Transport Research Laboratory
Creating the future of transport

PUBLISHED PROJECT REPORT PPR715

High level signals with a red cycle aspect

Track trial report

S D Ball, J Hopkin, C Reeves, R Gardner, P Knight and I York

Prepared for: TfL,

Project Ref: 11112436 WS3.HLSa.M3

Quality approved:

S Greenshields *Project Manager* M Jones *Technical Referee*

Disclaimer

This report has been produced by the Transport Research Laboratory under a contract with TfL. Any views expressed in this report are not necessarily those of TfL.

The information contained herein is the property of TRL Limited and does not necessarily reflect the views or policies of the customer for whom this report was prepared. Whilst every effort has been made to ensure that the matter presented in this report is relevant, accurate and up-to-date, TRL Limited cannot accept any liability for any error or omission, or reliance on part or all of the content in another context.

Contents amendment record

This report has been amended and issued as follows:

Version	Date	Description	Editor	Technical Referee
V1	01/10/2014	Final version	SG	MJ

Contents

Figures

Tables

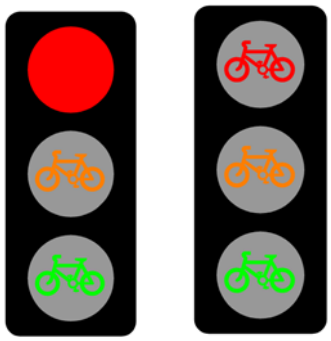
Executive summary

Background

Transport for London (TfL) commissioned TRL to test innovative cycle provision at the TRL test track and other facilities. This project involves undertaking several trials of cycle infrastructure using cyclists and other road users.

This is the report of the trial from Workstream 3: High Level Signals (with red cycle aspect) in which a signal with an illuminated red bicycle logo, a variation not currently permitted by the Traffic Signs Regulations and General Directions 2002 (TSRGD), was studied for its suitability to be added to the signal variants covered by these Regulations.

The trial on TRL's Small Roads System utilised the existing "Full Red" signal and the new "Cycle Red" signal, as shown below. Participant cyclists recruited to take part in the trials came from across a spread of age groups and cycling experience.



"Full Red" signal

"Cycle Red" signal

Trial Objectives

The objective of the trial was to assess if cyclists responded differently to the Cycle Red signal compared to the Full Red signal. The trial studied whether they adapted their behaviour in response to the Cycle Red signal and also considered the implications that introducing a change might have for cyclists if the new signal were introduced on the street.

This trial was a pre-cursor for future planned trials on Low Level Cycle Signals that include a red cycle aspect.

The key research questions for this trial were:

- Cyclists compliance with the signals – to what extent did the Cycle Red affect the compliance of cyclists with the signals and also to the stop line, in comparison with the Full Red?
- Cyclist perception and understanding of signals - to what extent did the participants correctly understand the Cycle Red in comparison with the Full Red?
- Direction of cyclists' vision on approach to intersection – to what extent was the Cycle Red signal noticeable to the cyclists, in comparison with the Full Red?

The trial used a mix of video analysis and both in-trial and post-trial questionnaires in order to help answer these questions.

Trial Methodology

The trial was undertaken at a cross-roads junction with standard ("Full Red") traffic signals for the motorised traffic movements and both bicycle and standard signals ("Cycle Red" and "Full Red") on the cycle approaches. Cyclists were released at controlled times by marshals so that they experienced a range of scenarios of signal phasing. During the trial participant cyclists experienced both the "Full Red" and "Cycle Red" signals in place at the junction.

Trial Findings

Whilst some (around 5%) cyclists were non-compliant with the Red signal, there was no indication from the trial that the type of signal head, whether "Full Red" or "Cycle Red", had an effect on compliance.

There was a good level of understanding of the Cycle Red signal with no significant differences from their understanding of the Full Red signal.

Video data was collected on the number of glances that the participants made at each of the signals: there was little difference in the number of glances made at the Full Red and Cycle Red signals.

There was a marginal preference from participants for the Cycle Red signal over the Full Red signal. Those who preferred the Cycle Red symbol mainly preferred it because it is clearer that it applies to all cyclists and it demonstrates a willingness to differentiate cyclists. Those who said they preferred the Full Red symbol mainly preferred it because it was more conspicuous, applies to all road users and is unambiguous.

In relation to whether the Cycle Red was more or less noticeable to the cyclists, in comparison with the Full Red, some concerns were expressed by participants about the Cycle Red signal. These included concerns about the visibility or brightness of the signal, and the way in which the signal might be interpreted, particularly by other road users. However, respondents were not aware that the signals would only be installed where all the traffic would be made up of cyclists and therefore mis-interpretation would not be an issue.

Responses about the configuration of the signals were also received; some (9%) commented that the signals were too high, or that an additional lower signal would be useful.

The findings from this study suggest that:

- The cyclists did not respond differently to the Cycle Red signals;
- The Cycle Red signal did not introduce any confusion over interpretation of signals; and
- Participants understood the meaning of the Cycle Red and Full Red signals, to the same extent.

The trial findings provide sufficient confidence that the trials of Low Level Cycle Signals can progress safely. In addition they provide evidence to support on-street trials of the Cycle Red signal.

1 Introduction

Transport for London (TfL) commissioned TRL to test innovative cycle provision at the TRL test track and other facilities. This project involved undertaking several trials of cycle infrastructure using cyclists and other road users. This is the report of the trial from Workstream 3: High Level Signals, with red cycle aspect (WS3.HLS.M3).

1.1 Background

The Traffic Signs Regulations and General Directions 2002 (TSRGD) shows that it is permissible to signal cyclist movements with a three aspect traffic signal head comprising a full red signal, an illuminated amber bicycle logo and an illuminated green bicycle logo. In order to offer an advanced cycle signal, this form of signalisation needs to be modified to give clearer messages to cyclists and also other road users. One such method is to remove any ambiguity between cycle signals and those controlling motorised or mixed traffic.

Currently there are no permitted variations to the standard signal (see Figure 1); specifically there is no permitted variation that would allow the use of an illuminated red bicycle logo. It is the sharing of a red cycle logo signal in a standard traffic signal application and in the signalisation of mixed traffic that is a possible cause for ambiguity if used alongside signals for mixed traffic.

Many countries throughout the world use smaller sized, low mounted traffic signals with illuminated bicycle logos for signalisation of cycle movements alongside traditional red-amber-green traffic signals. A red bicycle logo signal is not currently allowed by UK regulations for two reasons:

- Firstly the illuminated red bicycle logo is not approved for use on the UK road network; and
- Secondly the traffic signal lens size is smaller than those permitted in the TSRGD.

1.2 Facility to be trialled

This trial signal head had one design variable: this being the type of red aspect. The trial compared the currently permitted signal against one with a red cycle logo symbol, both at the current standard height (2.4m signal head centres). These are referred to as “Full Red” and “Cycle Red” respectively; see Figure 1.

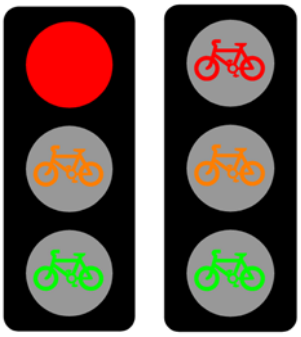


Figure 1 – Current signal (“Full Red”, left) and new signal (“Cycle Red”, right)

2 Objectives and research questions

2.1 Trial objectives

The objective of the trial was to assess if cyclists responded differently to the Cycle Red signal compared to the Full Red signal. The trial studied whether they adapted their behaviour in response to the Cycle Red signal and also considered the implications that introducing a change might have for cyclists if the new signal were introduced on the street. This trial was a pre-requisite for Workstream 4 on Low Level Cycle Signals.

2.2 Research questions

The key research questions were:

- **Cyclists' compliance with the signals** – to what extent did the Cycle Red affect the compliance of cyclists with the signals and also to the stop line, in comparison with the Full Red? This was assessed using a video survey on the time that participants passed timing points (see Section 4).
- **Cyclist perception and understanding of signals** - to what extent did the participants correctly understand the Cycle Red in comparison with the Full Red? This was assessed through a post-trial questionnaire (see Section 5).
- **Direction of cyclist's vision on approach to intersection** – to what extent was the Cycle Red signal more or less noticeable to the cyclists, in comparison with the Full Red? This was assessed using a combination of a video survey and a post-trial questionnaire survey (see Sections 4 and 5).

3 Methodology

3.1 Trial setup

3.1.1 The trial site

The trial took place at a four-arm junction on an off-street test track[1] at TRL, as shown in Figure 2 and Figure 3.

