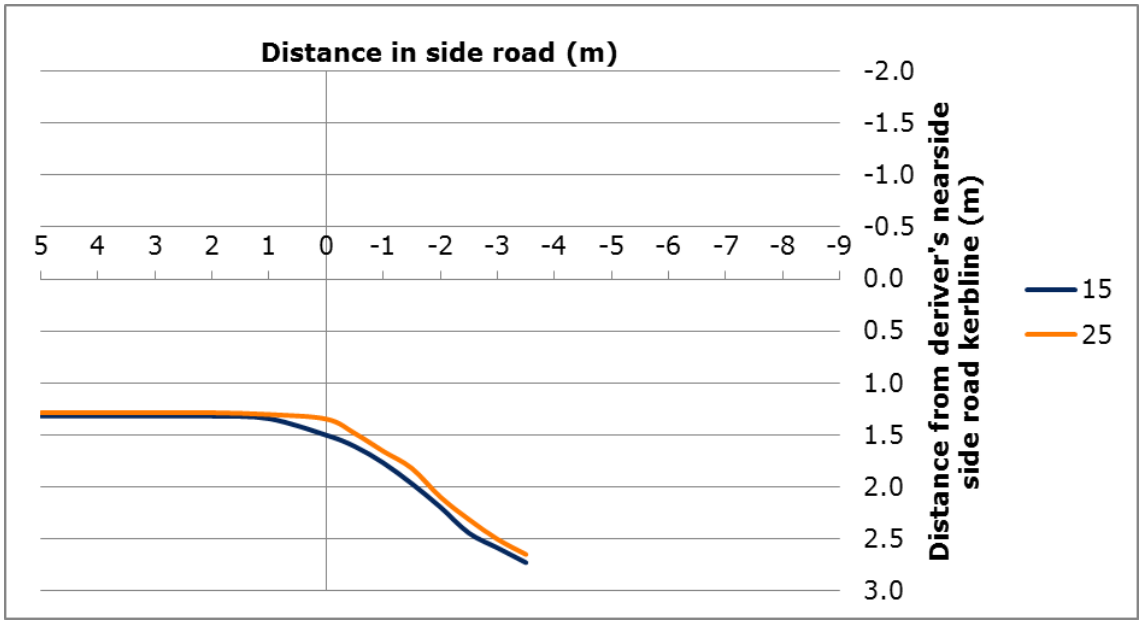

Figure 37: Average car path out of side road: Turning right

This shows that the paths out of the side road were unaffected by the traffic queue. However, drivers chose to enter the side road more sharply, i.e. at a more acute angle, when the traffic queue was present.

3.8.2 Speeds

The average speed of the car drivers measured from when they started to when they entered the conflict area with the cyclists are shown in Table 2 together with the speeds used in the same manoeuvres when a traffic queue was not present.

Table 2: Average speeds

	Into with queue	Out of with queue	Into without queue	Out of without queue
15m	11.60	9.48	13.70	9.80
25m	11.04	9.82	12.86	9.58

The speeds out of the side road were unaffected by the traffic queue. However, those into the side road were on average between 1.8 and 2 mph slower.

3.8.3 Decisions

Drivers always experienced a cyclist on the main road approaching the side road, who continued straight on. Drivers had to make a decision to either enter (or exit) the side road in front of the cyclist, as with the situations without a traffic queue. Furthermore, they were asked to report whether they had changed their initial decision during their approach to the side road. Figure 38 and Figure 39 shows their decisions and whether they had changed them.

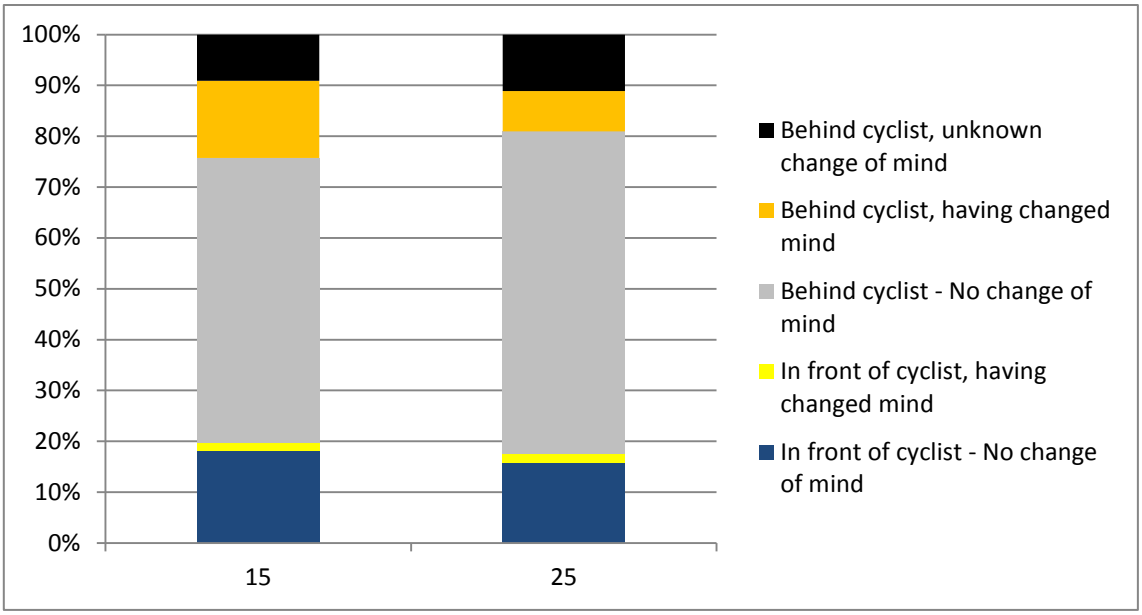

Figure 38 Driver decision turning right into junction with a queue (bold outline indicates a different group of drivers)

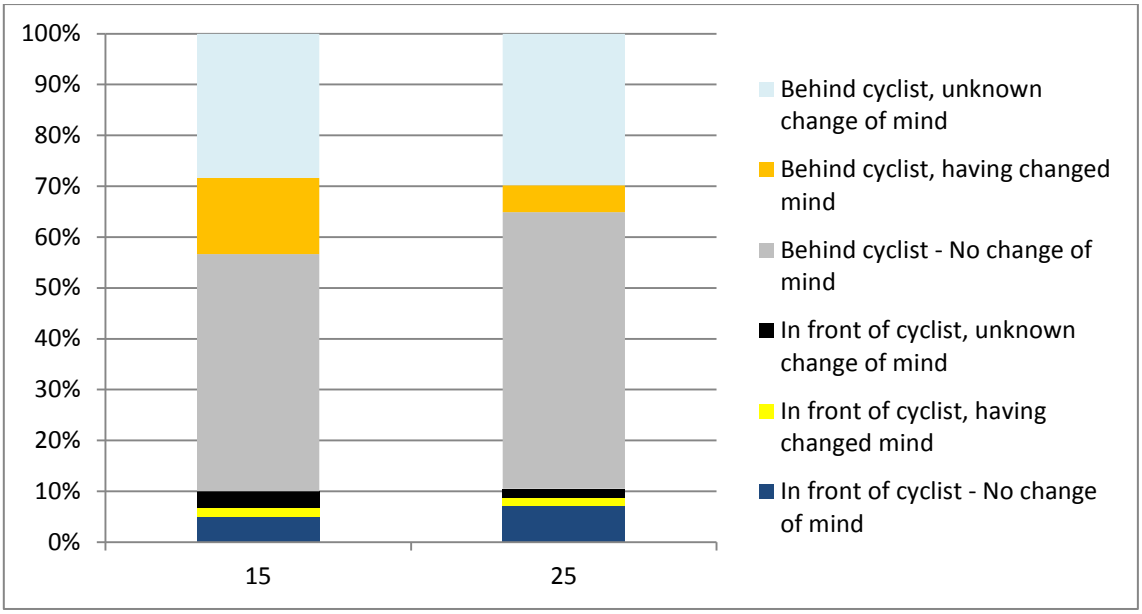

Figure 39 Driver decision turning right out of junction with a queue (bold outline indicates a different group of drivers)

The traffic queue had no observable effect on the decisions of drivers who exited the side road onto the main road. However, they were slightly less likely to turn in front of cyclist when entering the side road.

3.8.4 Safety

Drivers were asked to rate the safety of the situation that occurred near/at the side road, after each time they had either turned in, or out, of it on a scale of 1 (very unsafe) to 10 (very safe). Table 3 shows the average perceived safety scores with and without a traffic queue on the main road.

Table 3: Average safety scores

	Into with queue	Out of with queue	Into without queue	Out of without queue
15m	5.91	6.00	8.42	8.97
25m	6.18	6.88	8.76	9.19

Drivers felt less safe making the manoeuvres when a traffic queue was present. However, this only affected their behaviour (path, speed and decision) when turning into the side road between the cars in a traffic queue.

3.9 Summary of findings from video and track-side questionnaires

The key findings from the video surveys are summarised below, grouped against the research questions for the trial.

3.9.1 The position and driving style of drivers when undertaking the turning manoeuvres

The segregation set-back distance had little to no effect on car paths for set-back distances between 30 and 10 metres when drivers were turning into, or out of, the side road.

A 5 metre set-back did not affect the car paths when turning left out of the side road, and had little (if any) effect on those turning right into the side road.

However, there was a statistically significant effect with a 5 metre setback for car drivers turning left into the side road. The path with a 5 metre setback resulted in an average driver approaching the cycle lane at a more acute angle, maintaining their distance from the cycle lane for longer, and remaining out of the cycle lane for longer.

Also, there was a small effect on the car drivers' paths when turning right onto the main road with a 5 metre setback, with drivers using a more acute angle when exiting.

3.9.2 Drivers' decisions whether to turn in front of the cyclist or give way and turn behind

Significantly more drivers (approximately 15%) chose to turn behind the cyclists with a 5 metre setback when turning left into the side road. This was probably a result of them reducing their speed. Also, more drivers (approximately 10%) also chose to turn behind the cyclists with a 20 and 30 metre setback than with shorter setbacks, however this difference was not statistically significant. There was also a weak indication that drivers encountering a 10 metre set-back were more likely to pass in front of the cyclist when making a difficult decision turning left into the side road.

The same percentage of drivers decided to turn in front of the cyclists with all set-backs, when turning out of the side road. However, fewer drivers changed their mind as the set-back distance decreased.

3.9.3 The speed of drivers on approach to the junction

A driver's average speed increased as the approach path used got closer to the nearside kerb when turning left into the side road. Conversely, it increased the farther from the kerb when turning right into the side road. That is, the larger the radius of turning circle used to enter the side road, the greater the average speed.

It should also be noted that using a small turning radius into the side road results in a driver encroaching into the cycle lane later, and at an improved angle for seeing the cyclists.

Distances from the kerb with a 5 metre set-back were significantly greater than with a 10 metre set-back when turning left into the side road. This implies that the average speed of drivers turning left into the side road will be less with a 5 metre setback, and the observed averages were 11.6 mph with a 5 metre setback and 12.4 mph with a 10 metre setback. There were no observed differences in distance from the kerb, or speeds, for those turning right.

No relationships between distance from the kerb and speed were found for vehicles turning out of the side road, and no variations in speeds out of the junction were observed. However, when turning right out of the side road, with a 5 metre setback, a higher percentage of drivers were closer to the kerb. This implies the drivers were closer to the perpendicular with respect to the main road, which may be considered desirable for cyclist visibility.

3.9.4 The distance between the cycle and the car when they are parallel

The average distance between the drivers and cyclists were the same with 10, 20 and 30 metres segmentation set-backs.

It was found that the passing distance with a 5 metre set-back was significantly greater than with a 10 metre set-back: the difference being approximately one-third of a metre. Also, considering when the driver passed the cyclist between 20 and 5 metres before the side road the average passing distance was 0.5 metres greater.

3.9.5 Time spent waiting on the cycle lane

Setback distance had no effect on the time drivers waited on the cycle lane when exiting the side road. Very few drivers spent longer than 2 seconds in crossing the cycle lane. Also, only 0.7% of those turning right out of the side road took longer than 3 seconds, and none took longer than 3 seconds when turning left out of the side road. This suggests that drivers did not use the outside line of the cycle lane as a give-way line.

3.9.6 Perceived Safety

Perceived safety scores for setback distances of 10 metres and greater did not significantly vary when turning either into, or out of, the side road. However, drivers considered that the situations experienced with a 5 metre setback were slightly, but significantly, less safe when turning into the side road: a reduction of 0.7 on the safety scale out of 10. Also, slightly but not significantly less safe (0.2 to 0.3 on the safety scale) when turning out of the side road.

3.9.7 The effect of a traffic queue on the main road

Drivers' average paths turning right into, and out of, the side road when a traffic queue was present were at a more acute angle, when the traffic queue was present. Also, they felt less safe making the manoeuvres when a traffic queue was present.

This had no effect on speeds and decision when exiting the side road. However, speeds into the side road were on average between 1.8 and 2 mph slower and drivers were slightly less likely to turn in front of cyclist when entering the side road.

4 Post-trial questionnaire Results

4.1 Introduction

This section presents the results of the questionnaires completed by drivers after they had carried out all their runs for the trial.

Throughout this section the responses to closed questions are presented in graphs with vertical bars, and those from the open questions are presented in graphs with horizontal bars. This provides a clear differentiation between pre-defined categories explicitly selected by the respondents to the closed questions and categories defined by TRL's analysis on the basis of a manual classification of the free text responses to the open questions.

While the primary intention of the qualitative questions is to investigate the effect of different segregation set-back distances, the first set of questions asked more generally about the junction.

Drivers were asked a series of questions about how safe they felt, and how easy or difficult it was to turn at the junction, related to different aspects of the turning manoeuvre: seeing the cyclists, judging their speed and position, deciding to turn before or after the cyclist, getting into position, and making the turn. These questions also covered turning when there was a queue of traffic on the main road.

4.2 Overall perceptions of junction

4.2.1 Overall safety when turning left

Drivers were asked to assess the safety of turning left into or out of the side road (Figure 40). Most drivers thought it was safe or very safe and 14% thought it was unsafe or very unsafe. More of those turning left out of the side road rated it as very safe than those turning left into the side road, although the difference was not statistically significant.

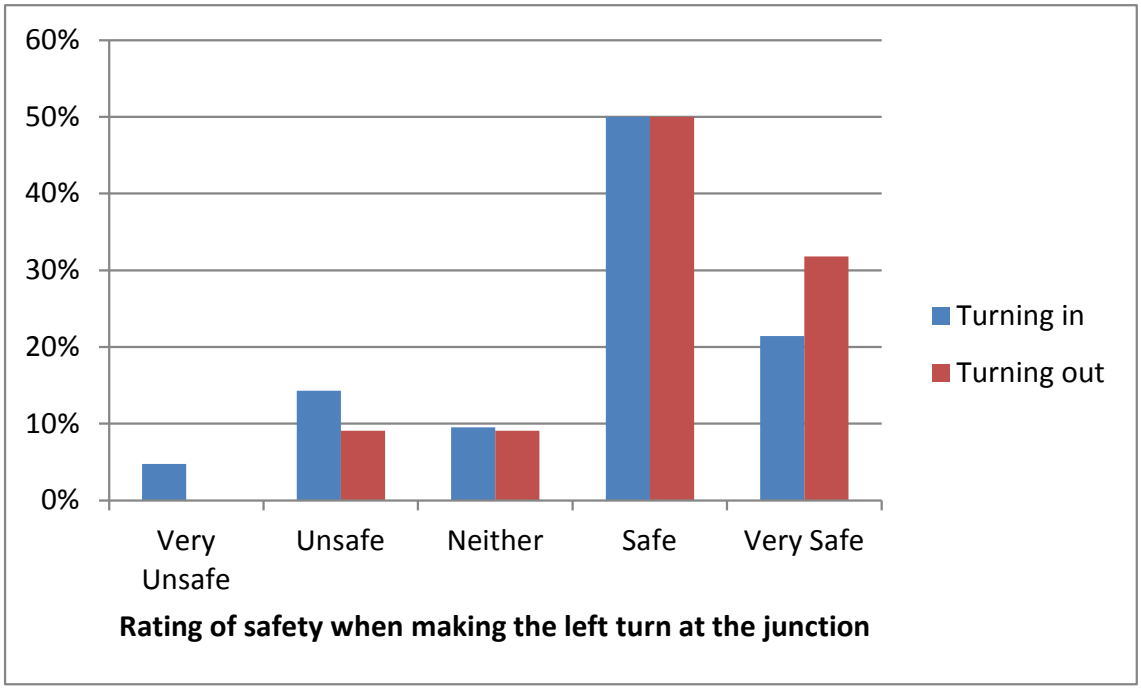

Figure 40: Rating of safety when making the left turn at a junction

In explaining their answers, some of the drivers turning left into the side road mentioned difficulties with seeing cyclists in their blind spot. One explained in some detail:

> *"Turning right - cyclist was always in full view with no doubt of his intention. Turning left- sometimes lost sight of cyclist in blind spot, not visible in side mirror, had to change mind and await cyclist to overtake on inside."*

4.2.2 Safety when turning right

Drivers were also asked to rate the safety of turning right into or out of the side road (Figure 41). A large majority thought it was safe or very safe and 3% thought it was unsafe. There was little difference between those turning out of the side road and those turning into it.