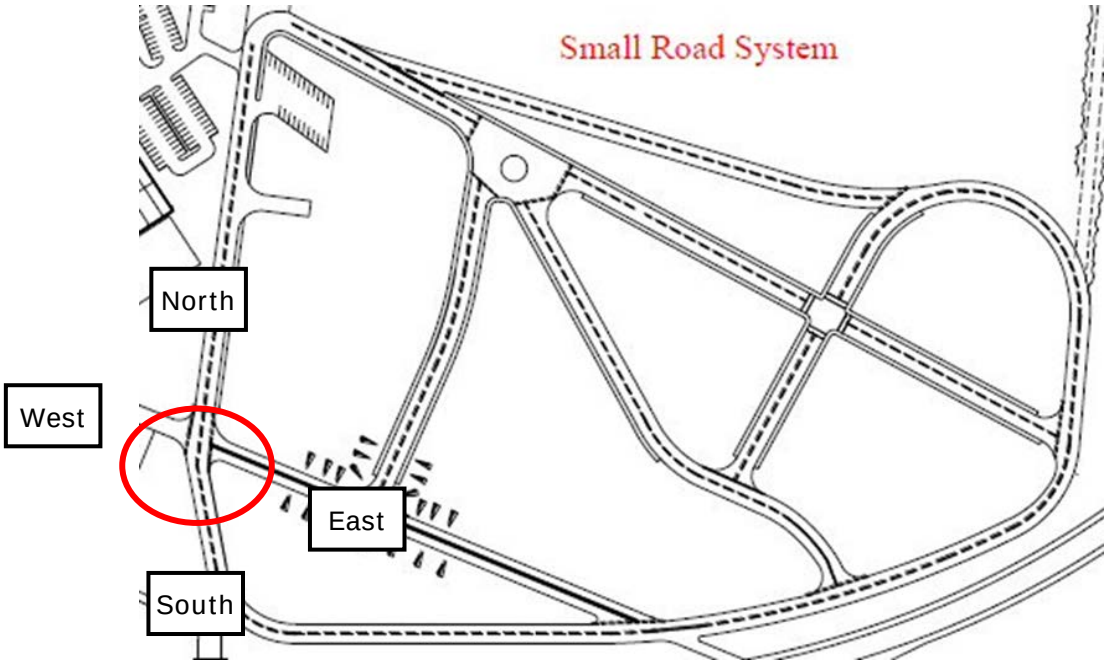


Figure 2 – Trial location

[1] Small Road System at TRL in Crowthorne. For more details see http://www.trl.co.uk/facilities/test_track_road_system/

Figure 3 – Trial site

The trial site comprised standard traffic signals on the motorised traffic movements (North and South arms) and bicycle signals on the cycle approaches (East and West arms).

The traffic signals were mounted at the standard height, using RJ115 sockets within temporary concrete foundations. The traffic signals were driven from a standard traffic signal controller (supplied by TfL), cabled over the surface, with the exception of the carriageway crossing over the cyclist movement. In this case ducting was set into the access road to ensure that cyclists didn't have to cycle over a thick cable.

A photograph of the Cycle Red signal head is shown in Figure 4.

Figure 4 – Trial signal heads (Cycle Red)

3.1.2 Cyclist and vehicle movements

Participant cyclists approached the junction from either the East or West arm, went straight on at the signals, did a U-turn and repeated from the opposite arm. Participants were released by a marshal at defined times ahead of the signals change. The West-to-East movement was on an uphill approach and the East-to-West movement was on a downhill approach.

Cars were driven by TRL staff on the other two arms of the junctions on some runs, always going straight on.

There were seven scenarios for release times, as described below:

- In five scenarios, participants were released on Green so that they arrived as the signals changed from Green to Amber to Red; this is denoted "Green to Red".

- In two scenarios, participants were released on Red so that they arrived as the signals changed from Red to Red & Amber to Green; this is denoted “Red to Green”.

3.2 Data collection and measures

3.2.1 Data collection

Data was collected from several video cameras, which were placed strategically to capture the status of the signals and the actions of cyclists simultaneously.

Data was extracted from the videos on the time that the signals changed, as well as the time that participants passed five timing points[2]:

- Timing Point 1 (TP1), release point, 24 metres upstream of the stop line;
- Timing Point 2 (TP2), 10 metres upstream of the stop line;
- Timing Point 3 (TP3), the ‘decision point’, 5 metres upstream of the stop line;
- Timing Point 4 (TP4), the stop line;
- Timing Point 5 (TP5), in the junction, 5 metres downstream of the stop line.

This is illustrated in Figure 5.

TP3 is of particular interest, because this is the point at which the participant makes the decision whether to proceed through the junction or not. TP4 and TP5 were also important, because these were used to determine whether the participants were non-compliant with the red light.

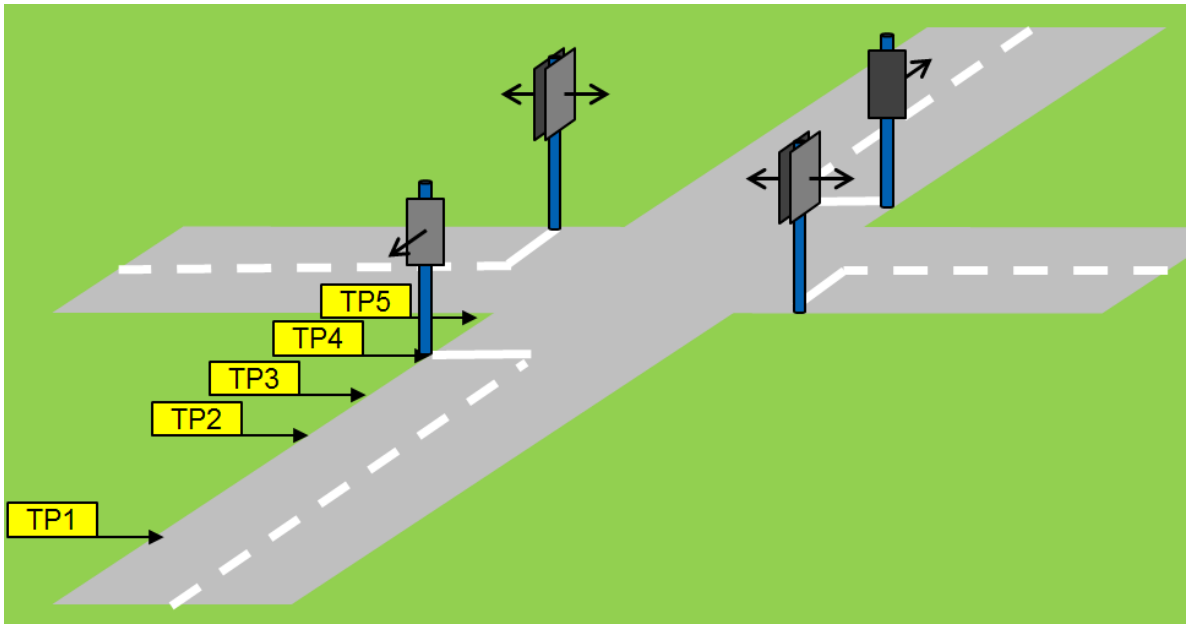


Figure 5 – Trial setup and timing points

[2] There were no visible markings for TP2, TP3 and TP5.

Data was also extracted from the videos on where participants were looking. This was used to gain an understanding of whether cyclists looked at the signals on their approach and the number of times they glanced at the signals.

Additional data was collected through a trackside questionnaire after each run.

There was also a written post-trial questionnaire to assess the opinions and preferences of cyclists when confronting the traffic signals. This was completed after the participants had finished all their time on track and had cycled through both the Full Red and Cycle Red a number of times. The questionnaire included questions focussing on the different interpretations of the Full Red and Cycle Red, as well as questions to obtain overall feedback of opinions and preferences.

3.3 Limitations

The situations presented to the participants were necessarily lacking some aspects of realism; some limitations of the experiment are listed below.

Compliance is notoriously difficult to study accurately on a test track, with participants often being more compliant than in the real world. Specifically in this experiment, the following factors may have had an effect of the compliance of participants:

- Participants were aware they were being studied.
- They were not under time pressures.
- Cyclists only went straight ahead[3].

Other limitations of the study, which affected realism included:

- A lower level of red light was observed when using a cycle mask on the lens, compared with an unobstructed red lens. No remedial action was taken since such a situation is not uncommon on roads in London.
- There was no vehicular traffic on the same arms as the cyclist.
- This trial did not consider features such as bus stops, on-street parking, loading/drop-off zones or pedestrian crossings, all of which would influence cyclist behaviour.
- Participants had clear information about their route.
- The likelihood of risk compensation[4] by participants was not addressed.

Previous experiments have been conducted under similar 'artificial' conditions, where absolute behaviour is often found to differ from reality. However, the extent of immersion in the conditions simulated has been found to be sufficient for participants to

[3] Other studies have shown that cyclists going straight on are less likely to jump red lights than those turning left (Riding through red lights: The rate, characteristics and risk factors of non-compliant urban commuter cyclists. Johnson et al, 2011, Accident Analysis and Prevention Vol 43, pages 323-328).

[4] Risk compensation is where people adjust their behaviour in response to the perceived level of risk, behaving less cautiously where they feel more protected and more cautiously where they feel a higher level of risk.

realistically adapt their behaviour. As such, it is possible to investigate the relative (although not absolute) effects of altering designs.

This provides an indication of the effect of implementing the same conditions in reality. The extent of the change may be over, or under, represented; however, the direction of the change would be expected to occur in reality and the effects can therefore be assessed as to whether they would be beneficial. Specifically, this trial enabled relative comparisons to be made between the Full Red and the Cycle Red.

4 Results – Video analysis

This section summarises the results from the analysis of the video data and also the trackside questionnaire.

4.1 Results for signal change from Green to Red

The results are summarised below for the observations where the participants were released by the marshal on Green (i.e. they approached the junction as the signals changed from Green to Red).

4.1.1 Arrivals at the junction

Figure 6 shows the distribution of the arrivals 5 metres upstream of the signals at Timing Point 3, i.e. the decision point. This shows that the trial setup was successful in releasing participants in a manner such that there was a good distribution of arrivals at the junction just before the signals changed from Green to Red.