One driver, however, explained that there were times when it was difficult to see the cyclists:

> *"The most unsafe scenario was when making right turn and the cyclist could only be seen through the windows of the parked cars."*

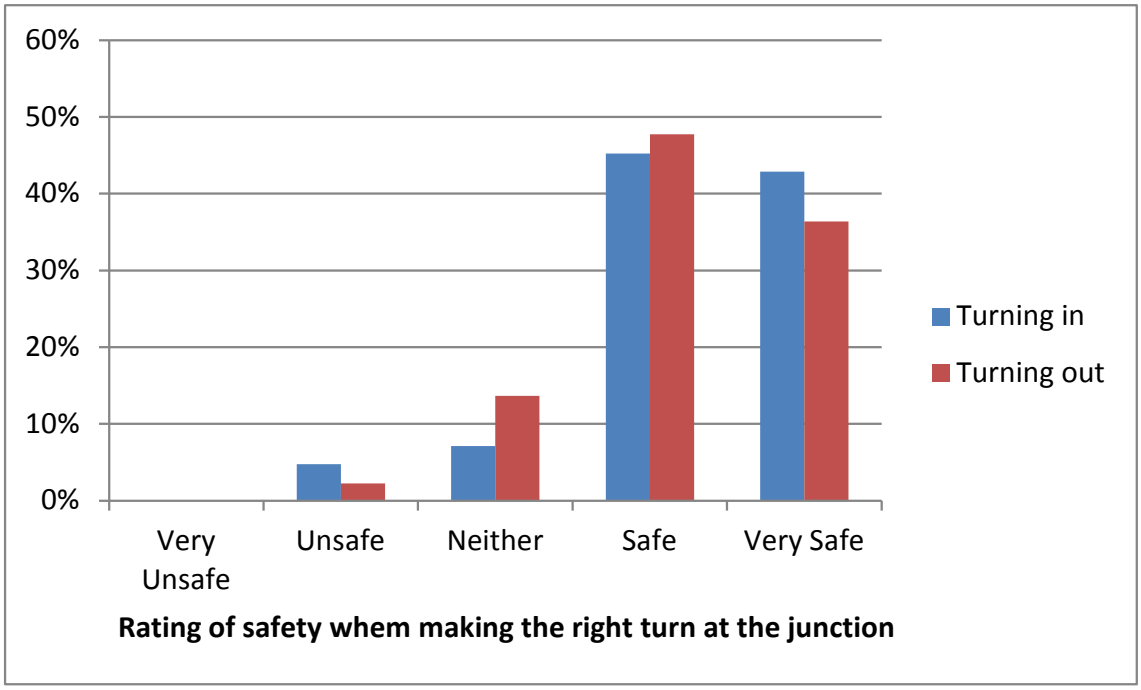

Figure 41: Rating of safety when making a right turn

4.3 Seeing cyclists and judging their speed and position

The majority of drivers said they found it easy or very easy to see the cyclists, as can be seen in Figure 42. A few of those turning into the junction found it very hard and a small proportion of those turning out found it hard. There was little overall difference between the drivers who turned into the side road and those who turned out of it.

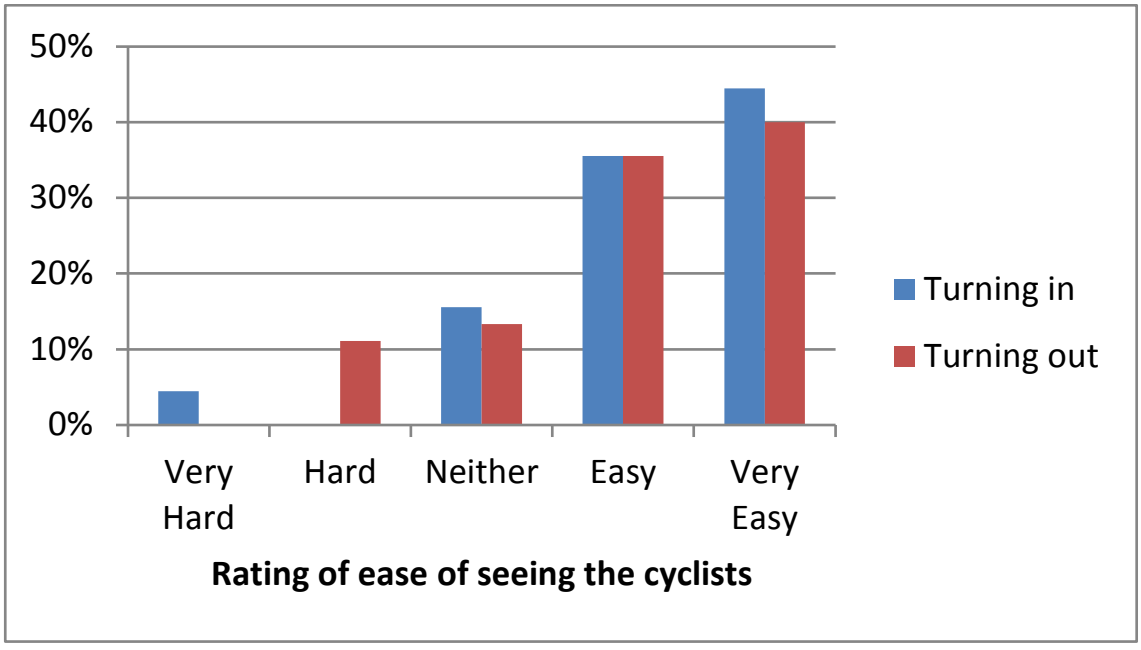

Figure 42: How easy participants found it to see cyclists

Most of the drivers also said it was either easy or very easy to correctly judge the speed of cyclists as they prepared to turn, as can be seen in Figure 43. Turning in and turning out had similar responses. A few of those turning into the side road found it very hard to judge, and about a fifth (whether turning in or out of the side road) found it hard.

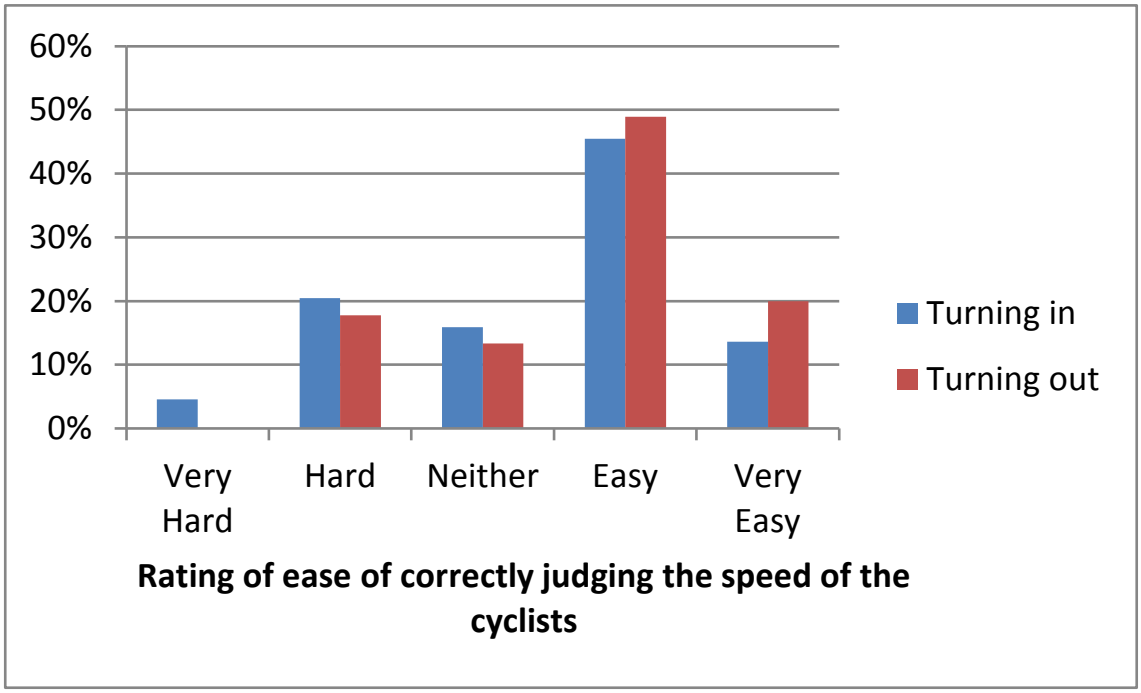

Figure 43: How easy participants found it to judge the speed of the cyclist

One driver explained why it was easy:

> *"It was very easy to judge what the cyclist was doing as you could see him in the mirrors all the time and in front of you."*

Some of the further comments about judging the speed of the cyclists from drivers turning into the side road explained the difficulties experienced by the drivers:

> *"I found it harder to judge the speed of the cyclist going away from me, and when turning right the cyclist wasn't always easy to view."*

> *"It is difficult to ascertain speed with a cyclist on your left and the possibility of a blind spot occurring. I would expect a cyclist to stop and give way to a car."*

One of those turning out of the side road commented:

> *"It was sometimes more tricky to gauge the speed of the cyclists, how much time I had to pull out."*

Most of the drivers said it was easy or very easy to judge the position of the cyclists correctly, see Figure 44. There were few (less than 5%) who found this hard or very hard. There was little difference between those turning into and out of the side road.

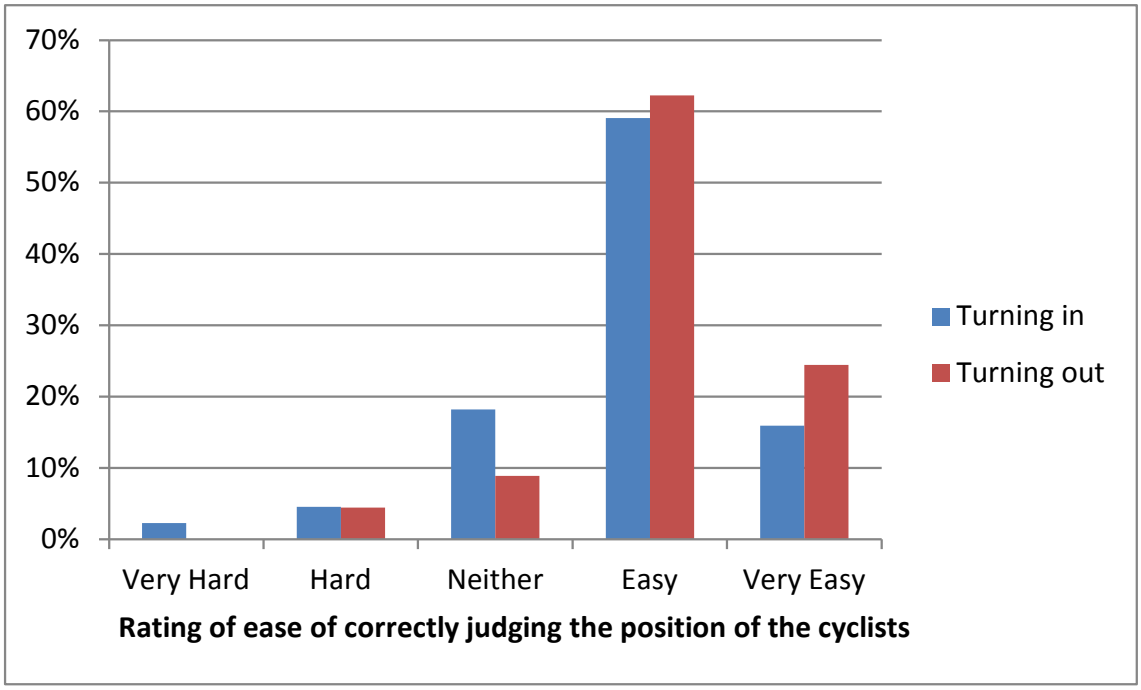

Figure 44: How easy drivers found it to judge the position of cyclists

However, the comments from the minority reporting difficulties identify some potential risks:

> *"When turning left it was not always easy to see the cyclist in the mirror/side mirror and therefore to judge where they were."*

> *"Because of the cycle lane you seem to be left stranded in the middle of the road - waiting an age until the cyclist makes a decision."*

4.3.1 Ease of making the decision to turn

A majority of drivers found it easy or very easy to decide whether to turn left before or after the cyclists (Figure 45). However drivers turning left into the side road found it harder to judge whether to turn before or after the cyclist, than those turning left out of the side road. Difficulties with seeing the cyclist on their left affected some drivers.

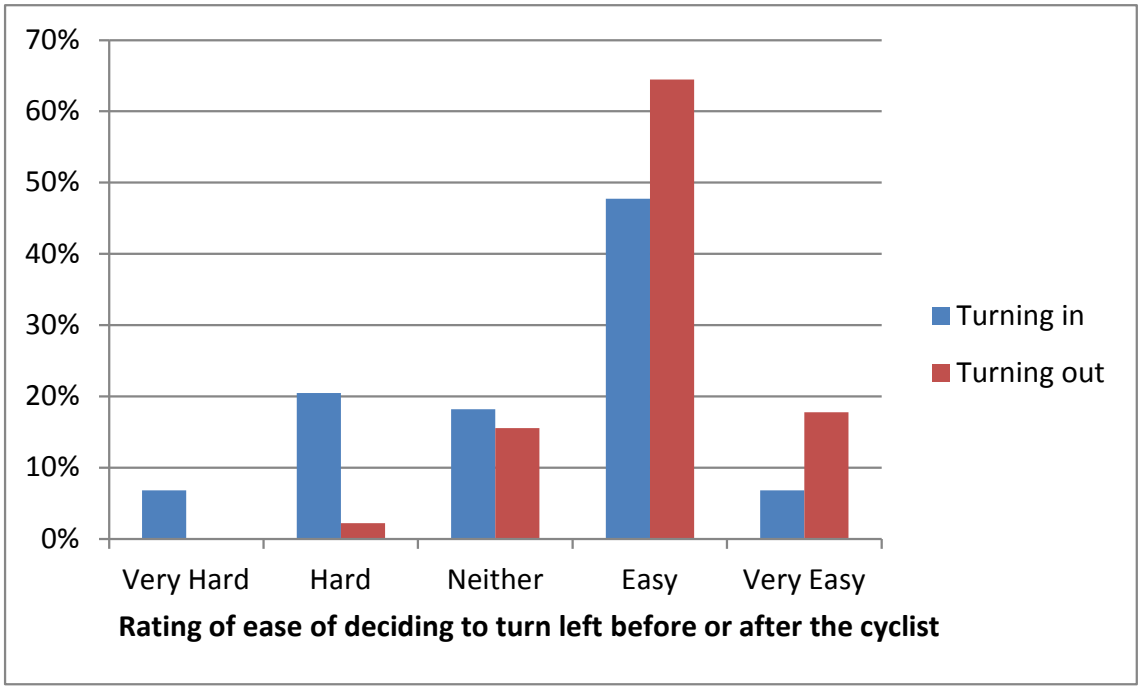

Figure 45: Ease of deciding whether to turn left in front or behind the cyclist

A majority (three quarters) of drivers found it easy or very easy to decide whether to turn right before or after the cyclists, as can be seen in Figure 46. It was also evident that deciding whether to turn right into the side road before or after the cyclist was easier than when turning left.