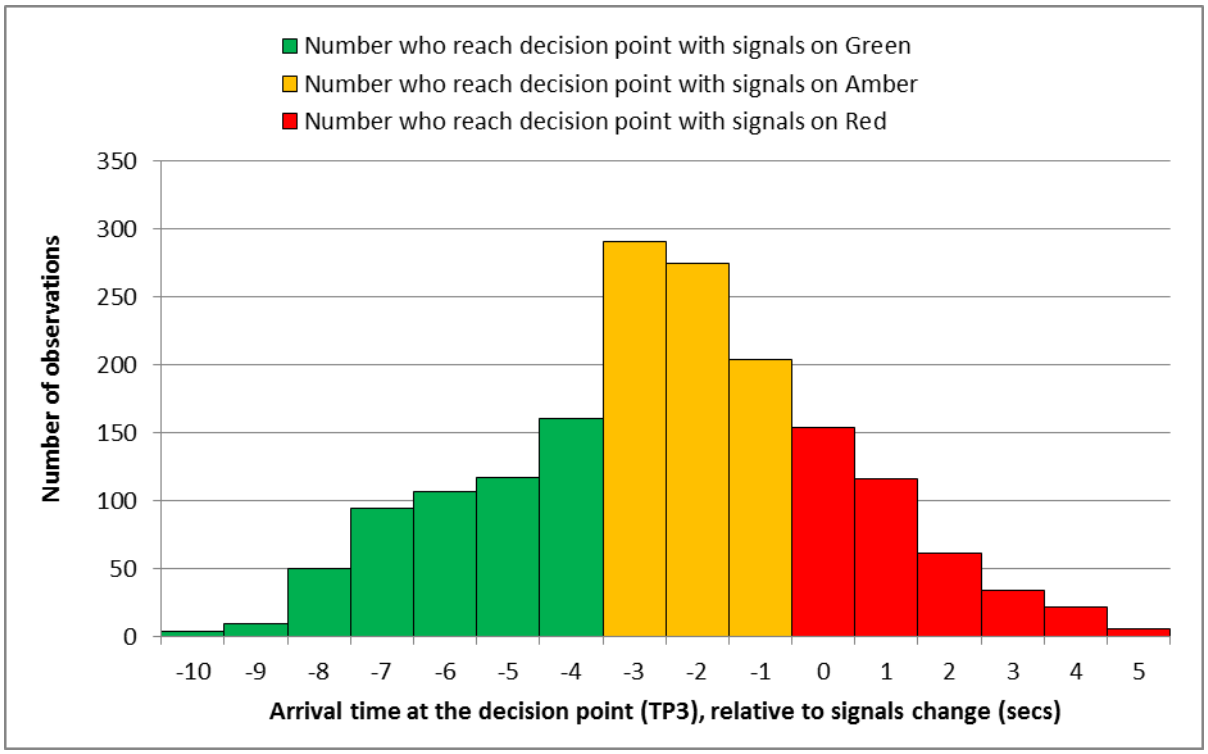


Figure 6 - Distribution of arrivals at the decision point (TP3), relative to the signals change (Green to Red)

4.1.2 Compliance with signals – video data

The strict definition of non-compliance with the signals is where participants pass the stop line when it is on red. A slight complication is that some participants passed the stop line (TP4) on Red, but then did not pass through the junction (TP5) until the signals had turned Green: i.e. the cyclists waited at the signals beyond the stop line. This is more an issue on compliance with the stop line, rather than compliance with the signals. Therefore TP5 was used instead of TP4 to determine whether participants stopped at the junction.

Figure 7 shows the distribution of the arrivals 5 metres downstream of the signals at TP5, i.e. in the junction. This gives some useful insights into the data:

- The participants to the left of the graph, who passed TP5 between -8 and 16 seconds, are those that did not stop at the junction.
- Likewise, the participants to the right of the graph, who passed TP5 after 16 seconds, are those that did stop at the junction and waited for the signals to change before proceeding.
- Of those that didn't stop, it shows that approximately 120 participants passed through the junction as the lights had just changed to Red, specifically:
    - approximately 80 did so 0 seconds after the change to Red;
    - approximately 15 did so 1 second after the change to Red; and
    - 25 did so between 2 and 16 seconds after the Red.
- Of those that did stop, it shows that there were only a small number of participants who may have moved off early as the signals changed from Red to Red & Amber.

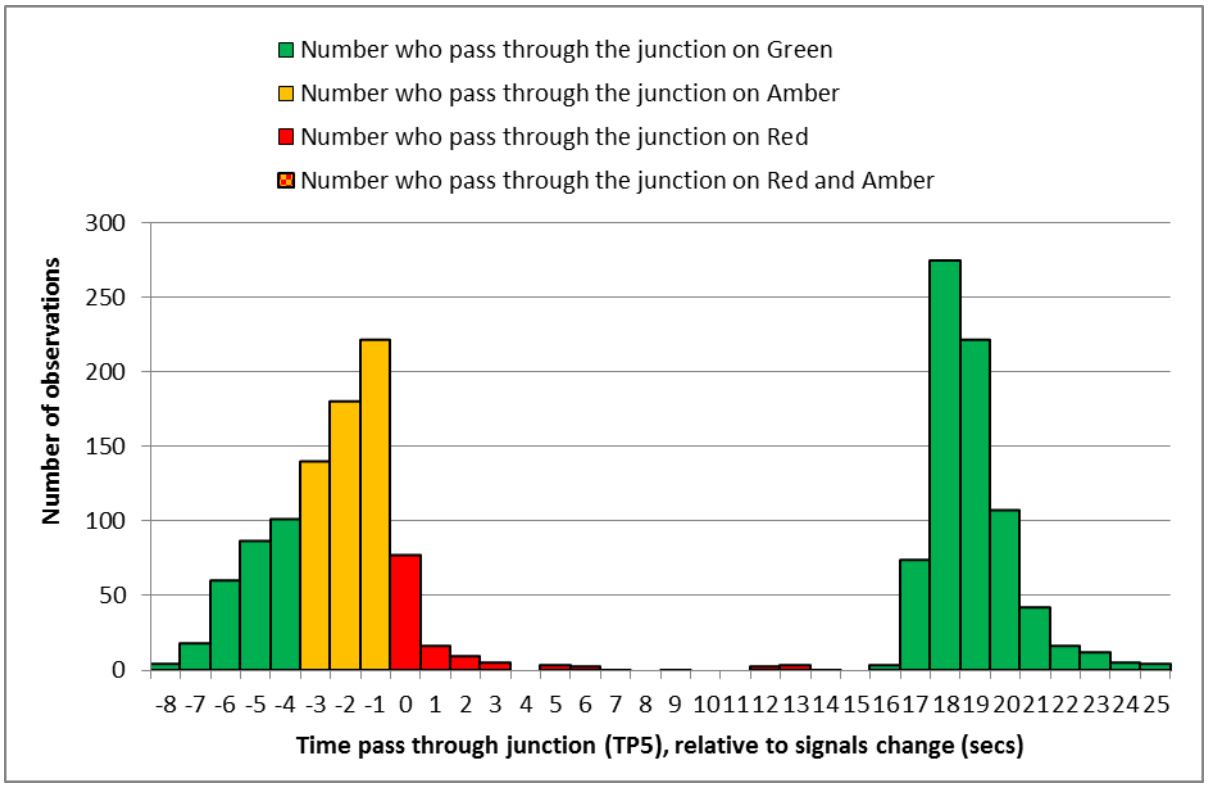


Figure 7 - Distribution of the participants passing through the junction (TP5), relative to the signals change (Green to Red)

Of the 120 participants that passed through the junction (TP5) just as the signal turned to Red, a proportion of these would have passed the stop line (TP4) on Amber. Technically, passing the stop line on Amber is allowed, because it is the clearance time. It is therefore necessary to filter these participants out in order to determine the numbers that were non-compliant.

Table 1 shows the number of participants who were non-compliant with the Red signal as defined above, split by Cycle Red and Full Red. To determine the non-compliance rate

as a percentage for the Cycle Red and the Full Red, it is necessary to filter out the participants to the far left of Figure 7, who approached the junction and entered it before the Red signal appeared i.e. those who passed through the junction on Green (without stopping) or Amber. This leaves the number of observations where non-compliance was possible i.e. those participants who saw a Red signal at some point during the run.

Table 1 - Number of participants who were non-compliant with the Red signal

Signal head	Non-compliant observations	Observations where non-compliance was possible	Percentage non-compliant
Cycle Red	23	441	5.2%
Full Red	22	443	5.0%

This suggests that the change in signal head made no substantial difference to the number of participants who were non-compliant with the Red signal at the change from Green to Red.

A number of the participants were non-compliant to the signals more than once during the session; hence the number of non-compliant observations does not represent 45 unique cyclists. The 23 non-compliant observations on the Cycle Red signal were made by 14 participants; 5 of which were non-compliant more than once in a session. The 22 non-compliant observations on the Full Red signal were made by 18 participants; 4 of which were non-compliant more than once in a session. Approximately 70% of the non-compliant observations for both the Cycle Red and Full Red signals were on the uphill approach. This is possibly due to reluctance to stop, due to losing their momentum to go up the hill; although there may be another explanation for this trend.

Figure 8 shows the percentage of observations where the participant stopped at the junction by arrival time at the decision point (TP3).