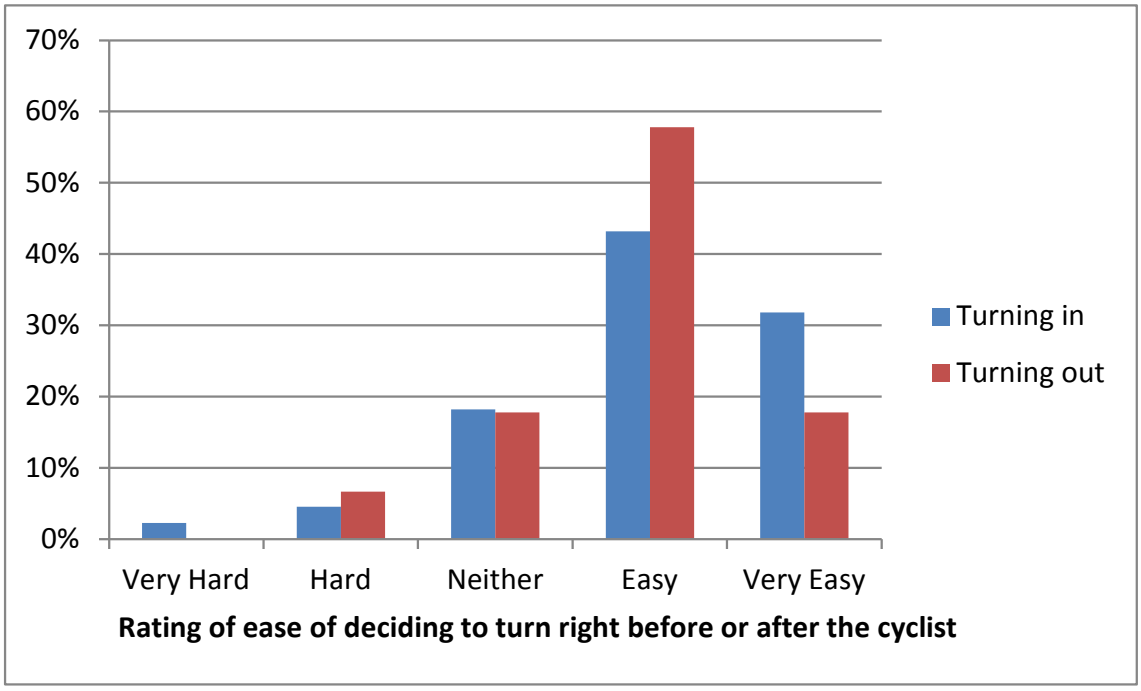

Figure 46: Ease of deciding whether to turn right in front of or behind the cyclist

Ninety percent of the drivers turning out of the side road and eighty percent of those turning into the side road said that initially it was either difficult or fairly difficult to make the decision to turn before or after the cyclist. However, more considered it difficult (rather than fairly difficult) to turn out of the side road, as can be seen in Figure 47.

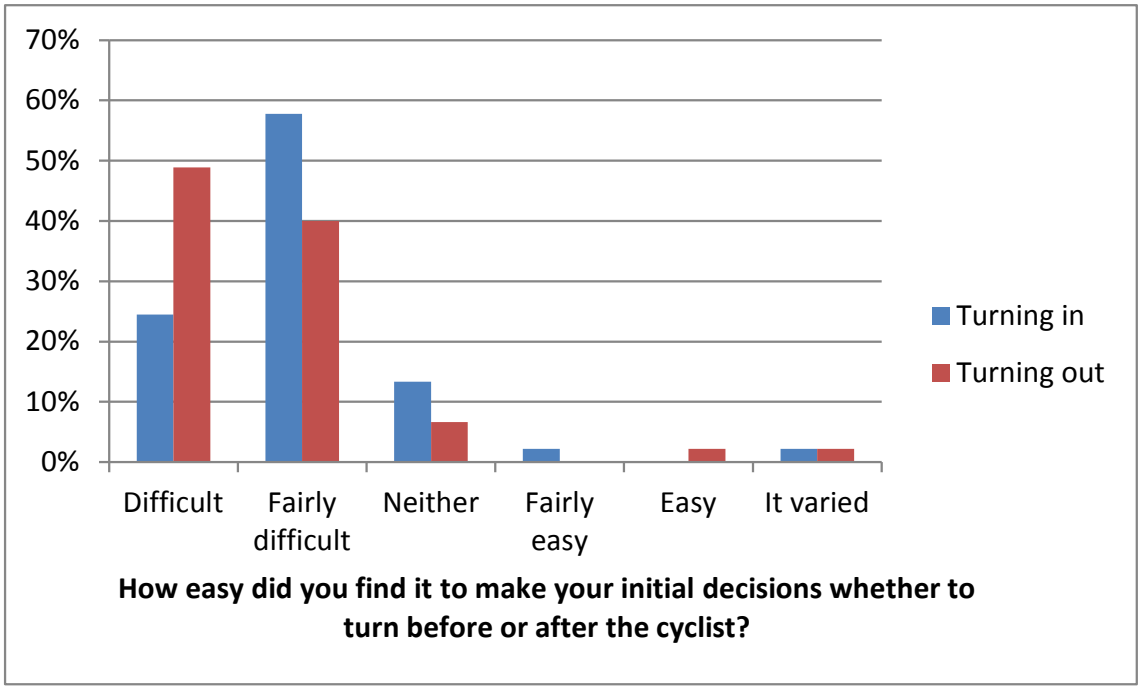

Figure 47: Ease of making initial decision to turn in front or behind cyclist

When asked to explain this further, the main issues mentioned were:

- Speed of the cyclist (mainly for those turning into the side road) – for example:

  "At times the cyclist seemed to speed up closer to the junction and a few times I felt I could go but decided it was safer to stop."

  "Speed of cyclist, some seemed to slow down after appearing to travel quite fast."

- Direction of the cyclist (mainly for those turning into the side road):

  "Easier with cyclist approaching."

  "Found it easier to judge the speed when cyclist coming towards me (may have been because in the other direction there were other cyclists."

- Whether the driver was turning left or right (mainly for drivers turning into the side road):

  "Turning right was hard as you could not see the cyclists till the last minute, so you have to take more care."

  "Turning right no problem, turning left- if lost sight of cyclist forced to wait [for] them passing in front of me."

  "Turning right was easy as the cyclist was in front of you in full vision. Turning left the decision was fairly easy in that if you couldn't see the cyclist in the mirror then you wouldn't turn but if you could see and judge the distance then you could make the decision."

- The driver's distance from the cyclist (mainly mentioned by drivers turning out of the side road):

  "*Depending on the speed and distance the cyclist was from the junction."*

  "The distances of the cyclist at the junction was always too close or not far enough away for me to turn. It was only on one occasion it was far enough away for me to turn and this was the time I had to feel confident about my judgement and I felt slightly unsafe."

Another factor mentioned was the general visibility (mainly by the drivers pulling out of the side road). Some drivers (a few turning into the side road and more turning out of it), chose always to wait for the cyclist before they turned:

"The decision was easy when turning as I won't compromise the cyclist so more often than not I would wait for the cyclist to clear past me. If the cyclist was at a safe distance away to make the turn which was quite far away then I would/maybe do so."

"[The] dotted 'give way' lines made it easy to know to take care and look for cyclists, they were always near enough to let them pass before I turned left or right."

Drivers were asked whether they ever had to change this initial decision to turn (Figure 48). Hardly any said they did so often or very often. However the drivers turning into the side road were much less likely to say 'never' than those turning out of the side road, while those turning in were more likely to say 'sometimes'.

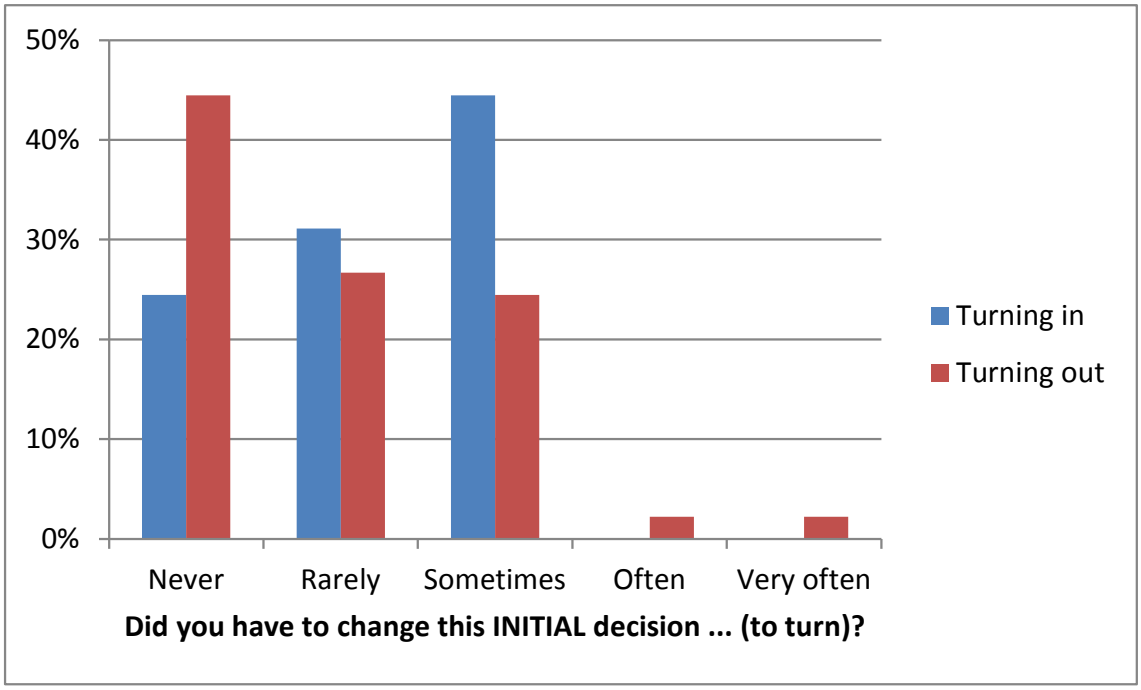

Figure 48: Whether drivers changed their decision to turn in front or behind the cyclist

From the explanations given, drivers mainly changed their original decision to go and then waited; just a few stated that they decided to go after initially deciding to wait. This may not be surprising under trial conditions- changes of mind are in the direction that might be expected where drivers are showing greater caution and are not under pressure to maintain progress and speed.

The comments indicate that drivers mainly changed their minds as a result of mis-judgements of cyclists' speed and distance (or both), but speed was mentioned more than distance:

> *"Bike speed - faster than [I] thought, [due to] traffic – [I] could only see cyclist's helmet."*
>
> *"Only a few times I changed my mind as the speed of the cyclist changed each time and depending on how far or near the cyclist was at the junction."*
>
> *"When the cyclist was slower I would reach the junction and it would take a few moments to ascertain whether I had time to go before the cyclist approached."*
>
> *"When [the] cyclist was at a certain distance, [I] thought about whether there was time to pull out or not without causing cyclist to stop."*
>
> *"When I was thinking about going and the cyclist got closer sooner than expected."*

Several drivers mentioned cyclists speeding up and slowing down, which was probably an effect of the trial conditions, although this could also reflect a of misjudgement of relative speed, especially if the driver was having to slow more for the turning than they had anticipated. A few drivers said they did not change their mind at all, often as a matter of principle:

> *"I wouldn't change my decision as this could often be disastrous."*
>
> *"I always stick to my first decision."*

4.3.2 Ease of getting into position to turn

Figure 49 shows that most drivers said they found it easy or very easy to get into position to turn left, and there was little difference between those turning into and out of the side road. Just under 10% said it was hard to get into position to turn left into the side road and just over 10% found it hard to get into position to turn left out of the side road.

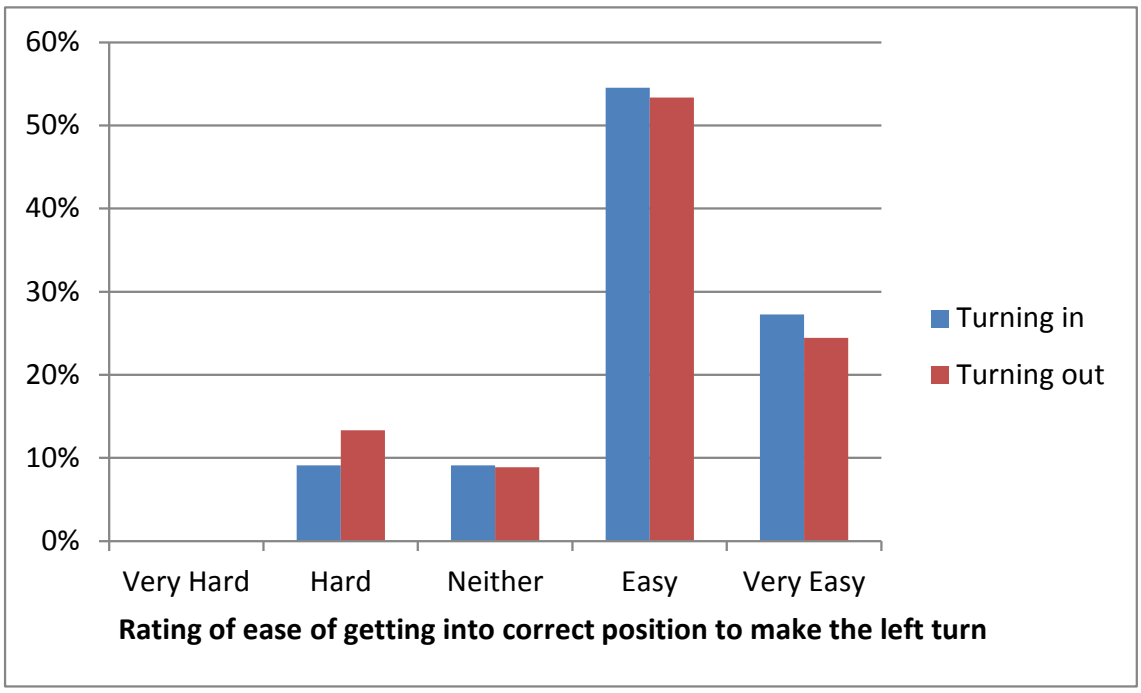

Figure 49: How easy drivers found it to get into position to turn left

Figure 50 shows that a rather larger proportion of drivers said they found it easy or very easy to get into position to turn right; turning right into the side road was rated by more drivers as 'very easy' than turning right out of the side road.

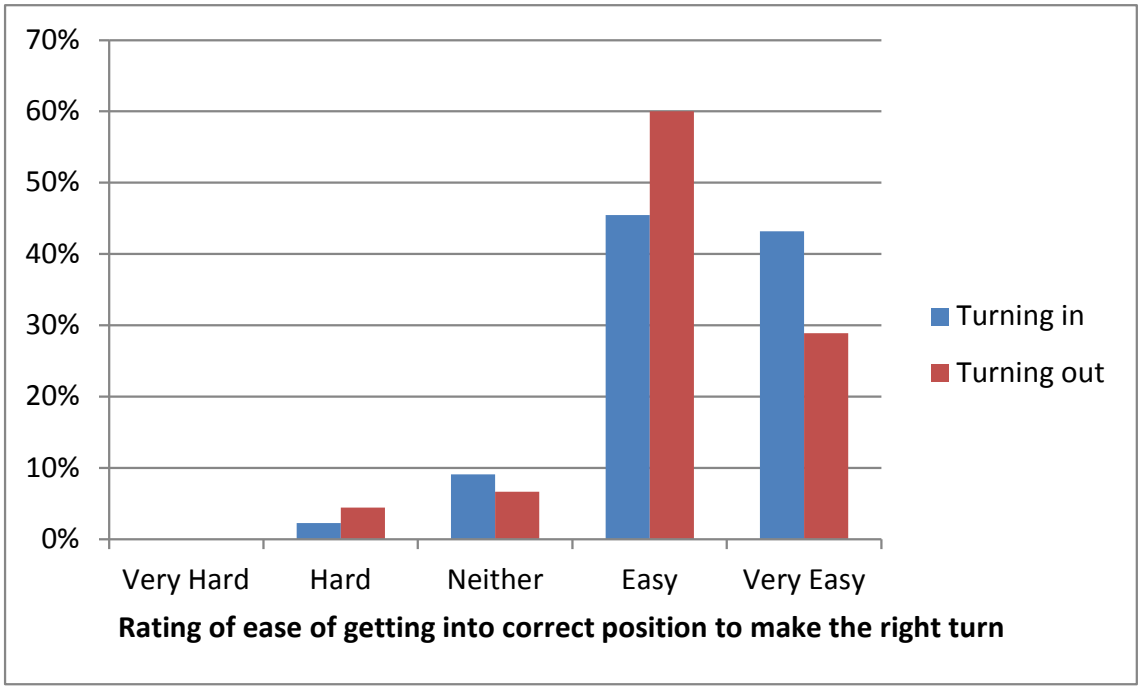

Figure 50: How easy drivers found it to get into position to turn right

Most of the drivers found it easy or very easy to make a left turn at the junction, and this did not vary between those turning into and out of the side road, as can be seen in in Figure 51. A minority (14%) found it hard or very hard to make a left turn. The great similarity between the last two results could be an indication that participants are not differentiating between these two similarly worded questions.

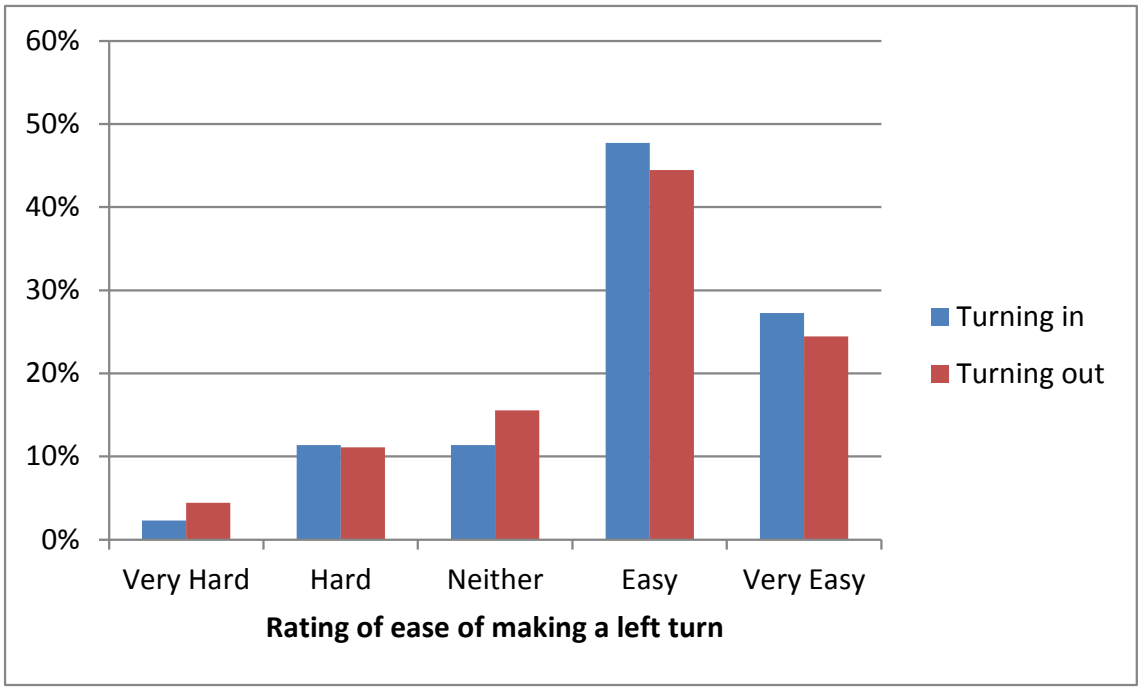

Figure 51: Ease of making a left turn

Figure 52 shows that almost all of the drivers found it easy or very easy to make a right turn at the junction. Those turning out of the side road tended to be more likely to rate this as 'very easy' compared with those turning right into the side road. Just 3% said it was hard to make a right turn.

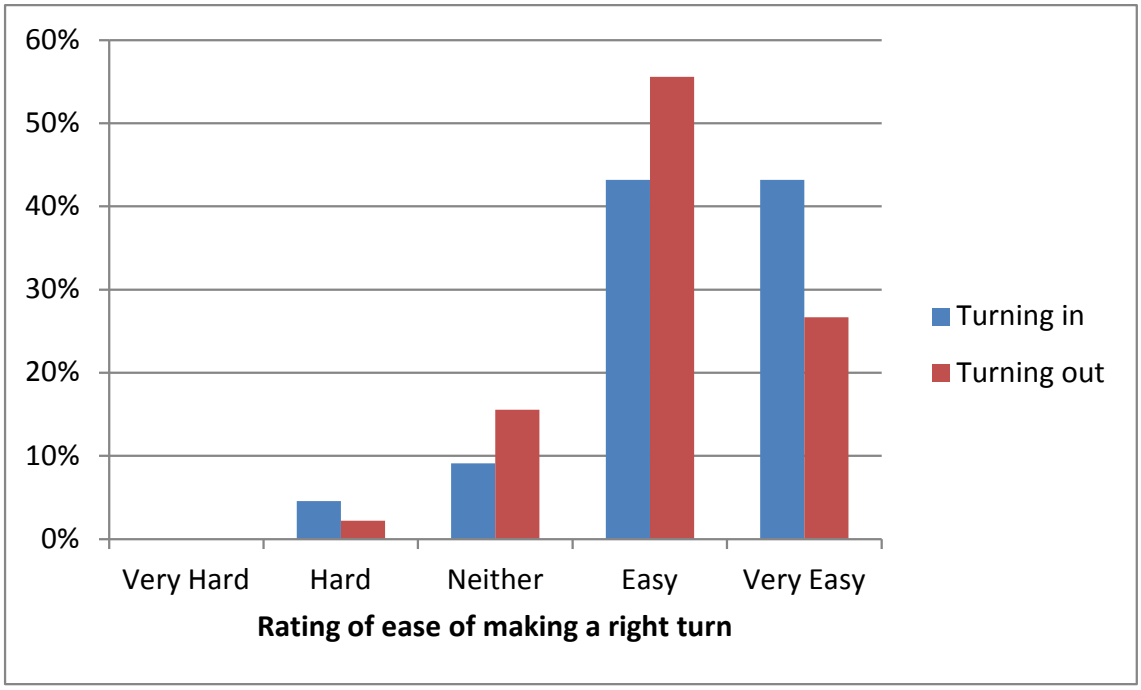

Figure 52: Ease of making a right turn

Drivers' comments about turning showed that several drivers turning left out of the side road had difficulty seeing the cyclists to their right, and judging their speed. Clipping the kerb and avoiding swinging out into the opposing traffic were also mentioned:

> *"For the left turn I had to check for the kerb more it seemed, but it was still easy to negotiate."*
>
> *"Found cycle path paving a hindrance when turning left."*
>
> *"Harder to make a left turn, felt I was having to go out further onto the opposite side of the road to make the turn past the kerb so I didn't clip the car."*
>
> *"The kerb on the left turn maybe a hazard if the driver is looking too much to the right hand side to turn left."*

Some of the drivers turning into the side road mentioned difficulties with seeing the cyclists and judging their speed:

> *"Did not feel as comfortable turning left as cyclist was then behind me."*
>
> *"Harder to see cyclist when you are turning left, blind spot makes it difficult."*
>
> *"…. It was only when the cyclist was already crossing the junction as I was driving towards the junction that I felt unsafe as you don't have time to judge and make a decision about the situation."*
>
> *"Turning right - cyclist was always in full view with no doubt of his intention. Turning left- sometimes lost sight of cyclist in blind spot, not visible in side mirror, had to change mind and await cyclist to overtake on inside."*
>
> *"Found it harder to judge the speed of the cyclist going away from me and when turning right the cyclist wasn't always easy to view."*
>
> *"It is difficult to ascertain speed with a cyclist on your left and the possibility of a blind spot occurring. I would expect a cyclist to stop and give way to a car."*

The assumption that cyclists should give way to a car, as demonstrated in the final comment, is a potential concern even if it only reflects the view of a small minority of drivers.

4.4 Effect of traffic queues

Drivers were also asked about how easy it was to see the cyclists, judge their speed and position and to make a right turn when there was a queue of traffic on the main road. There were just 20 drivers who experienced a queue so the results should be treated only as indicative, and no quantification is attempted in the summary report below.

In comparison with the no queue situation, there was an increase in the number of drivers reporting that it was 'hard' or 'very hard' to:

- see the cyclists when turning into the side road.
- judge the speed of cyclists when turning into the side road; and to
- judge the position of cyclists, both when turning in and out.

More stated that it was hard or very hard to decide whether to turn right before or after the cyclists, than when there was no queue. It was also less easy for drivers turning out of the side road to make this decision to turn right.

Overall, drivers found it somewhat less easy to get into the correct position for a right turn if there was a queue. This was the case both for drivers who turned into the side road and those who turned out of it. Also:

- Drivers turning into and out of the side road also tended to find it less easy to make the turn if there was a queue on the main road.
- Drivers rated the junction as less easy to use overall when there was a traffic queue on the main road, whether they were turning into or out of the side road.

4.5 Effect of different set-back distances

As each group of participants experienced only three of the different set-back distances used in the trial, and were not told the specific distance, questions referred to 'short', 'medium' and 'long', defined as follows:

- A short set-back distance with the kerb segregation stopping 5 to 10m before the junction
- A medium set-back distance with the kerb segregation stopping 15 to 20m before the junction
- A long set-back distance with the kerb segregation stopping 25 to 30m before the junction.

A caution does have to be applied to the results, as some responses to open questions suggest that a small number of respondents may have interpreted the distances the opposite way round, i.e. the 'long' kerb being the one that continued closest to the junction.

The participants were asked which of the three set-back distances that they had experienced felt the safest. 55% of those who answered this question stated that all three set-back distance felt the same with regards to safety. Of those that had a preferred set-back length, the middle length was their preference.

Figure 53 shows the responses split by gender and whether the participant was part of the group that turned into the side road or out of it. A larger proportion of those people

turning out of the junction felt that all the set-back distances were equally as safe. A higher proportion of women who turned into the side road felt that a particular set back distance was safest; however, the split between the three lengths was much the same, particularly between the medium and long set-backs.

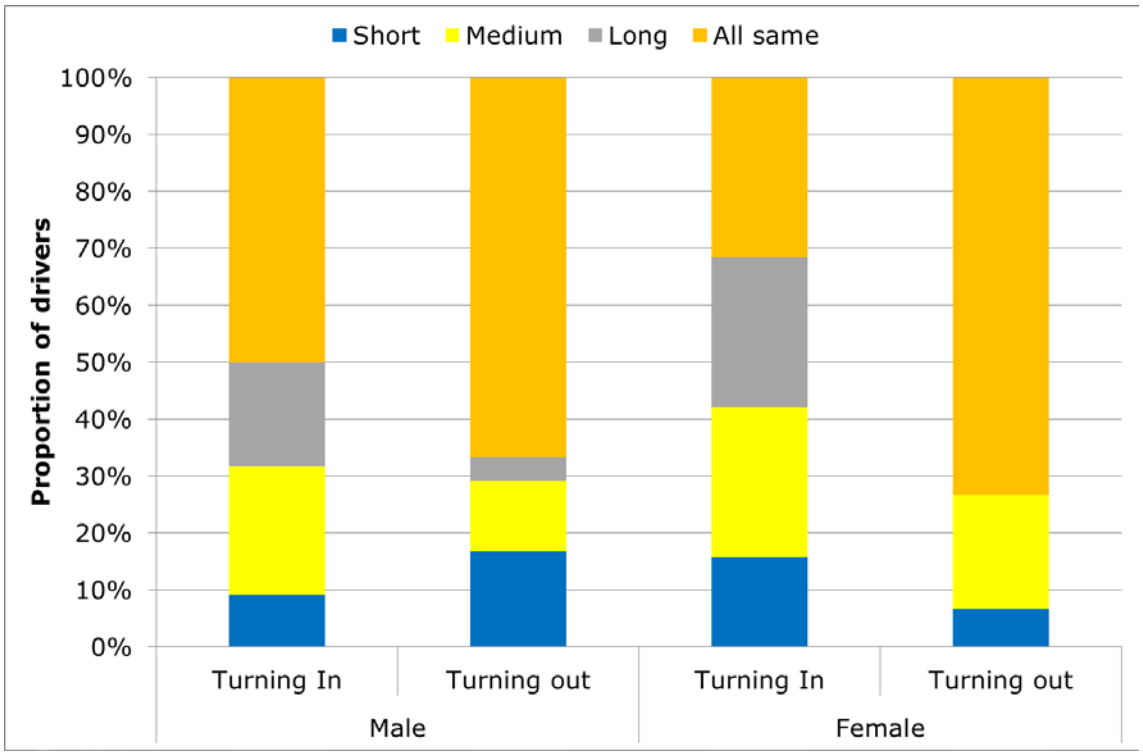

Figure 53: Proportion of participants rating each set-back distance as safest

Some of the comments that participants made regarding safety are given below:

> *"Short kerb set-back near junction made me more aware of cycle lane and cyclists."*
>
> *"I felt the cyclist and I were safer with the medium distance, it gave enough space to turn left but also made me more aware of the cyclist."* (Driver turning into the side road)
>
> *"Long - safer to make the turn."* (Driver turning out of the side road)

4.6 Ease of turning with different set-back distances

4.6.1 Preparing to turn

Drivers were asked about the relative ease of turning into or out of the side road with different segregation set-back distances, or whether they were all the same.

Figure 54 shows that a large proportion (around 70%) of the drivers who turned **out of the side road** did not find that the different set-back distances affected how easy it was to see the cyclist, judge their speed or position, to decide whether to turn before or after the cyclist or to make the initial decision to turn. Of those drivers turning out of the side road who did find one of the set-back distances easier than the others, more favoured the short and medium set-back distance over the long distance for these tasks involved in preparing to turn.

About 45-50% of the drivers who turned **into the side road** said that the set-back distance did not affect how easy it was to see the cyclist, to judge their speed or position, to decide whether to turn before or after the cyclist or to make the initial decision to turn. There was no clear preference for any of the three set-back distances among drivers turning into the side road.