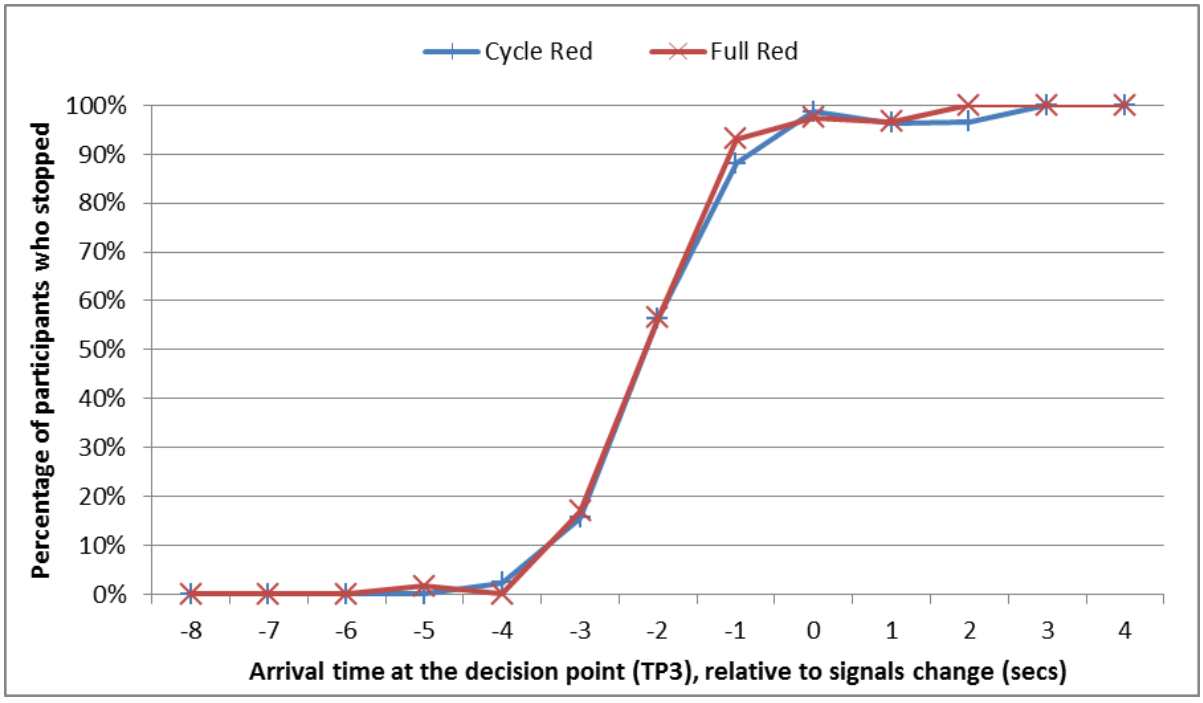


Figure 8 – Percentage of participants who stopped at the junction by arrival time at the decision point (TP3), relative to the signals change (Green to Red)

Almost all participants chose to pass through the junction without stopping between -8 and -4 seconds; during this time only the Green signal was shown. Between -3 and -1 seconds the signals were on Amber. The percentage of participants who stopped increased from approximately 15% at -3 seconds up to 90% at -1 seconds. These trends were very similar for both the Full Red and Cycle Red scenarios; this is as expected, because the red signal was not showing.

After the signal change to Red at 0 seconds, over 95% of participants chose to stop for both the Cycle Red and Full Red signals. These trends were very similar for both the Full Red and Cycle Red scenarios.

4.1.3 Compliance with signals – trackside questionnaire

As part of the trial, participants were asked a number of trackside questions; the responses to two of these questions for the 45 non-compliant observations are given in Table 2.

Table 2 – Reponses to track questionnaire by non-compliant participants

Signal head	Did you stop?	In hindsight, was this the correct decision?	
		Yes	No
Cycle Red	Yes	5	0
	No	15	3
Full Red	Yes	7	0
	No	13	2

Although these 45 observations were all deemed to be non-compliant to the signal (i.e. passing through TP4 and TP5 on red), twelve questionnaire responses indicated that the participant stopped at the junction. In these cases it may be that the participant stopped initially for a few seconds, but then passed through the junction on red a few seconds later. Only 5 responses indicated that the participant thought that in hindsight, their decision to pass through the junction was incorrect. There appears to be no substantial difference in the responses to these two questions for Cycle Red and Full Red signals.

Participants were also asked to rate how safe their decision was on a scale of 1 (very unsafe) to 10 (very safe). The results for those observations deemed to be non-compliant are shown in Figure 9.

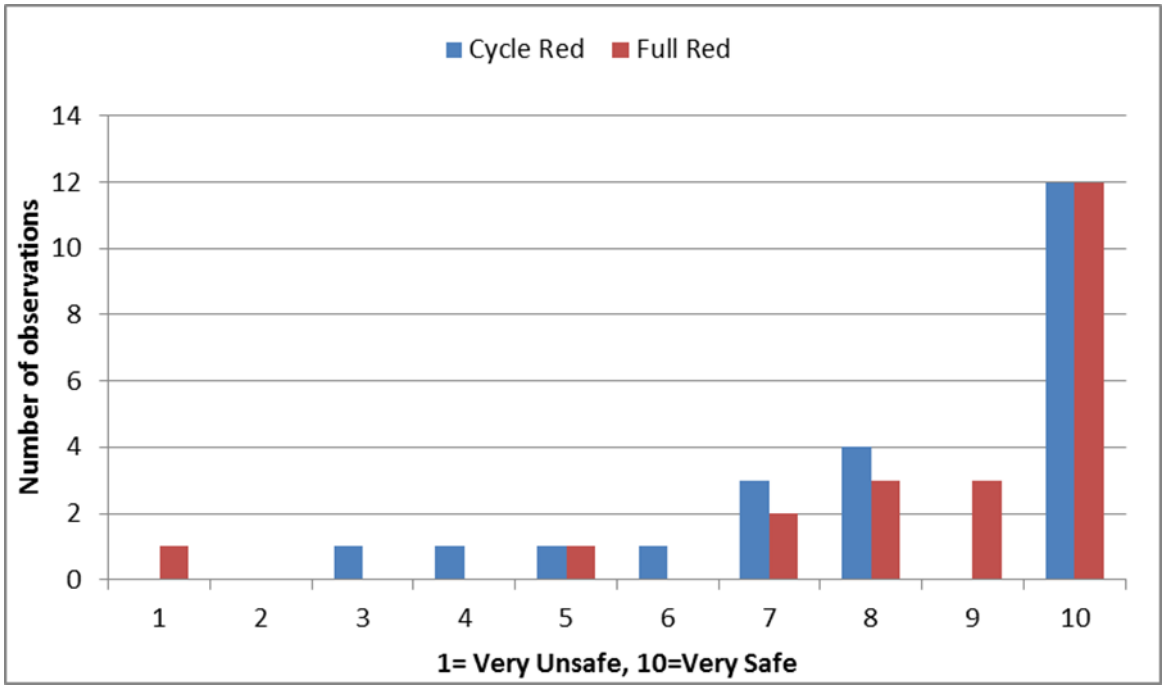


Figure 9 – Responses to question 'how safe would you rate your decision?' by non-compliant participants

The majority of non-compliant observations were reported as being 'very safe'. There is little difference in the responses to this question for Cycle Red and Full Red signals.

4.1.4 Glances at the signals

Data was collected on the number of glances that the participants made at the signals and this is summarised in Figure 10. This shows that there is no discernible difference in the number of glances made at the signals between the Cycle Red and Full Red.

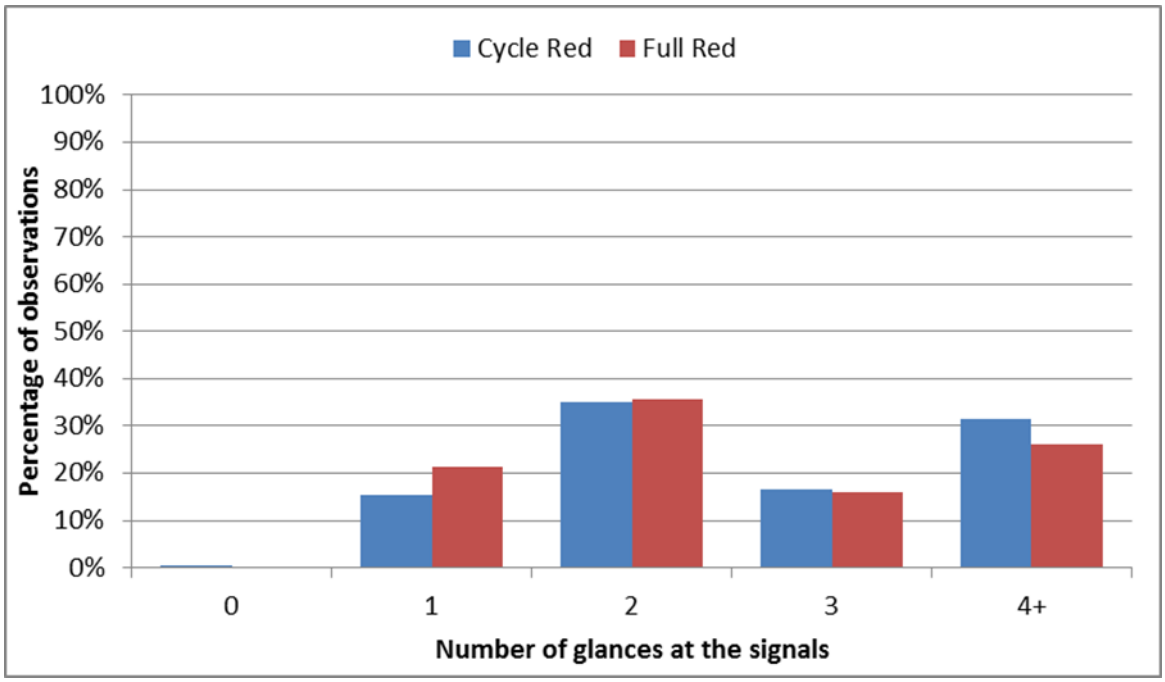


Figure 10 - Number of glances made at the signals

Data was also collected on the number of glances at the signals on the other arms (perpendicular to the cyclists); see Figure 11. This shows that there is no discernible difference in the number of glances made at the secondary signals between the Cycle Red and Full Red.

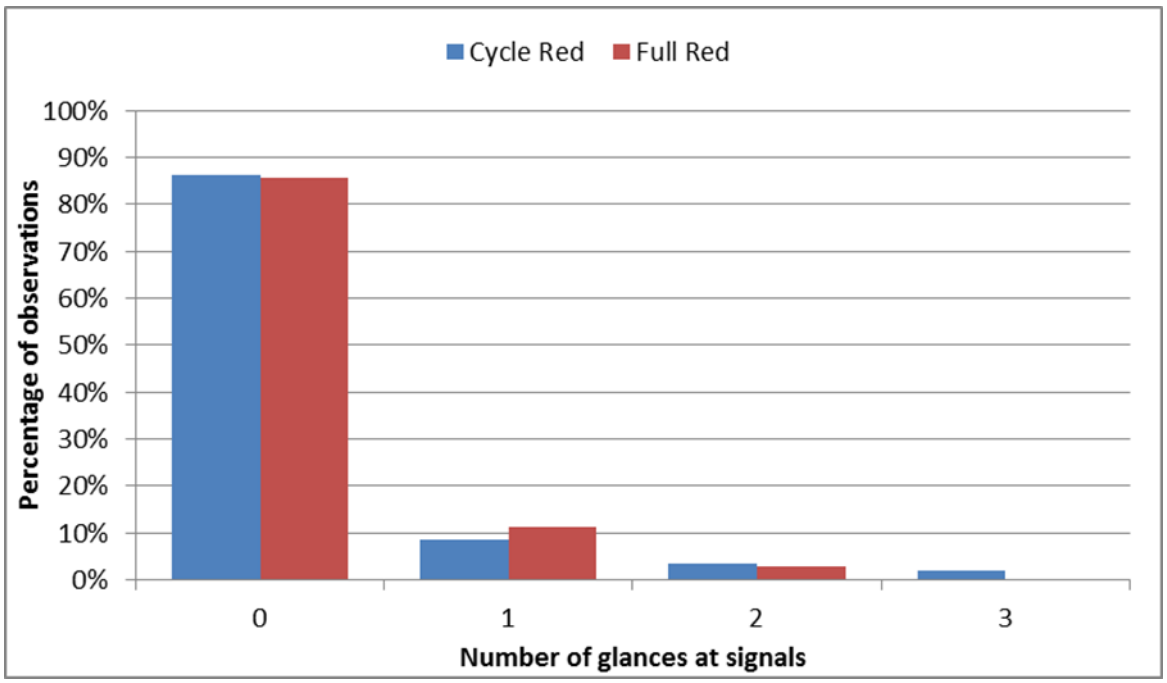


Figure 11 - Number of glances made at the signals on the other arms

4.2 Results for signal change from Red to Green

The results are summarised below for the observations where the participants were released by the marshal on Red, i.e. they approached the junction as the signals changed from Red to Green.

4.2.1 Arrivals at the junction

Figure 12 shows the distribution of the arrivals 5 metres upstream of the signals at Timing Point 3, i.e. the decision point.

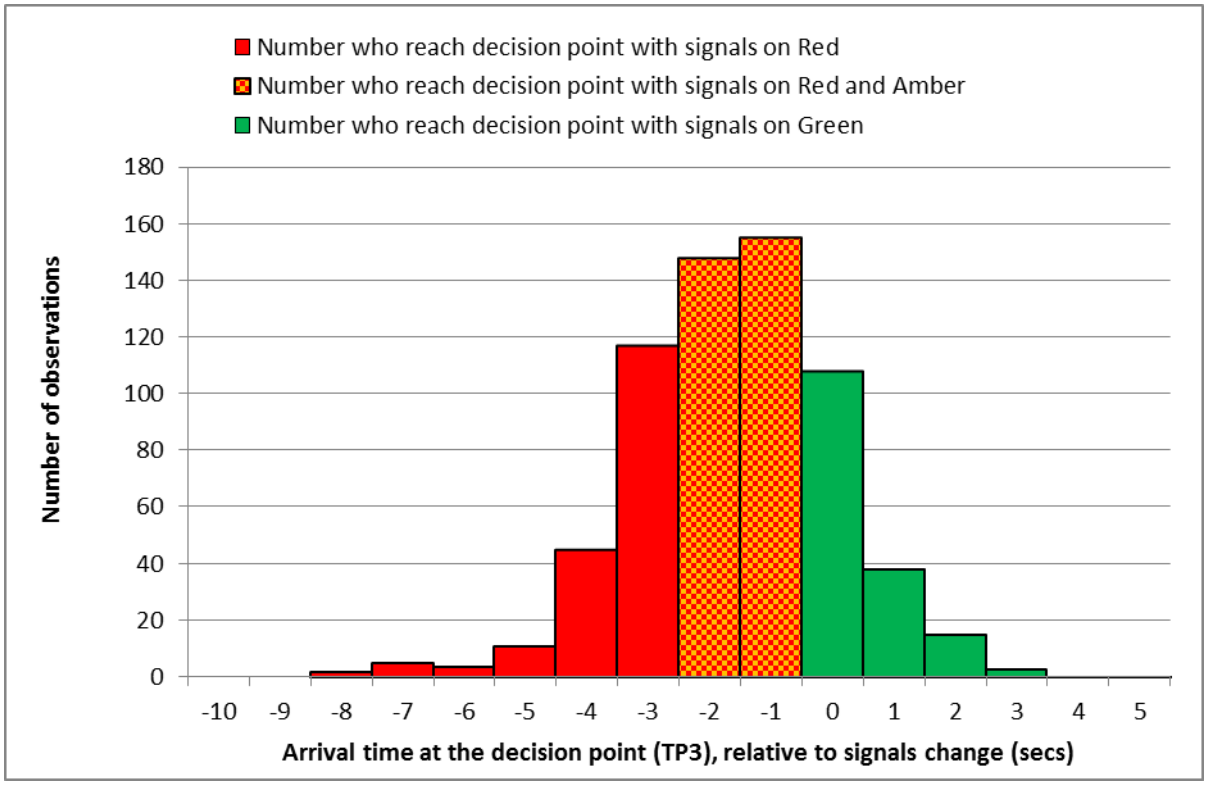


Figure 12 - Distribution of arrivals at the decision point (TP3), relative to the signals change (Red to Green)

This shows that the trial setup was successful in releasing participants in a manner such that there was a good distribution of arrivals at the junction just before the signals changed from Red to Green.

4.2.2 Compliance with signals

Figure 13 shows the distribution of the arrivals 5 metres downstream of the signals at TP5, i.e. in the junction.

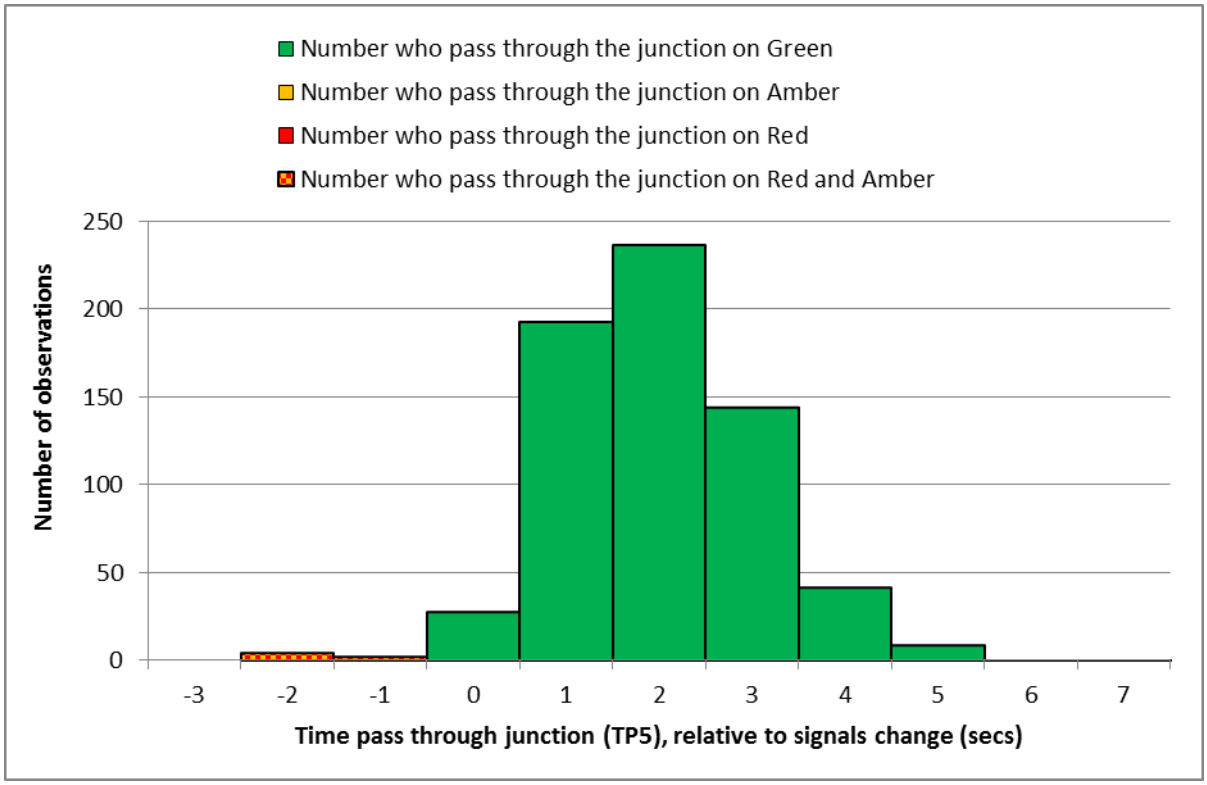


Figure 13 - Distribution of the participants passing through the junction (TP5), relative to the signals change (Red to Green)

This shows that for the participants who approached the junction as the signals changed from Red to Green, almost all entered the junction on Green, regardless of whether it was the Full Red or Cycle Red.