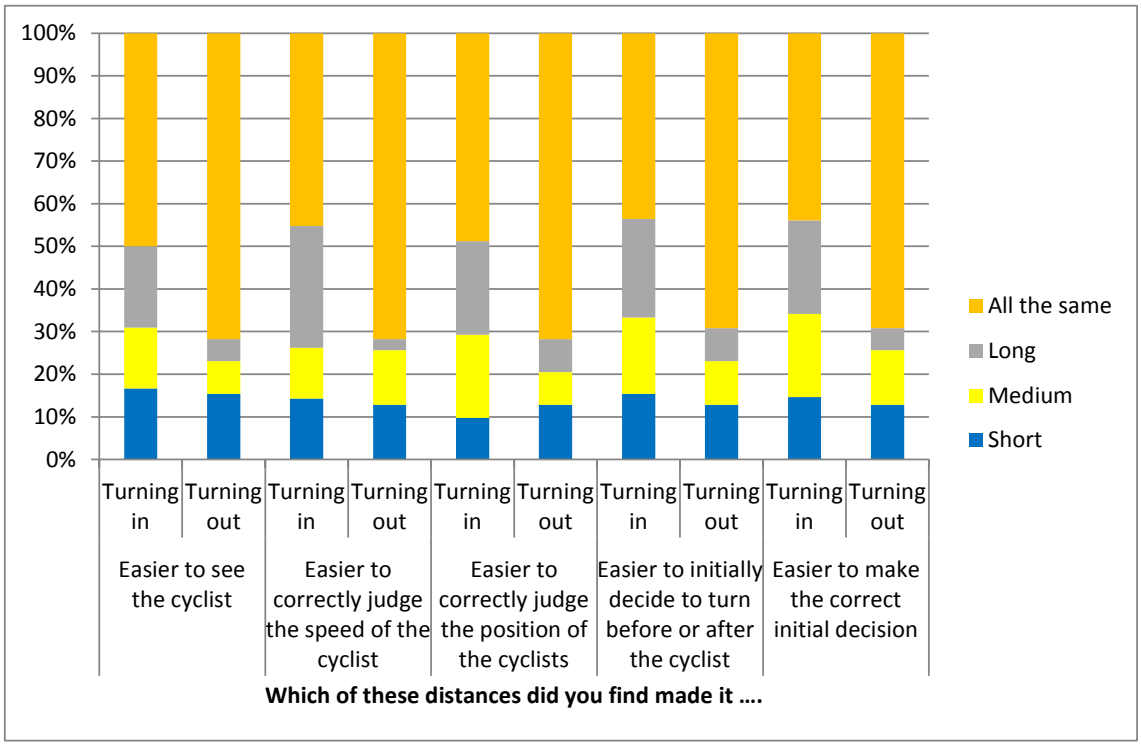

Figure 54: Effect of set-back distance on preparing to make the turn

4.6.2 Making the turn and using the junction

Figure 55 shows that most of the drivers (70-80%) who turned **out of the side road** did not find that the set-back distance affected how easy it was to get into the correct position to make the turn, to make the turn, to make the turn safely, or to use the junction overall. The drivers turning out of the side road who did have a preference were fairly evenly split between the short and medium set-back distances; very few favoured the long set-back distance.

About 40% of the drivers who turned **into the side road** said the set-backs were all the same for ease of getting into the correct position to make the turn, to make the turn, make the turn safely, or use the junction overall. Those drivers turning into the side road who did find a difference were evenly split in preferences for any particular set-back distance.

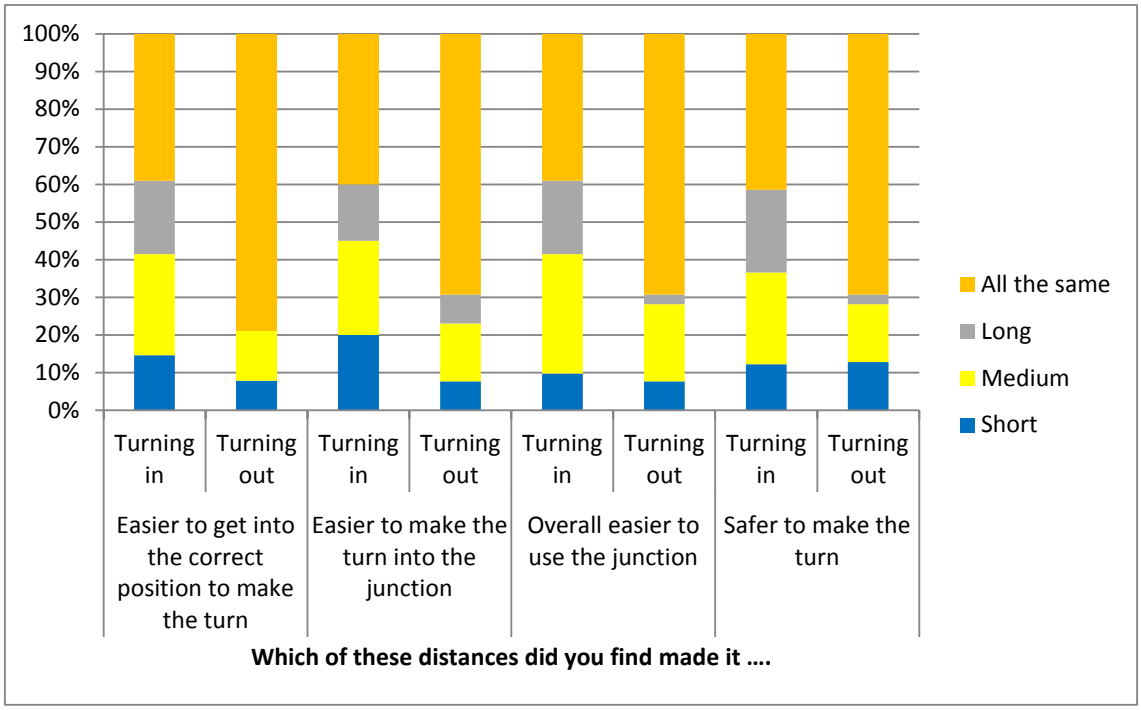

Figure 55: Effect of set-back distance on ease of making the turn

4.7 Comments about the different set-backs

Drivers were asked to explain their answers about preferences for set-back distances (Figure 56). Notably, many people said they did not notice that there were different set-back distances (26% of all drivers) or that the distance made no difference (7%). The drivers turning out of the side road tended to be more likely to say that they had not noticed or that it made no difference, compared with those turning into the side road, although this is less surprising as only those turning right out of the side road would have driven alongside the affected section of cycle lane, and for them it would have been on the opposite side of the road.

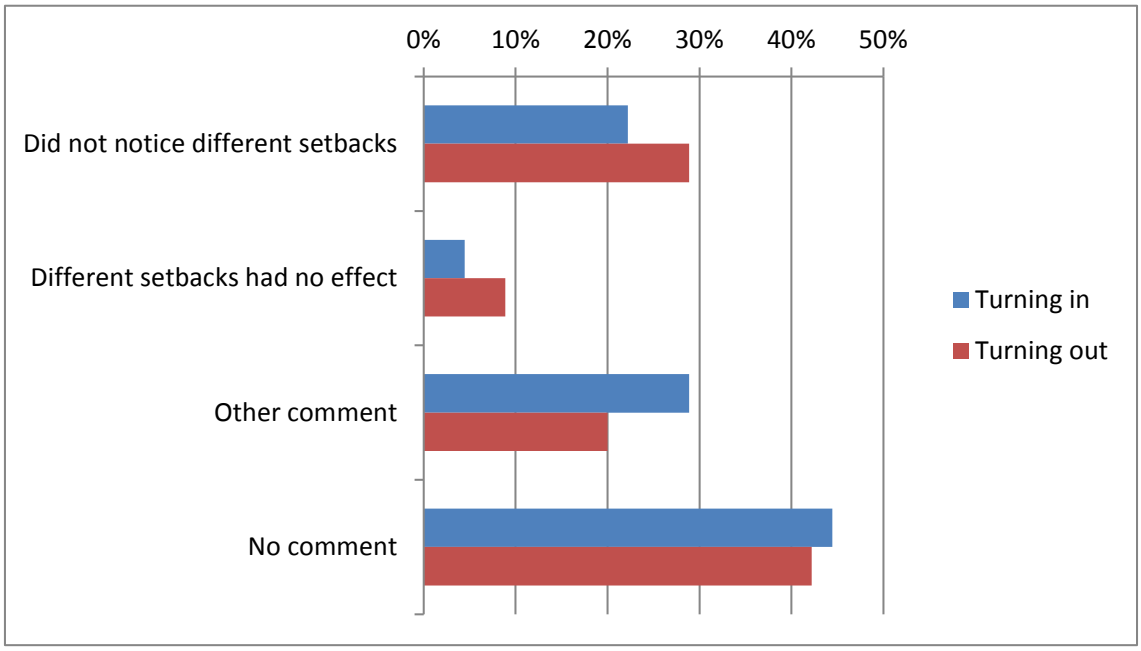

Figure 56: Driver comments on different set-back distances

In explaining why they did not notice the different set-backs, some explained that they were focused on the cyclist – for example:

> *"I didn't notice the set-backs as such when I was driving, I concentrated on how close the cyclist was and his speed and also my position in the car at the T junction."*

> *"The position of the kerb did not influence my decisions, these were based on cyclists position and speed."*

One of the drivers turning out of the side road felt that the length of the set-back did not affect drivers making this manoeuvre:

> *"I only came from the minor road and turned left or right onto the main road so I didn't feel the length made any difference to that turn."*

However other comments indicated that some drivers felt that the short set-back distance made it difficult for drivers turning left into or out of the side road, as the kerb was in the way:

> *"I didn't notice any difference on the length of kerb other than they were more in the middle of the road and in my way especially when turning left." (*Driver turning out of the side road)

> *"[I] only noticed the kerbs on the way out turning left, I normally drive a sprinter van and don't want to clip the rear wheel."* (Driver turning out of the side road)

> *"There is not much difference when pulling out from the side turning, I think the short kerb set back on the whole slowed you down pulling out." (*Driver turning out of the side road)

> *"I found the short kerb set back harder when turning left but no difference when turning right."* (Driver turning into the side road)

One driver commented in favour of the short set-back distance:

> *"Short kerb set-back near junction made me more aware of cycle lane and cyclists."*

Some of the drivers who preferred the medium set-back distance felt that it helped with the decision on when to turn or made it safer for the cyclist:

> *"I found for cyclists the short kerb set back was better but as for driving it was easier with the medium kerb set back."* (Driver turning out of the side road)

> *"Using the medium distance kerb gives you plenty of time to judge how the cyclist is doing also your judging distance is best."* (Driver turning into the side road)

> *"I thought with the medium line it helped make my decision as to whether to turn left/right as once they passed this marker I felt that it would have been unsafe."* (Driver turning into the side road)

> *"Medium gave clear indication for when cyclist could be vulnerable."* (Driver turning into the side road)

> *"I felt the cyclist and I were safer with the medium distance, it gave enough space to turn left but also made me more aware of the cyclist."* (Driver turning into the side road)

Two drivers turning out of the side road commented that the longer set-back distance either made the turn safer, or the cyclist more visible:

"Long - safer to make the turn."

"Cyclist in view at all times at all distances."

One driver turning into the side road preferred the longer set-back distance for the visibility of the cyclist:

"Cyclist would be in sight longer."

4.8 Understanding of junction layout and priorities

One question covered drivers' understanding of the layout in this trial (Figure 57). Drivers were asked whether they thought they should cross the solid white lines after the cycle lane kerb ends before the junction (this was a mandatory cycle lane).

Just over a third of drivers (38%) correctly answered 'no'. Almost a quarter did not know and about a third did not notice the lines. Just a few drivers (7%) wrongly said 'yes' (more of those turning out of the side road than turning in); again, those turning out of the side road would have been further away from this section of cycle lane than those turning left into the side road.

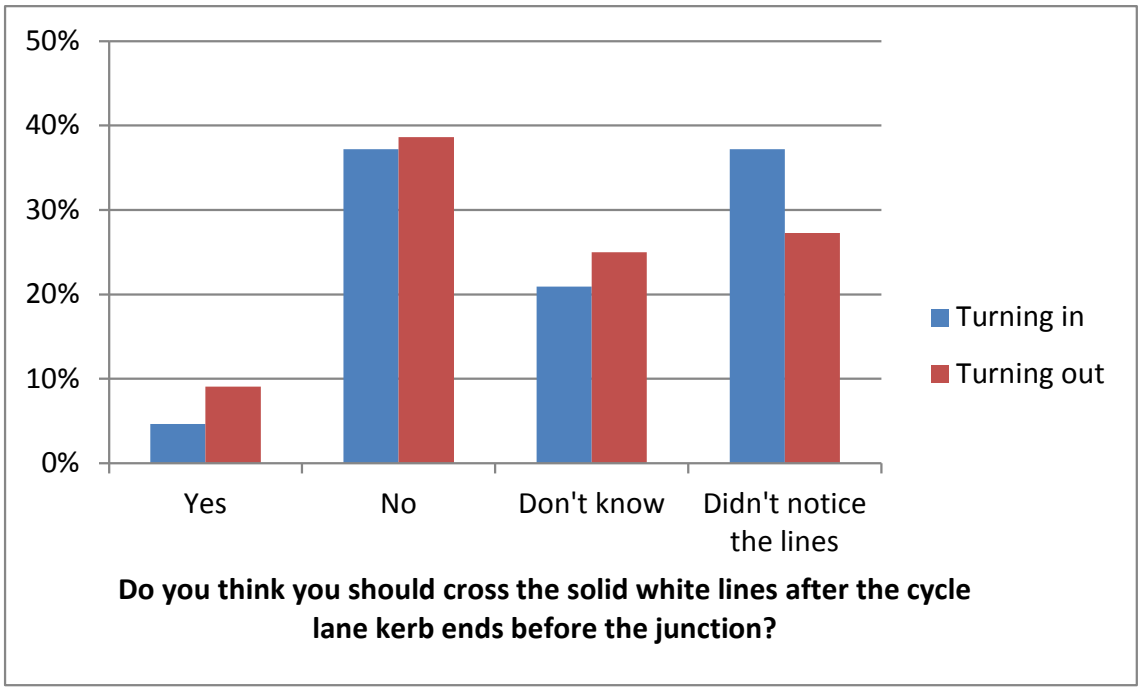

Figure 57: Drivers' understanding of meaning of mandatory cycle lane markings

4.9 Views on segregation

4.9.1 Perceived benefits for cyclists

Drivers were asked whether they thought segregated cycle lanes are a good idea for cyclists and for car drivers (Figure 58). Almost all of the drivers said they are a good idea for cyclists. There were some differences in opinion between the group that was turning out of the junction and the group that only turned in: 13% of those turning into the side road said they are not a good idea but none of those turning out of the side

road did. This suggests that closer proximity to the segregated lane when turning in may have drawn the drivers' attention to potential problems that would not otherwise have been noticed.

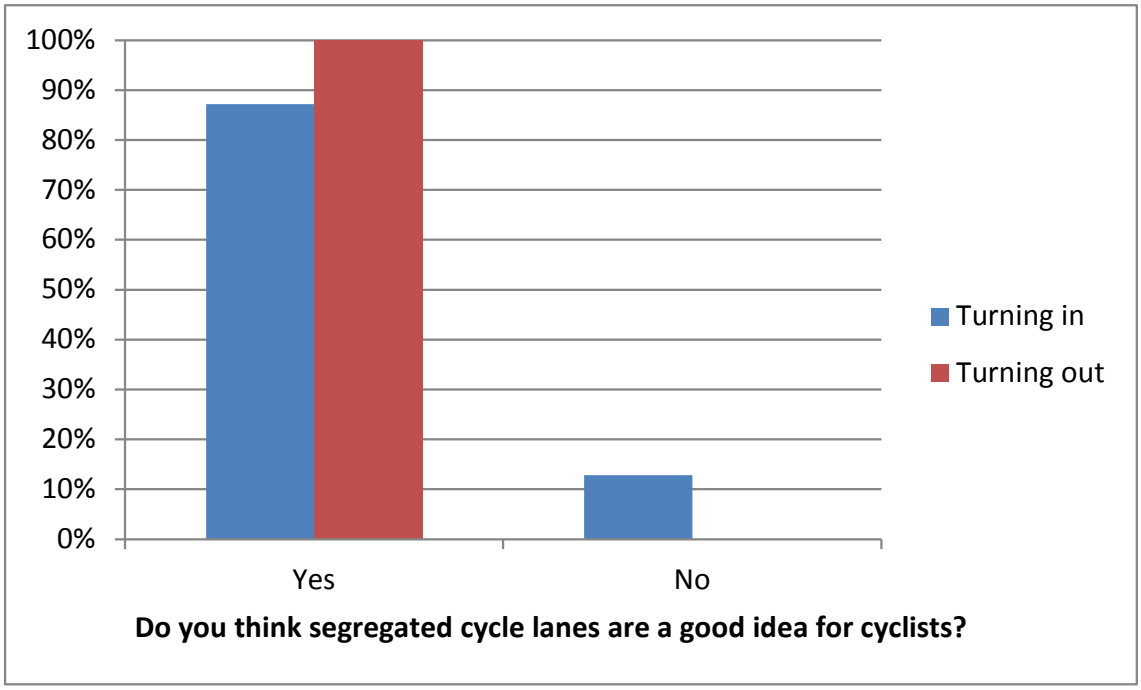

Figure 58: Drivers' views on benefits of cycle lanes for cyclists

Most drivers thought segregated cycle lanes are a good idea for cyclists for safety reasons; however, this reason was also given by some of those who thought these are not a good idea for cyclists. Several other reasons were related to clarity, visibility, increasing awareness and defining the right of way. These comments are summarised in Figure 59.

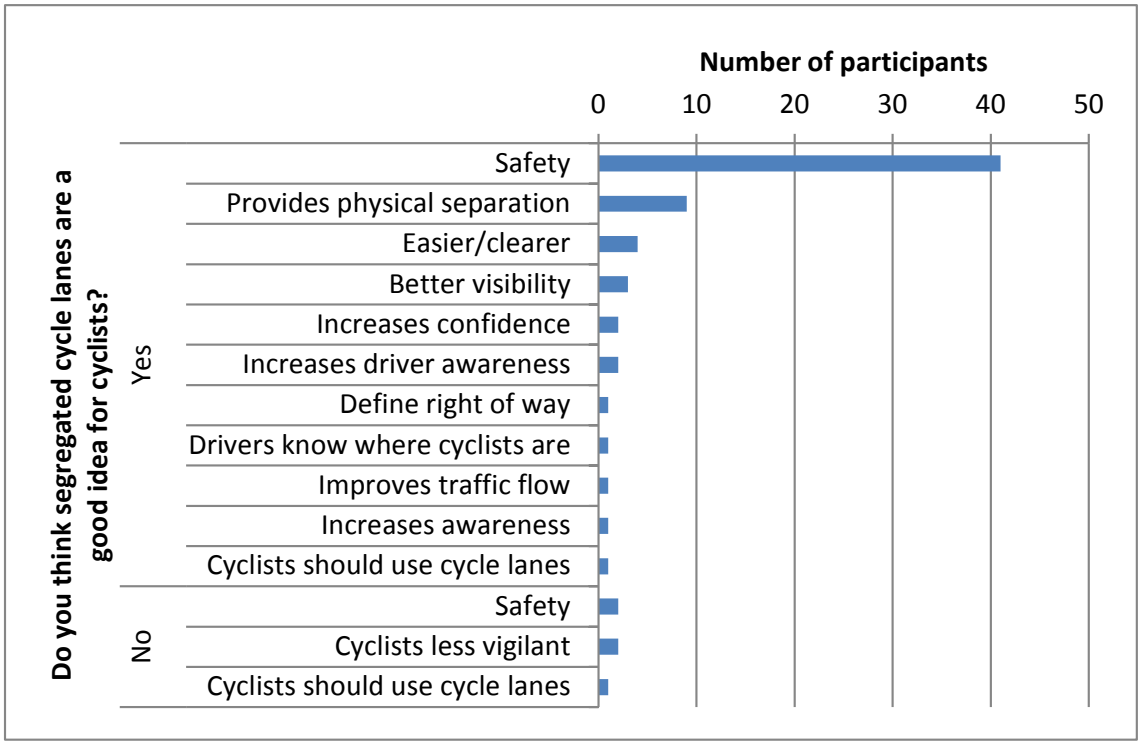

Figure 59: Drivers' comments on segregated cycle lanes for cyclists

The comments made by drivers responding favourably to segregation illustrate the benefits they see from it, which include perceived benefits for drivers as well as for cyclists:

> *"Cyclists are more vulnerable than car drivers, they also want to go faster most of the time. A segregated cycle lane allows them to do this whilst being safer"*
>
> *"Cyclists are neither a pedestrian or a driver and as such should have their own space otherwise they are very vulnerable to accidents."*
>
> *"Distance between car and cyclist is greater and therefore safer. less likely to clip a cyclist"*
>
> *"Easier to see if segregated"*
>
> *"It highlights the cycle lane very clearly and approached with much more caution than I would do normally- due to colour"*
>
> *"It keeps them out of way of traffic which must be safer"*
>
> *"Keeps them away from fast traffic. Safer. Stops car drivers getting concerned and angry with cyclists"*

Some of those who were favourable qualified their support:

> *"Provided lane is wide enough cyclists feel safer"*
>
> *"Safer for cyclist although some become complacent and lose alertness when using them"*
>
> *"Some cyclists wander off lane and some motorists are poor at allowing a safe distance for cyclists to steer round obstacles such as potholes, broken slabs etc."*

"Yes if there is going to be a law which stipulates a cyclist has right of way in case of an accident and the motorist should have to prove negligence"

Those not in favour refer to predicted non-use by cyclists and reduced awareness of risk:

"Because cyclists don't use them"

"I think a cyclist would be less vigilant of drivers as the lane is non stop they would just continue"

"Works fine until a junction comes up also it puts them off their guard"

4.9.2 Perceived benefits for car drivers

Figure 60 shows that almost all of the participants said segregated cycle lanes are a good idea for car drivers; however, 10% said they are not a good idea, and this did not vary between drivers turning into and out of the side road.

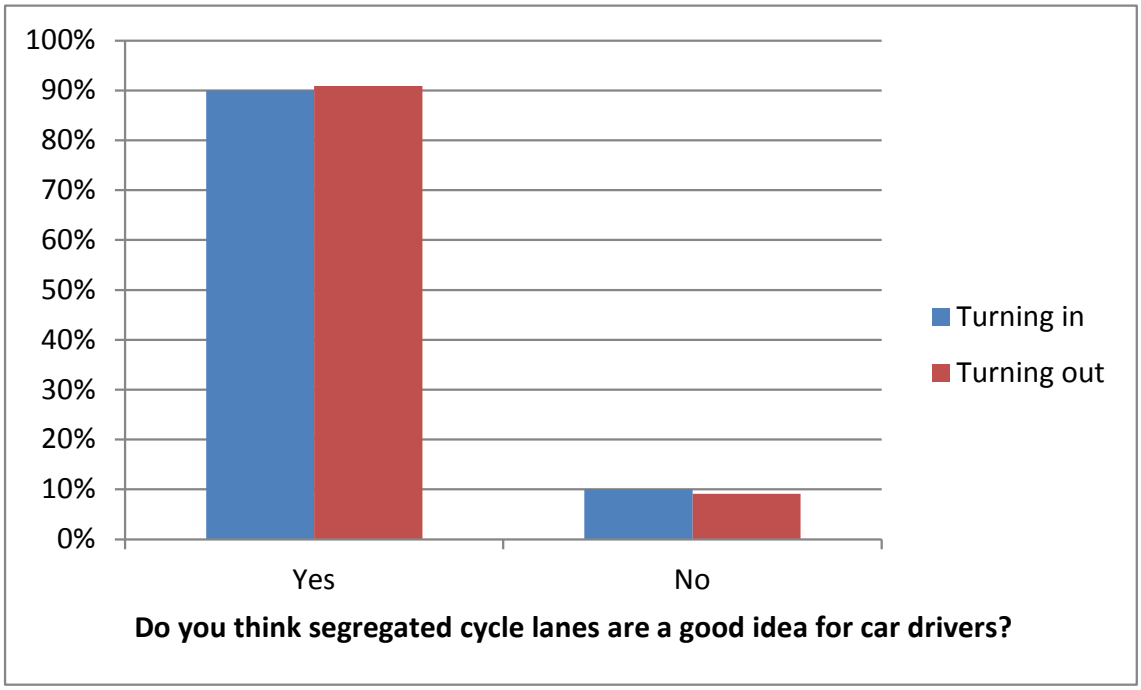

Figure 60: Drivers' views on benefits of cycle lanes for drivers

Figure 61 shows that safety was a common reason given for saying that cycle lanes are a good idea for car drivers, but more of the drivers said it was a good idea because cyclists were out of the way – e.g. so drivers do not have to worry about hitting them, that they are not held up by them, there is one thing less for drivers to worry about, or there are fewer conflicts. Making drivers more aware of cyclists and making cyclists easier to see, or easier to predict where they are, were also mentioned by several drivers who thought segregated cycle lanes are a good idea from the driver's point of view.

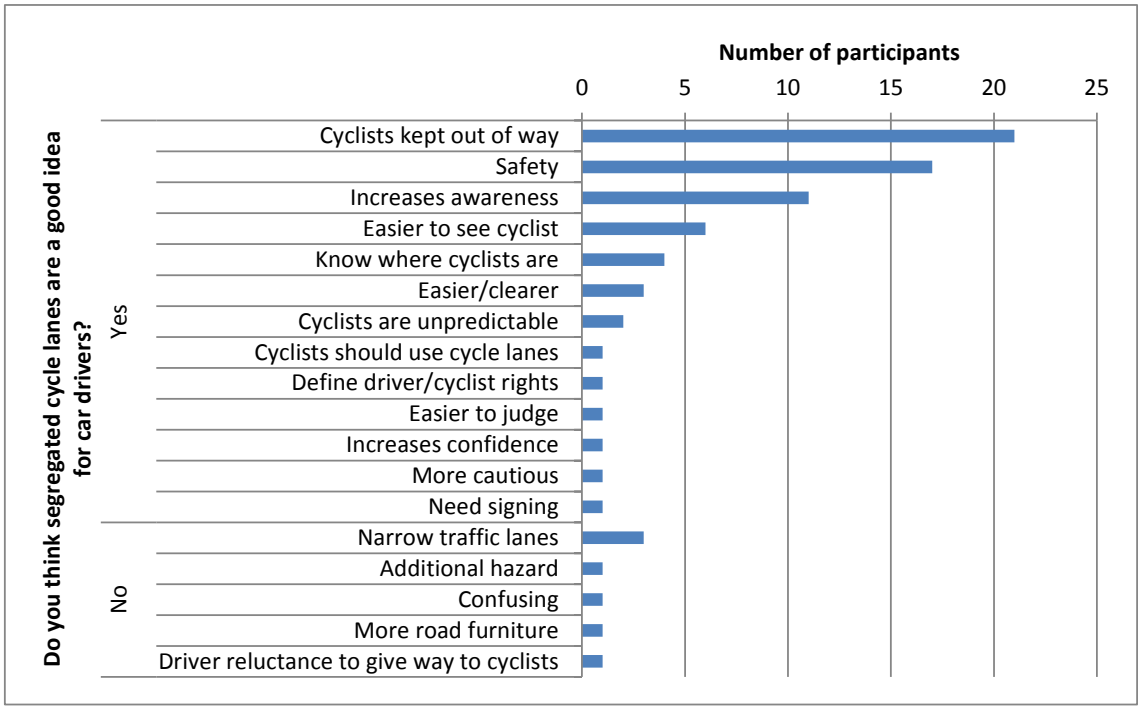

Figure 61: Drivers' comments on segregated cycle lanes for drivers

Comments in favour show that a preference for segregation is based both on a perception that it is safer for cyclists and drivers to be segregated, and to keep cyclists out of the way. Some responses indicate a lack of confidence amongst some drivers when faced with passing cyclists in traffic.

"Again safer for cyclist and car driver"

"Raises awareness and keeps you out of their space"

"Car drivers know where cyclists should be although this could lower awareness of cyclists potentially outside the cycle lane"

"Cyclists tend to overtake stationary or slow moving traffic on both sides- cycle lane would keep them on the side."

"Easier when passing cyclists as you don't need to think about when to pass them

"I dislike being stuck behind a cyclist and trying to overtake with traffic coming the other way. Don't like driving too slow when behind one and feel unsafe judging how close I am to cyclist when overtaking"

"It helps keep traffic moving and also helps slightly indecisive drivers make decisions slightly easier"

"Less likely to worry about cyclist, still to be aware but no real need for sometimes dangerous impatient overtaking"

"Less requirement to be aware of cyclists on the road"

"One less problem to deal with in busy traffic"

One respondent felt that cyclists wouldn't use a segregated lane anyway:

"A major step would be that cyclists in real life used their defined cycle lanes and did not ignore them and use the road."

Those responses indicating that one benefit of segregation is that drivers have less need to be aware of cyclists are highlighting a potential risk that these drivers will not be prepared to encounter cyclists in the traffic when they get to the junction.

The drivers who did not think segregated cycle lanes are a good idea for drivers mentioned that the roads aren't wide enough. Other reasons included that the kerbs represent an additional hazard, there is confusion for drivers turning left, and that drivers are reluctant to give way to cyclists.

> *"Additional road hazard i.e.. concrete kerb."*
>
> *"Already too much stuff on the roads for drivers to deal with (sign posts, speed humps, traffic lights, roundabouts etc.) this just adds to the already long list."*
>
> *"Car drivers 'own' the road in their mind, there is a reluctance to give way to bikes."*
>
> *"I cannot see that many of our roads are sufficiently wide enough to add another section specifically for bikes- so will cause more traffic jams."*

4.10 Purpose of segregation set-back

Drivers were asked why they thought the cycle lane kerb ended a distance before the side road (Figure 62). The most common reasons mentioned were about turning space for cars and larger vehicles, to allow cyclists out, and to ensure that cars do not hit the kerb. A few mentioned safety.

As noted previously, it is significant that around a quarter of participants had not noticed that the set-back distance varied, so their responses to this question will have been less informed by their experience on the track.

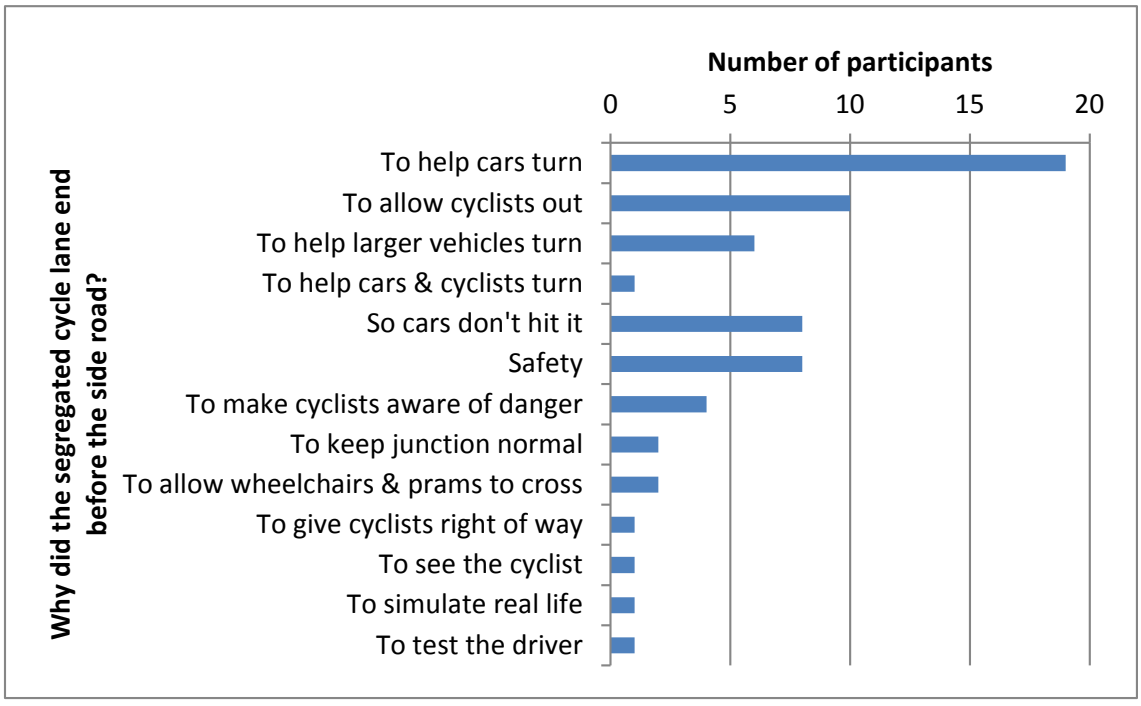

Figure 62: Participants' comments on purpose of segregation set-back

Of those referring to allowing cyclists out, four mentioned allowing cyclists to turn right, which may have been prompted by the presence of an unused fourth arm of the trial junction, as there were no right-turning cyclists in the trial.

The largest group of responses reflect a belief that the segregation is set back for the benefit of vehicles turning into the side-road, some mentioning not having to slow or change position, or not hitting the kerb.