5 Results – Post-trial questionnaire

This section presents the results of the participant questionnaires completed at the end of the day. It focuses on two aspects:

- Responses to closed questions (graphs with vertical bars)
- The classifications of the responses to the open-ended questions (graphs with horizontal bars).

5.1 Participant Characteristics

In total 89 people completed the post-trial questionnaire. The characteristics of the sample were as follows:

- 72% were male and 28% female. In the 2012 National Travel Survey (NTS), 74% of cycle trips were made by males.
- A spread of age groups was included, but with a larger proportion of people aged 45-54 than in the NTS.
- Most of the cyclists cycled regularly.
- Leisure and commuting were the main purposes for cycle journeys.
- Most participants generally cycled on roads.
- Almost all participants were regular car drivers.
- The main purposes of car journeys were leisure, commuting and business travel.

Further details can be found in Appendix A.

5.2 Understanding of signals at junctions

When asked about the meaning of the various phases of the cycle signals, many did not mention cyclists in their explanations; perhaps this was considered to be obvious.

There was a good level of understanding of the red cycle signal. A minority (11%) said they would go through the signal – mainly if safe to do so and the traffic is quiet.

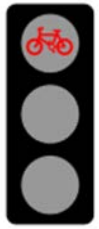
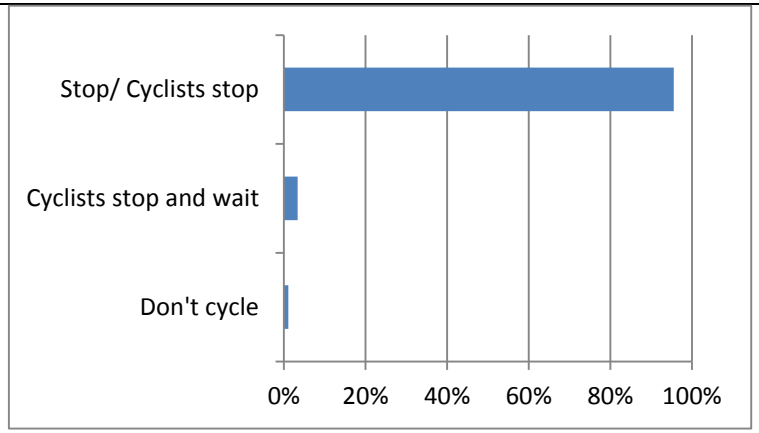
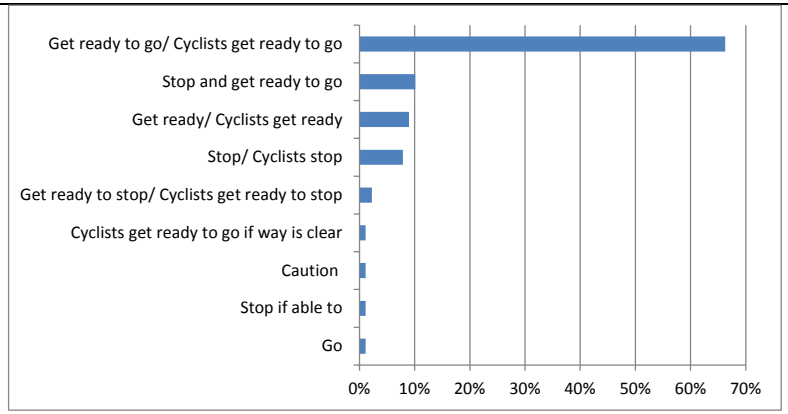
A few (6%) interpreted the red and amber signal (incorrectly) to mean 'go', 'caution' or 'be prepared to stop'. Almost half said they would enter the junction if it was showing – mainly if the road was clear and it was safe to do so.

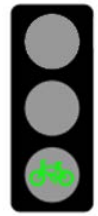
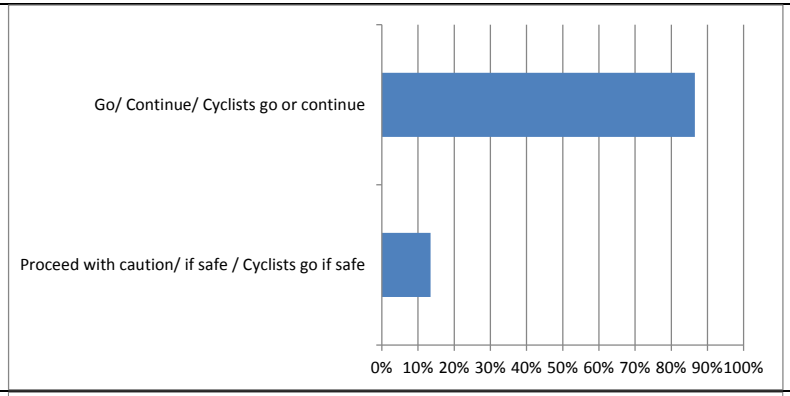
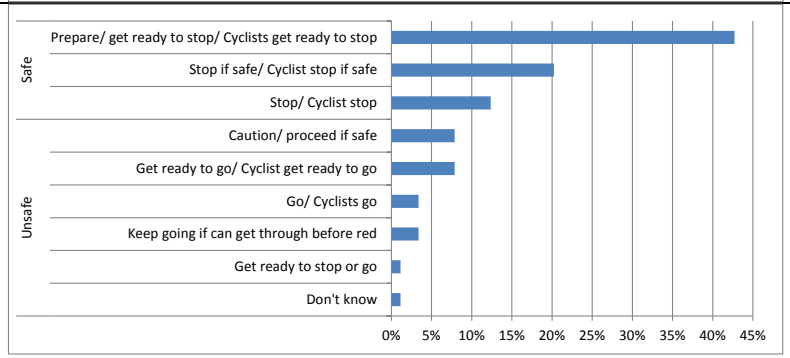
There was a good level of understanding of the green cycle symbol; only 13% mentioned any checks or cautions when explaining the meaning, although a larger proportion (42%) said they would enter if it was safe, clear or if they had checked.

Three quarters of the cyclists gave an interpretation of the amber cycle symbol which could be described as 'safe' and another few (8%) said it means 'caution', 'proceed if safe' or 'proceed if clear'. Two-thirds said they would enter the junction – mainly if it was safe to go, but some said they would enter if it was unsafe to stop.

Understanding of the solid red signal was good, but two participants clearly did not fully understand and thought that it applies only to cyclists or to cars. A minority (9%) said they would go through the signal – mainly if the road was clear and it was safe.

The results are summarised in Figure 14.

	Meaning	Would you enter the junction?	If yes, when would you enter? (Number responding to main categories of response)
		Yes 11% No 89%	N No perceived conflict 6 Only if, after waiting, signals do not detect me 2 If crossing traffic had just stopped 1 If bad weather and no perceived conflict 1 If I know the junction 1 If no cyclists behind who might follow without looking 1 If cycle lane only 1 If a blockage stopped my view of the road 1
		Yes 48% No 52%	Number If safe/ road clear/ traffic stopped/ traffic gone 28 Enter slowly, checking 4 If moving and signal about to change 2 If clear and going fast - risk skidding to stop 1 If quiet time of day 1 To see the view 1 Anticipate green signal, proceed through amber* 16 (*includes 'when signal appears', 'second signal appears', 'before next change')

	Meaning	Would you enter the junction?	If yes, when would you enter? (Number responding to main categories of response)
		Yes 100%	Always/ my right of way (no conditions) 35 If safe/ road clear/ opposing traffic stopped 24 Caution/ while checking/ alert 12 When signal appears 9 Continue at speed/ keep going 3
		Yes 65% No 35%	N If safe/ road clear/ opposing traffic stopped 27 If unsafe to stop 11 When signal first appears 11 If can get across/ going fast enough/ not uphill 10 If close to stop line when signal changes 5 Caution/ checking/ discretion 2 If already moving 1

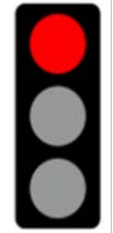
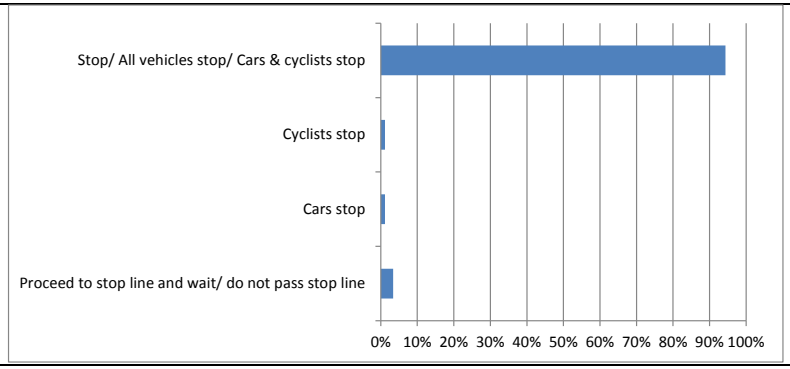
	Meaning	Would you enter the junction?	If yes, when would you enter? (Number responding to main categories of response)
		Yes 9% No 91%	If safe/ road is clear/ no vehicles approaching 5 Caution/ judgement 2 No traffic/ quiet traffic 1 Quiet time of day 1 Only if signals have not detected me 1 If bad weather and no vehicles approaching 1

Figure 14 - Questionnaire: "Would enter the junction?" (with various signals showing)

5.3 Compliance with signals at junctions

This section evaluates the reported levels of compliance with signals. For the most part, the level of compliance stated by respondents was high.

There was a tendency for women and less frequent cyclists to be more likely to report that they never disobeyed the signals when cycling than men and frequent cyclists.

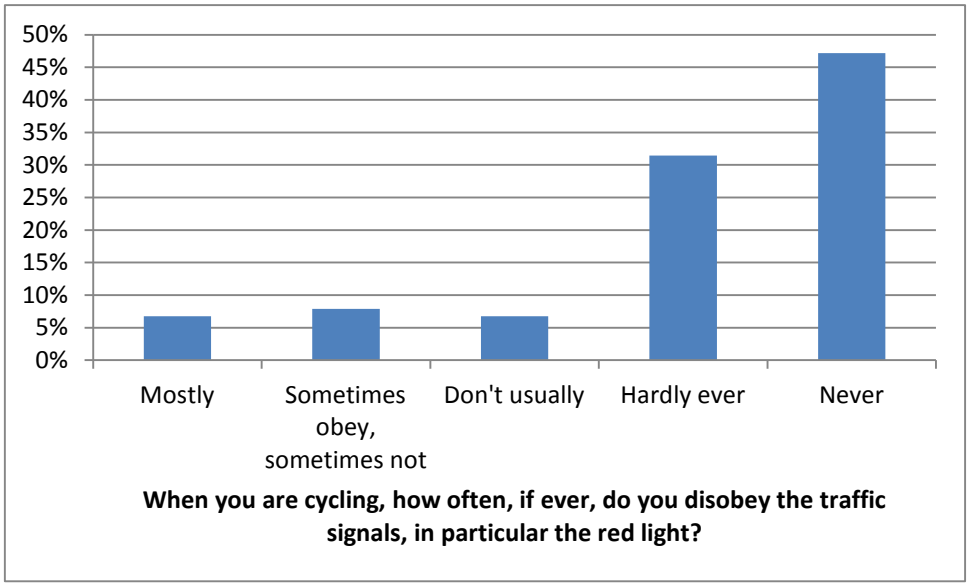


Figure 15 - Questionnaire: compliance with red signals

The main circumstance in which cyclists said they would not obey traffic signals was when cyclists could see that it is all clear (no traffic). (Note – some response options were offered for this question, but other responses were also recorded, and shown in red in the graph below.)

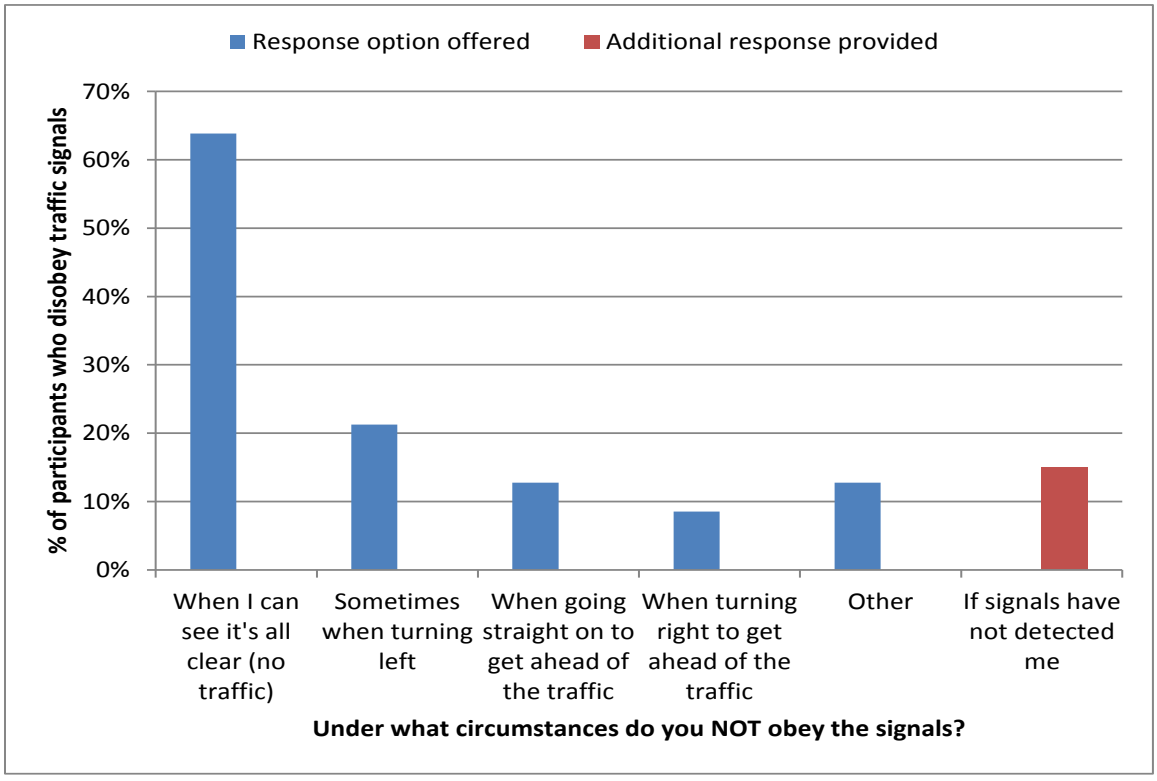


Figure 16 - Questionnaire: situations for non-compliance with red signals

5.4 Views on the signals seen during the trial

Participants were asked whether they noticed that both types of signal were used during the experiment, using the illustration below.

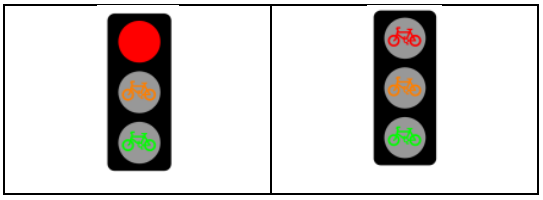


Figure 17 - Questionnaire: stimulus used to compare Full Red and Cycle Red

Two-thirds (69%) said 'yes', 30% said 'no' and 1% said 'don't know'.

The signal with the red cycle symbol was marginally more popular than the solid red, but some participants said they preferred neither.

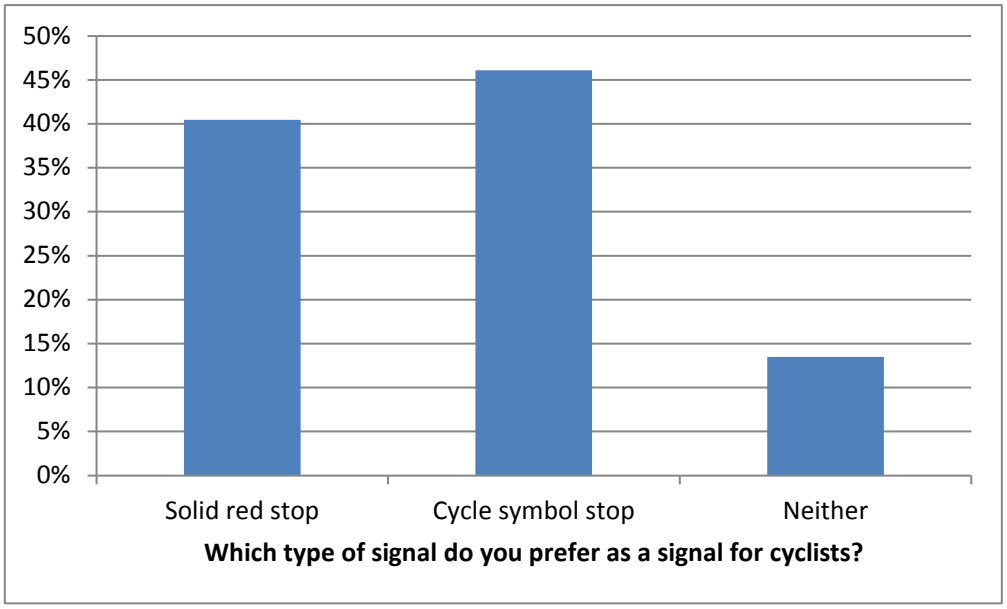


Figure 18 - Questionnaire: preference of Full Red or Cycle Red

Those who said they preferred the solid red symbol mainly preferred it because it was easier to see, more conspicuous or clearer; the other main reasons were that it applies to all road users and that it is unambiguous.

Those who preferred the red cycle symbol mainly preferred it because it is clearer that it applies to all cyclists, is unambiguous, or because it demonstrated a focus on cyclists or a willingness to differentiate cyclists. A few preferred it as being simpler (e.g. in cycle lane) if used in a cycle lane, and more likely that cyclists would adhere to it.