> *"Because if it continued too close to the junction there is a danger that cars pulling out may hit the kerb"*
>
> *"For ease of vehicles turning particularly on a left turn and in particular large vehicles"*
>
> *"So it allows for the car user to manoeuver easier without hitting it-without making the driver pull out into the road more"*
>
> *"To reduce decision time to keep junction as near normal as possible"*

Only a small number of responses reflect the intended purpose of the set-back in allowing cyclists to re-introduce themselves into the traffic flow to minimise conflict:

> *"To enable a driver coming up to the junction to see the cyclist and make a safe judgement about the turn."*
>
> *"Make cyclists aware of the impending junction and remove the potential comfort of the cycle lane"*
>
> *"Not sure if the kerb ended too soon the car may cut the corner, however the distance allows cyclists the opportunity to join the traffic after the junction."*
>
> *"Perhaps to make the cyclist more aware of the oncoming traffic-may feel safer with concrete divide."*

This suggests that there is a lack of understanding amongst drivers of how cyclists will behave at the junction.

4.11 Preferred set-back distances

Drivers were asked whether they thought it is better for cyclists to join the main traffic earlier before the junction, or to remain separate for as long as possible (Figure 63). A majority of drivers said they preferred cyclists to remain separate for as long as possible, and there was little difference between drivers turning into and out of the side road.

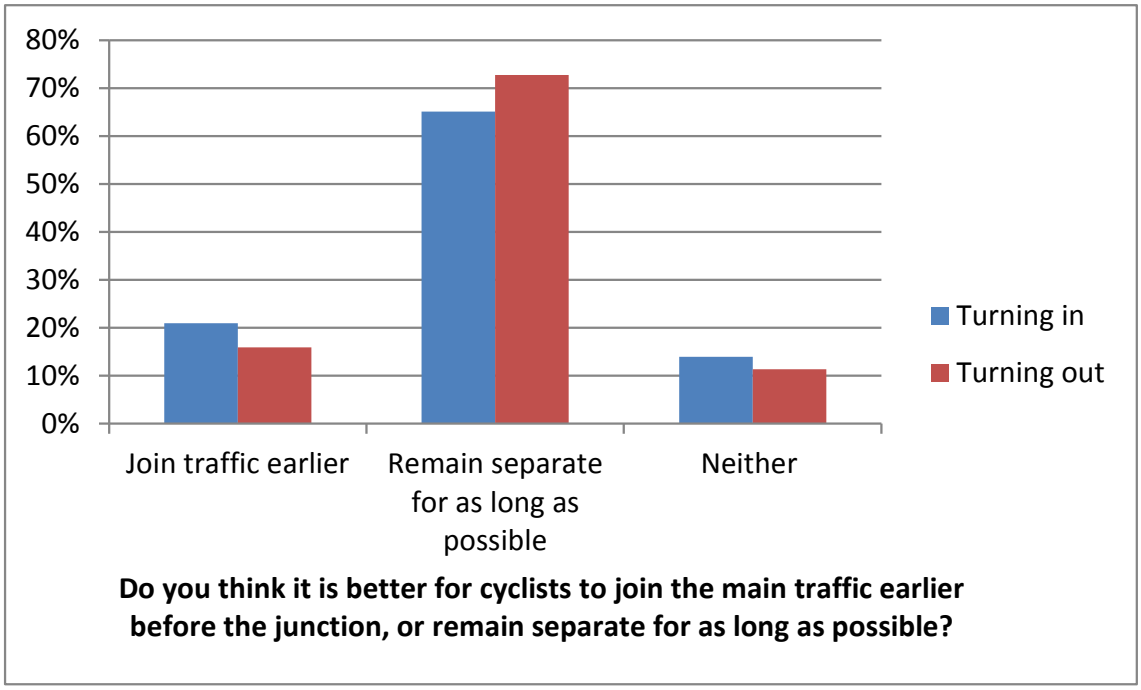

Figure 63: Participants' views on how close to a junction cyclists should remain segregated from the traffic

Drivers who preferred cyclists to remain separate for as long as possible mainly gave cyclist safety as the reason. Other reasons were about the benefits of segregation, enabling drivers to react or to see the cyclists, however some of these reasons were also given to support the view that it is better for cyclists to join the traffic earlier.

The drivers who said it was not better for cyclists to join the traffic earlier or to remain separate for as long as possible supported segregated lanes, and or said that it depends on either the layout, the amount of traffic or the cyclist. Figure 64 summaries these responses.

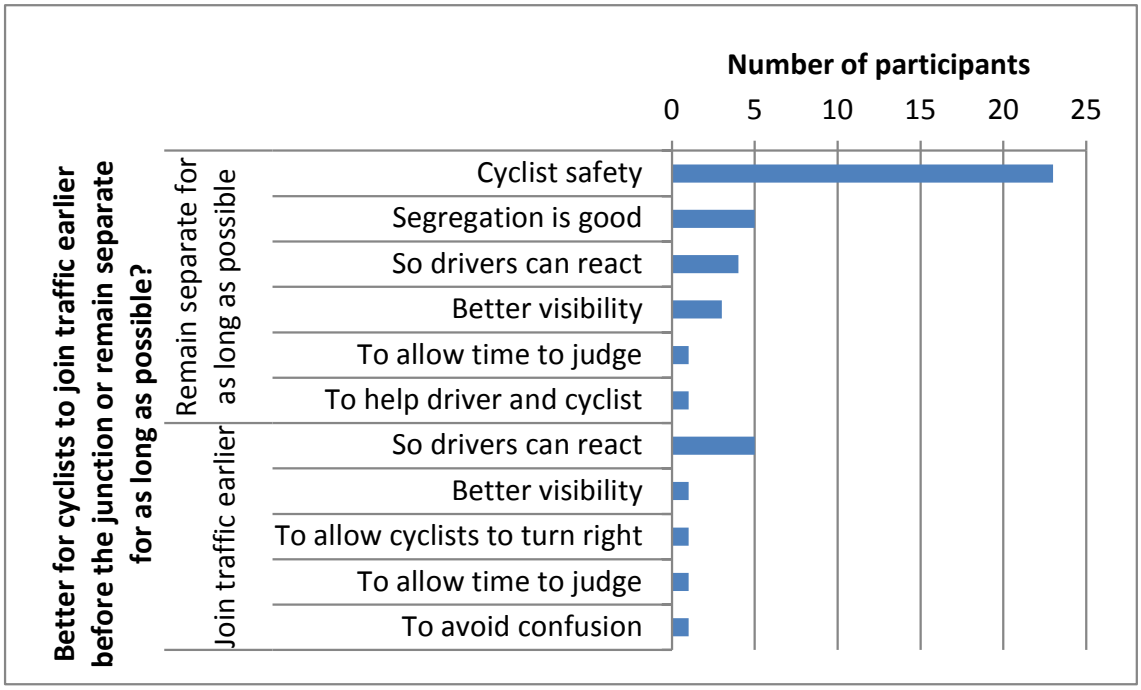

Figure 64: Participants' comments on how far before a junction cyclists should re-join cyclists should be segregated from the traffic

As with previous questions some respondents referred to cyclists turning right, even though this would not have applied to the trial junction.

> *"if junction is left hand turn only then separate for longer but if cyclist could turn right then need to be able to manoeuvre when safe - break in traffic and therefore be able to join traffic earlier."*

There are some contradictory views on which will be best to allow drivers and cyclists to become aware of each other before the junction.

> *"I think remain separate for as long as possible, however if they join the traffic earlier drivers should be more aware of cyclists for a longer period of time."*
> *"It would make it easier for both the driver and the cyclist to remain separate for as long as possible as this gives both parties time to judge the distance and timing."*
>
> *"if you join traffic too late at a junction cars turning do not always visually see them until quite late but if too far away can make mistake of thinking they have enough time to turn first."*
>
> *"So drivers can react" (respondent favouring maximum segregation distance)"*
>
> *"With my cyclist head on I would feel safer remaining separate for longer and as a result the driver feels more confident the cyclist knows what he/she are doing."*

Many of the responses to this question were similar to those on the more general question about the benefits of segregation in general, and it is possible that many respondents had interpreted the question more generally rather than specifically considering the implications of set-back distance at a junction. It is important to note that the wording of this question did not specifically mention set-back distance, unlike

the questions concerning ease of turning, to which there was a greater level of preference for middle distances expressed.

4.12 Concerns about set-back distances

Drivers were asked whether they had any particular concerns or issues over using the road with the kerbs stopping at different distances before the junction (Figure 65). Most of the drivers reported no concerns, and there was no difference between drivers turning into and out of the side road. The concerns expressed appeared mainly about the short set-back distance, although there may have been some confusion of terminologies: for example participants referring to a short kerb probably indicated they were referring to a long set-back.

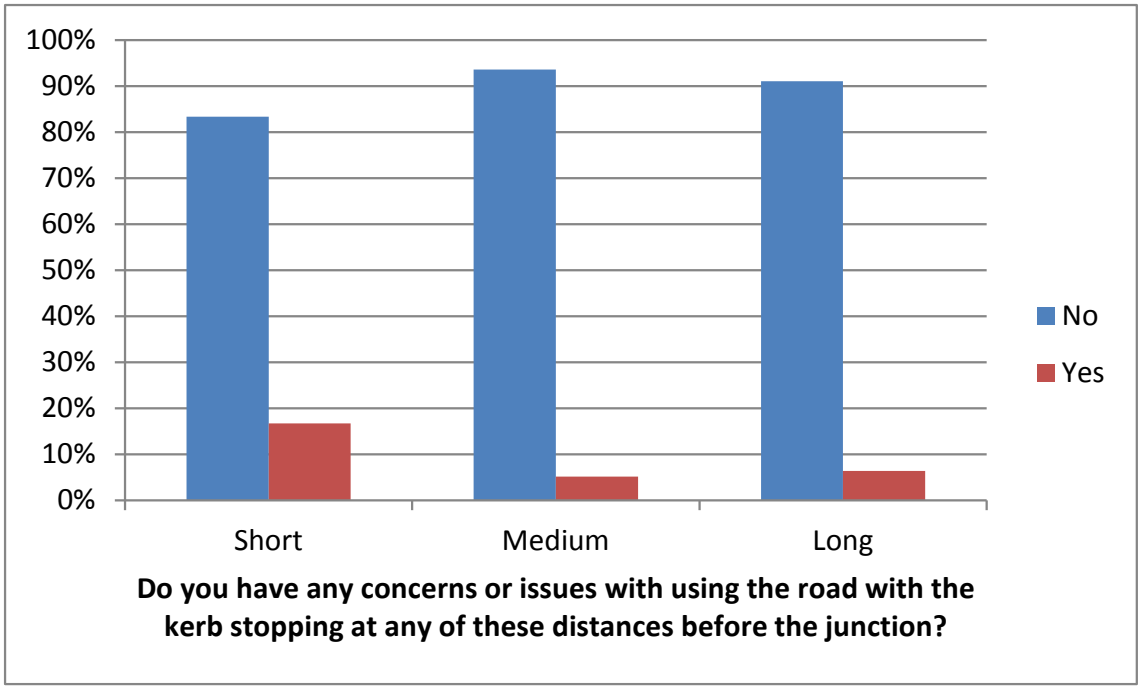

Figure 65: Whether participants had concerns about any particular set-back distance

Concerns with the short set-back distance were mostly about space for turning or hitting the kerb, with some saying left turns were a difficulty:

> *"I found myself looking out for the kerb [so] as not to clip it."*
>
> *"Easy to clip kerbs when paying attention to cyclists."*
>
> *"It may be in the way of cars turning."*
>
> *"Kerbing the car or having to pull out a bit wider."*
>
> *"I felt it was more difficult to make a safe turn."*
>
> *"Slightly harder when turning left."*

The other main reason was that there was less time to make a decision or it was more difficult to judge:

> *"Not enough space to judge the speed correctly."*
>
> *"The cyclist seemed to come into view much later than usual which would be dangerous if a driver was not driving with due care and attention."*

"I couldn't judge if I could make the turn before the cyclist caught up."

One driver raised a concern about hitting the kerb when the set-back distance was 'medium':

"Scared of hitting kerb."

The long set-back distance led to concerns from drivers turning out of the side road about visibility:

"I could not see as well as short."

The other concerns were about protection of cyclists from traffic and maintaining a defined space for cyclists.

4.13 Suggestions for changes in junction layout

Drivers were asked whether they had any suggestions for changes in the junction they had used during the trial (Figure 66). Just 15 of the drivers made suggestions, of which the most common were that four drivers turning out of the junction suggested starting the kerb later (beyond the junction) and four drivers (some turned in and some turned out) suggested making the kerbs more visible.

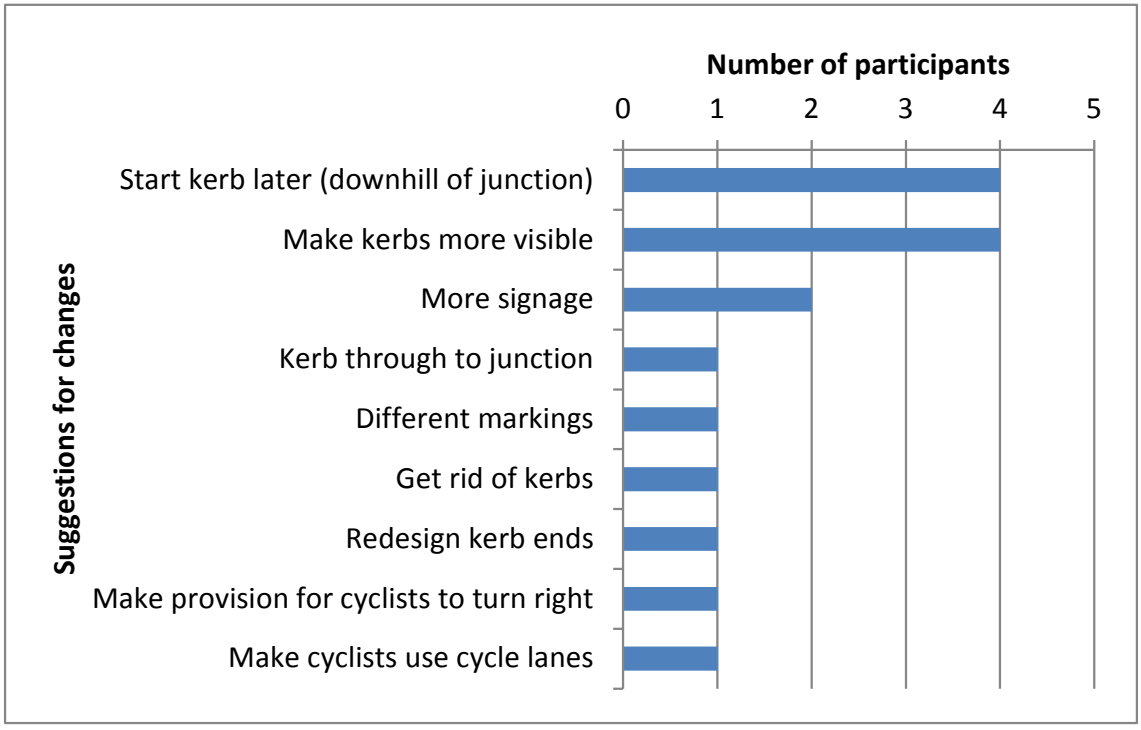

Figure 66: Suggestions for changes to junction layout

Drivers turning out of the side road who suggested starting the kerb later said:

"Start the kerb further down the road as it makes the left turns difficult."

"Easy to clip kerbs turning left with kerbs close to junction."

"The cycle lane kerb edge [was] too close to the junction as I pulled out."

The suggestions for more visible and re-designed kerbs were:

"Brighter paints."

"I very much liked the medium distance one, would probably like to see some lights implemented into the kerb."

"Make the kerbs more visible or advise the drivers of the kerb options in use."

"More highlight to the end of the kerb."

"I think the end of the kerb should slope to make it safer in the event that the car should hit it." (Driver turning out of the side road)

The suggestions about signs and markings were:

"More signage to warn drivers that cyclists are nearby."

"Maybe before the junction it could turn into a chevron pattern, maybe 5m before."

In addition in further comments at the end of the questionnaire, one driver made a suggestion about signs and markings:

"The start of kerbing in cycle lane should be highlighted by bollard or the like."

The other suggestions were:

"I think the cycle kerb should remain in place all the way to the road."

"Segregation would need to make provision for right turning cyclists."

"Get rid of the kerbs - unnecessary and get in drivers way."

"A major step would be that cyclists in real life used their defined cycle lanes and did not ignore them and use the road."

4.14 Summary of findings from questionnaire results

The key findings of the questionnaires are summarised below, grouped against the research questions for the trial.

Some caution on interpretation of long (25 and 30m) and short (5 and 10) set-back distance is required, as it appears some respondents confused short set-back distances with 'short kerbs'; which would be a long set-back distance.

4.14.1 Participants' general assessments of safety and ease of use of the junction

Before being asked about how the different segregation set-back distances, participants were asked a series of questions about their perceptions and use of the facility. The key findings are summarised below.

Safety

Most drivers thought it was 'safe or 'very safe'; however of the minority that reported feeling 'unsafe' or 'very unsafe' more did so when turning left (14%) than when turning right (3%). Comments made by those who didn't feel safe included concerns about blind spots and not being able to see cyclists.

Being able to see cyclists

The majority (over 70%) of drivers said they found it easy or very easy to see the cyclists. There was little overall difference between the drivers who turned into the side road and those who turned out of it.

Judging speed

Most (over 70%) of the drivers also said it was either easy or very easy to correctly judge the speed of cyclists as they prepared to turn. Turning in and turning out had similar responses. Comments from those not finding it easy referred to difficulty seeing cyclists, and blind spots.

Judging position

Most of the drivers said it was easy or very easy to judge the position of the cyclists correctly. There were few (less than 5%) who found this hard or very hard. There was little difference between those turning into and out of the side road. A minority of comments where on the difficulty of seeing cyclists in their mirrors, and on 'being stranded' in the middle of the road waiting for the cyclist.

Ease of deciding whether to pass in front or behind the cyclist

A majority of drivers found it easy or very easy to decide whether to turn left before or after the cyclists. However drivers turning left into the side road found it harder to judge whether to turn before or after the cyclist, than those turning left out of the side road. Comments refer to greater difficulty seeing cyclists when turning into the side road, leading to greater difficulty making decisions.

Whether drivers changed their decision

Hardly any said they did so often or very often. However the drivers turning into the side road were much less likely to say 'never' than those turning out of the side road, while those turning in were more likely to say 'sometimes'. The comments indicate that drivers mainly changed their minds as a result of mis-judgements of cyclists' speed and distance (or both), but speed was mentioned more than distance.

How easy drivers found it to get into position to turn

Just under 10% said it was hard to get into position to turn left into the side road and just over 10% found it hard to get into position to turn left out of the side road. Drivers' comments about turning showed that several drivers turning left out of the side road had difficulty seeing the cyclists to their right, and judging their speed.

4.14.2 Effects of different segregation set-back distances

How does changing the kerb set-back affect car drivers' perceptions of safety?

More than half of respondents (55%) stated that it made no difference to their perceived level of safety. It is important to note that 26% did not notice that the segregation set-back distance had varied during the trial. Where a preference was expressed the middle distance (15 and 20m) was preferred by the single largest group and, although there is no strong pattern, those turning into the junction appear to be more likely to prefer long set-backs in comparison with those turning out.

Responses to open questions suggest that drivers' assessments of safety includes considerations such as a perceived risk of hitting the kerb, as well as the risk of conflict with cyclists.

How easily could the driver make the turn with different set-back distances?

There were some indications that the kerb segregated cycle lanes affected drivers turning into and out of the side road in different ways. Drivers on the main road turning

into the side road found some aspects of the turn harder than the drivers who turned out of the side road; from the main road it was harder to make the decision to turn left, harder to decide whether to turn before or after the cyclist and having made the decision, this was more likely to be changed. Compared with drivers turning out of the side road, those turning into the side road were more likely to notice and be affected by different set-back distances, and to express a preference for a particular set-back distance. Drivers turning left into the side-road in particular commented on difficulties judging speed and cyclists being in their blind spots

For drivers turning out of the side road, it was harder to get into the correct position to turn right, than for drivers turning into the side road.

How does changing the kerb set-back affect the decision making process of drivers?

Considering all the tasks involved in making a turn when there were cyclists using the cycle lane, a large proportion of the drivers found that these were not affected by the different set-back distances; a substantial minority did not notice that there were differences. For the various tasks involved in turning, drivers turning out of the side road who did favour one set-back distance were fairly evenly split between those favouring the 'short' and 'medium' set-back distances. However amongst those turning into the side road there was no strong preference for any of the three set-back distances.

What are the preferences of car drivers regarding set-back distance?

The purpose of the segregation set-backs was most commonly understood to be to enable vehicles to turn easily and to ensure that cars do not hit the kerb. Only a few participants commented on the intended purpose of the set-back distance (i.e. as described in technical guidance) which is to allow cyclists and drivers to become aware of each other and adapt to each other before the junction so as to reduce conflict. Where this was mentioned there were some contradictory views, with some respondents stating that the shortest set-back distance was best to enable drivers to become aware of cyclists, others arguing for the longest for this purpose.

Most of the drivers preferred cyclists to remain separate from traffic as long as possible, mainly citing safety reasons and a general belief that segregation was preferable. The few drivers who expressed concerns about particular set-back distances mainly mentioned issues with the short set-back distance: restricted space for turning, risk of hitting the kerb and having less time to make a decision or finding it more difficult to judge when to turn, possibly owing to the tighter turn requiring a greater speed modification at the junction.

It should be noted that there is a slight contradiction between the responses to the question on whether it is better for cyclists to join the traffic earlier before the junction, or to remain separate as long as possible; and responses to the earlier questions on ease of turning, with more respondents favouring middle distances to the latter questions, suggesting that responses may have been influenced by the different wording.

4.14.3 Participants attitudes towards and understanding of the segregated cycle facility

What are participants' views on segregated cycle lanes?

Almost all of the drivers thought segregated cycle lanes are a good idea for cyclists and for car drivers. Responses to open questions show that, while they considered segregation to be safer for cyclists, most respondents cited benefits to drivers, such as keeping cyclists out of their way. Some of those responses indicate concerns or a lack of confidence when faced with having to pass cyclists in traffic. A small minority were negative about segregation. Some comments expressed frustration about perceived refusal to use cycle lanes by many cyclists. Others believed that the kerbs were a hazard and took too much space from the carriageway.

Interestingly, those drivers in the group that were turning into the side road, which had the greatest exposure to the segregated cycle lane, were less likely to think that segregated cycle lanes are a good idea for cyclists than the group of drivers that were turning out.

How well did participants understand the road layout and priorities?

Some respondents stated that they found the layout and markings confusing, with some requests for warning signs. Nearly two thirds of respondents either did not understand the meaning of the mandatory cycle lane markings that followed the segregation, or did not notice it. Two responses suggest that the driver believe themselves to have priority over cyclists when turning, which is a potentially dangerous assumption for that layout. As noted previously, a quarter of participants stated that they had not noticed that the segregation had been set back at different distances. Some responses expressed concern that the end of the kerb line was not clear enough and that it should be indicated in some way.

5 Summary of findings

5.1 Key findings- video and track-side questionnaires

5.1.1 Path

The set-back distance had little or no effect on the paths taken by paths on most turning movements. However, there was a statistically significant effect on path with a 5 metre setback for car drivers turning left into the side road. The path with a 5 metre setback resulted in an average driver approaching the cycle lane at a more acute angle, maintaining their distance from the cycle lane for longer, and remaining out of the cycle lane for longer.

It was found that the passing distance with a 5 metre set-back was significantly greater than with a 10 metre set-back: the difference being approximately one-third of a metre.

Also, there was a small effect on the car drivers' paths when turning right onto the main road with a 5 metre setback, with drivers using a more acute angle when exiting.

Distances from the kerb with a 5 metre set-back were significantly greater than with a 10 metre set-back when turning left into the side road.

5.1.2 Decision making

Significantly more drivers (approximately 15%) chose to turn behind the cyclists with a 5 metre setback when turning left into the side road. This may have been a result of them reducing their speed. Set-back distance had no effect on this decision for those turning out of the side road.

5.1.3 Speed

Although speed was measured as averages over the 80 to 90m run, which will understate any speed reduction taking place at the turning, statistically significant average speed reductions were observed when comparing 5m (11.6mph) and 10m (12.4mph) set-backs.

5.1.4 Perceived safety reported by driver at track-side

Perceived safety did not vary significantly with set-back distance, except for 5m, which they considered slightly, but statistically significantly, less safe when turning into the side road: 0.7 on the safety scale out of 10. As this was combined with lower speeds and changed path this could be regarded as showing a greater degree of caution for this set-back distance.

5.1.5 The effect of a traffic queue on the main road

Drivers' average paths turning right into, and out of, the side road when a traffic queue was present were at a more acute angle, when the traffic queue was present. Also, they felt less safe making the manoeuvres when a traffic queue was present.

Queues had no effect on speeds and decision when exiting the side road. However, speeds into the side road were on average between 1.8 and 2 mph slower and drivers were slightly less likely to turn in front of cyclist when entering the side road.

5.2 Key findings: post-trial questionnaires

The majority of responses show that participants found the junction to be safe for all the turning movements investigated, and found it easy to see cyclists, judge their position, make a decision about whether to overtake the cyclists, and to be able to make the turn. However, for the minority expressing concerns, the most difficult manoeuvre appeared to be turning left into the junction. Comments refer to difficulty seeing the cyclists to their right, and judging their speed; as well as referring to the perceived risk of hitting the kerb.

When asked about the effects of different segregation set-back distances more than half said it made no difference to safety. Indeed 26% did not notice that the set-back distance had varied. Drivers turning into the side-road were more likely to report a difference than those turning out, and to express a preference. While there are some contradictions in the different responses, the overall preference appears to be for set-back distances that maximise segregation from cyclists while minimising effects on turning, i.e. not requiring drivers to slow down significantly or deviate from a turning path with a large turning radius. The purpose of the segregation set-back was not well understood- most believing it to be to make it easier for vehicles to turn, only a few referred to it providing space for cyclists and drivers to adjust to each other before the junction. This suggests that there is a lack of understanding amongst drivers of how cyclists will behave at the junction.

Participants were asked a number of questions about segregated cycle provision more generally and also on their understanding of the junction layout used in the trial. The vast majority were supportive of segregated cycle facilities in principle, with safety being the main reason given. However, many comments refer to benefits to drivers such as not having cyclists in their way in traffic, not having to deal with overtaking cyclists and not having to be as aware of cyclists when they are segregated.

Nearly two thirds of respondents either did not understand the meaning of the mandatory cycle lane markings that followed the segregation, or did not notice it. Some responses expressed concern that the end of the kerb line was not visible enough and that it should be more clearly indicated in some way, e.g. with a bollard.

Although constraints on sample size limits the extent to which responses to the qualitative questions can be regarded as ‘representative’ of the wider population, some of the comments highlight issues that are of potential concern, even if they only reflect views held by a very small minority.

5.3 Discussion

The video observations are consistent with the previous trial on this facility (presented in Annex 3) in showing that segregation set-back distance has little impact on car drivers’ speed and turning path, with the exception of the 5m set-back. When the kerb is this close to the junction it has the effect of tightening the turning radius, so that drivers turning left, into the side-road, slow down and take a position further away from the kerb. Although the speed reduction observed is small, it was measured as an average over a distance of 80m (side roads) or 90m (main road) of the drivers’ run, so will understate the reduction at the turn. Furthermore, as speeds were generally low, below 15mph, a smaller reduction would be expected as the driver would already be close to a comfortable turning speed for that geometry when approaching. A greater speed reduction would therefore be expected if the driver was starting from a greater approach

speed. A further observation is that, with the 5m set-back, left-turning drivers passed the cyclist at a greater distance, and are crossing the cycle lane close to the perpendicular, which should improve the drivers' visibility of approaching cyclists.

Video observations showed limited effects of different set-back distance on other turning movements, other than having also to take a more perpendicular angle across the cycle path for drivers turning right out of the side-road. Although there might have been expected to be a potential problem with drivers leaving the side road encroaching into the cycle lane across the junction mouth, effectively using its outside edge as the give way line, this was not observed in the trial.

When interpreting the qualitative findings of this trial it is important to remember that the only participants were drivers, and only a minority of these stated that they also cycled regularly, so their perceptions of safety and preferences for junction design are very much from a car drivers' perspective. Thus, 'safety' is often interpreted in terms of wishing to avoid kerbs close to the junction, and being able to turn easily, i.e. without having to slow suddenly or move out to the right. There is a large majority in favour of segregating cyclists from other traffic as much as possible, which appears to be motivated by desire to avoid having cyclists in the traffic as well as because it is perceived to be safer for cyclists. Some responses indicate that some drivers lack confidence when faced with having to pass a cyclist in traffic and so would prefer not to have to deal with this situation. Notably, a number of comments refer to the benefit of not having to be as aware of cyclists when they are segregated.

Overall, turning into side road was perceived to be more difficult than turning out, with turning left into the side road reporting greatest number of concerns. Difficulties mentioned include difficulty seeing cyclists, judging speed and position etc. with references to blind spots and uncertainty about what a cyclist is doing.

Where drivers expressed a view as to the purpose of the segregation set-back these principally concerned benefits to drivers, such as being able to turn easily, rather than for the actual intended purpose, which is to permit cyclists to be re-introduced to the traffic flow in advance of the junction to reduce conflict. This suggests that there is a lack of understanding amongst drivers of how cyclists will behave at the junction.

There was a degree of contradiction observed in drivers' preferences for set-back distances depending on what they were being asked about: when considering ease of turn with different kerb lengths there was a greater support for long and medium distances than when asked how far before a junction cyclists should be re-introduced into the traffic.

Furthermore, some of responses to open questions indicate behaviours and attitudes which, even if only present in a small minority of the population, indicate potential risks that need to be considered, in particular:

- a fairly low level of understanding of the mandatory cycle lane, leading to likelihood that turning vehicles would encroach in it;
- comments suggesting that some drivers would assume they had priority over cyclists in the cycle lane when turning left; and
- comments suggesting that drivers will give less attention to cyclists in the segregated section of the lane.

Consequently, if drivers' preferences, as expressed in this questionnaire, were used as the basis for determining optimum set-back distance, the chosen value would be one

that maximised segregation while not affecting drivers' ease of turning left. However, this would result in drivers being able to turn across the cycle lane at their normal speed, and following their normal path, with minimal distance in which to respond to cyclists emerging from the segregated lane. These problems would be exacerbated where drivers are paying less attention to cyclists as they approach, because they are segregated, or if the driver assumes they will have priority at the junction.

It is important to note that where participants commented on potential conflicts with cyclists at the junctions many refer to cyclists in blind spots when turning left into the side-road, which will be a particular problem when drivers are able to take a wide turning radius that encroaches into the cycle lane.

In conclusion: the greatest overall safety to all road users is therefore likely to be greater either with longer set-back distances i.e. 20 to 30m, which give drivers more time to notice cyclists and adapt to their presence on the road, or with a very short set-back distance, sufficiently close to the junction (5m or less in the trial example) to force turning vehicles to slow down and cross the cycle lane in a more perpendicular path, thereby giving the driver better visibility of the cycle lane.

The fact that a large proportion of drivers did not notice the different set-back distances suggests that more needs to be done to highlight the end of segregation, and so draw drivers' attention to the presence of unsegregated cyclists on the carriageway. A bollard, or change of lane colour etc. would also help address the concern expressed by many participants that they might clip the kerb with short set-back distances.

Potentially, the use of intermittent separators could be explored to create an extended transition zone between full segregation and re-introduction to traffic.

The low level of awareness of the meaning of the mandatory cycle lane suggests that publicity/awareness raising may be needed.

An assumption by a few drivers, even if a tiny minority, that cyclists would have to give way to them is potentially dangerous and may require further investigation.