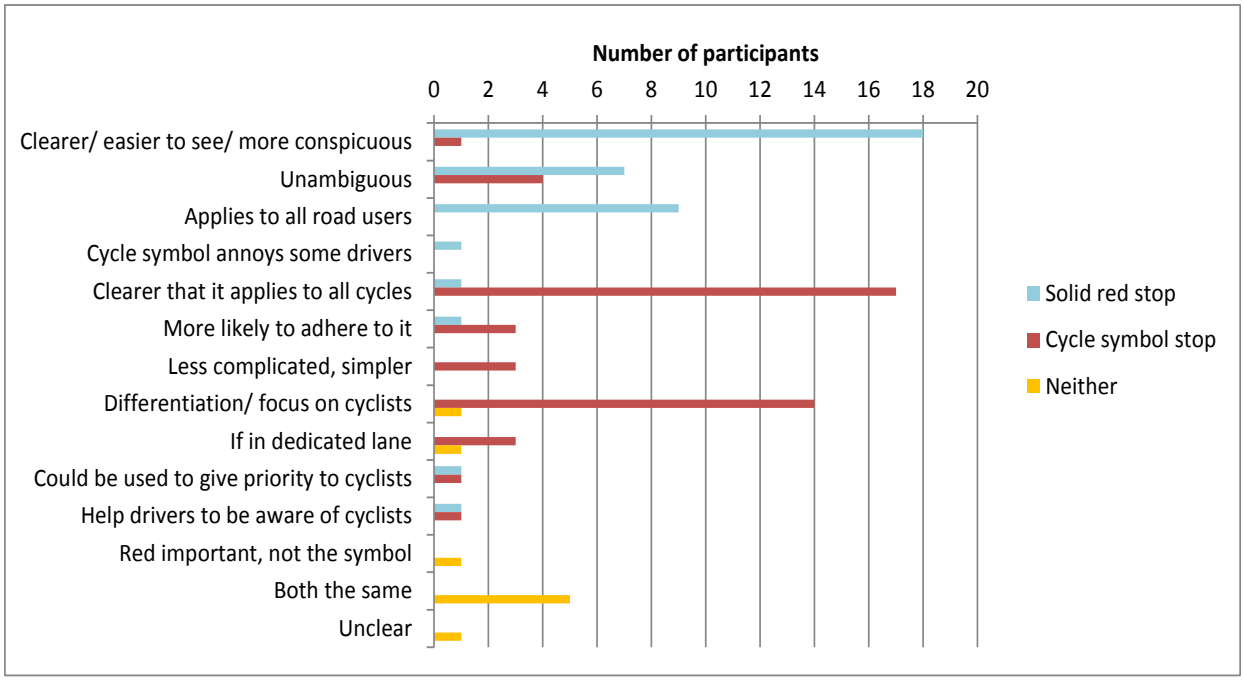


Figure 19 - Questionnaire: reasons for preference of Cycle Red over Full Red

A few of the preferences for each of the symbols reflect 'tensions' between cyclists and other traffic: giving priority to cyclists, making drivers aware of cyclists and the cycle symbol potentially annoying some drivers.

Participants were also asked whether they had any concerns or issues with either of these signals.

Just 8% expressed concern with the solid red signal. More of the participants (19%) expressed concern with the red cycle symbol signal.

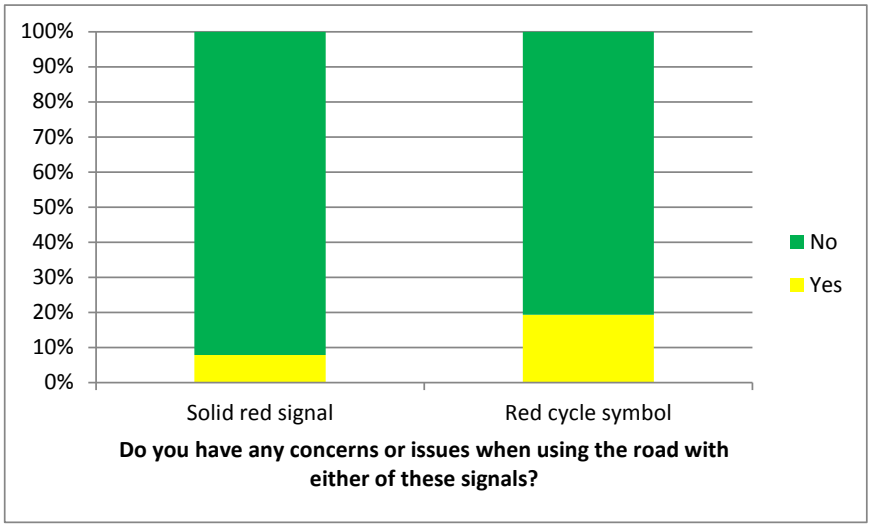


Figure 20 – Questionnaire: concerns with either Full Red or Cycle Red

The concerns mentioned for the solid red signal were mainly about confusion as to which user group they apply to (4 participants):

"It can cause confusion as to who can go."

"Lack of clarity as to whether this applies to all traffic or only cyclists."

"I felt it was slightly confusing and not clear to non-cyclists or new cyclists to the road."

"I wasn't sure if other vehicles would be included."

One participant inferred confusion in commenting on it being different from the expected signal:

"All lights should be of the same type i.e. normal traffic light."

One participant talked about the difficulty in distinguishing between the signals:

"If other lights are present it would be harder to distinguish the difference between the two sets of lights."

One participant's concern about the solid red signal was a more general issue with the configuration of the signals – the height and lack of signal on the other side of the junction:

"The signals were quite high up and I couldn't see the lights when at the stop line so I had to stop 0.5m behind. Also there was no signal head on the other side of the junction."

This issue was also raised at the end of the survey when participants were asked to mention any further comments about the trial (see Section 5.7).

Two types of concern with the version of the signal with the red cycle symbol were expressed: visibility or brightness of the signal (6 participants) and the way in which the signal might be interpreted, particularly by other road users (4 participants) but also confusion because it is unfamiliar (2 participants).

Examples of concerns about the visibility were:

"Not always clear. Potentially not in bright light, i.e. early am/dusk."

"Not bright enough."

"Red light not as visible from a distance as solid red."

Examples of those concerned with interpretation were:

"Clearly applies to cyclists but will other traffic understand/obey?"

"It may be interpreted by pedestrians or other non-cyclists as allowing them to pass on red."

"Unfamiliar signal signs would take longer time to process what they mean."

A comparison of the concerns raised about the solid red signal and the red cycle symbol indicates that in each case 4 participants referred to confusion about who the signal applies to, and 1 or 2 referred to lack of familiarity. The main difference between the concerns about the two types was that 6 people were concerned with the visibility or brightness of the red cycle symbol, but visibility was not a concern with the solid red signal.

However, regarding the concerns about potential mis-interpretation by other road user groups, respondents were not aware that the signals would only be installed where all the traffic would be made up of cyclists and therefore mis-interpretation would not be an issue.

5.5 Interpretation of the signals seen during the trial

Participants were asked to explain the difference in meaning between the two types of signal. The difference in meaning between the two types of signal was most commonly explained (by 62%) as being that the solid red signal applies to all traffic and that the red cycle symbol applies to cyclists only. A further 22% said there was no difference in meaning between the two signals. A few (5%) stated that the solid red version is used when the traffic is mixed and the red cycle symbol is used on cycle facilities.

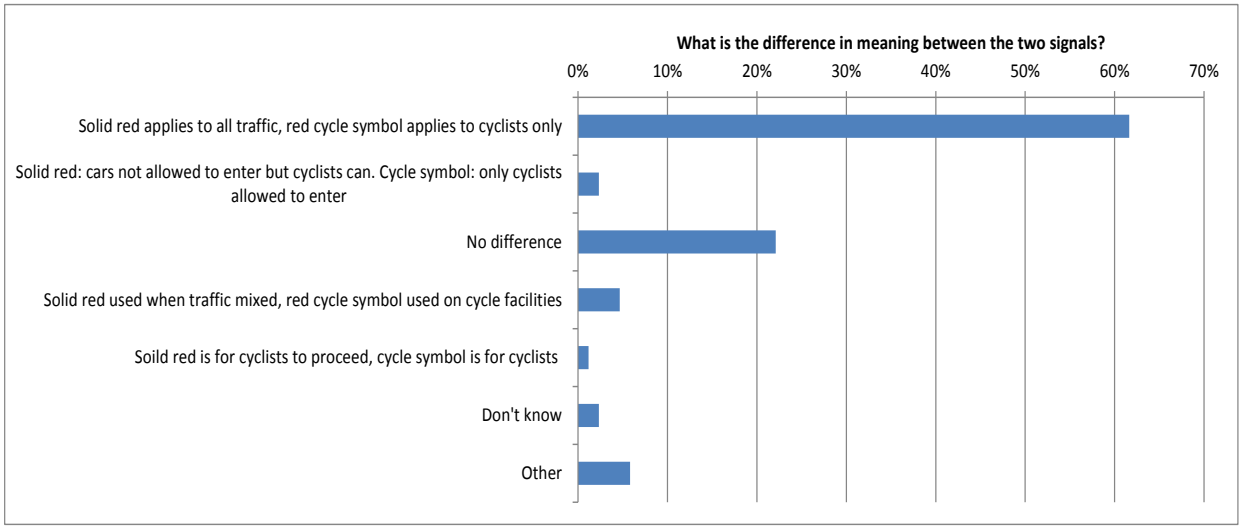


Figure 21 – Questionnaire: difference in meaning between the two signals

There were 3 participants who explained the difference with an explanation which could be interpreted as 'unsafe', saying that the solid red means that cars are not allowed to enter or proceed, but cyclists can. This may have reflected some confusion in the way in which the symbols were presented without any contextual information to assist with interpretation, and without showing the complete signal sequence.

However when asked whether they treated the two signals differently during the trial, all but one of the participants said 'no'. The one who said they treated them differently did not explain why.

5.6 Information used when deciding to enter a junction

Cyclists were asked: "When you are cycling, what do you look at when deciding to enter a junction?". Almost all of them said that they looked at the signals in front of them, but only half said they looked at other signals, such as those on other roads. Almost all said they looked at the position and speed of other approaching vehicles, the position and speed of pedestrians crossing and most said they looked to see whether the junction was empty.

A few mentioned other factors which they took into account such as road surface and weather conditions, whether there were vehicles behind them, and their own speed, load and ability to accelerate rapidly. (Note some response options were offered for this question, but other responses were also recorded – these are indicated in red in the graph below.)

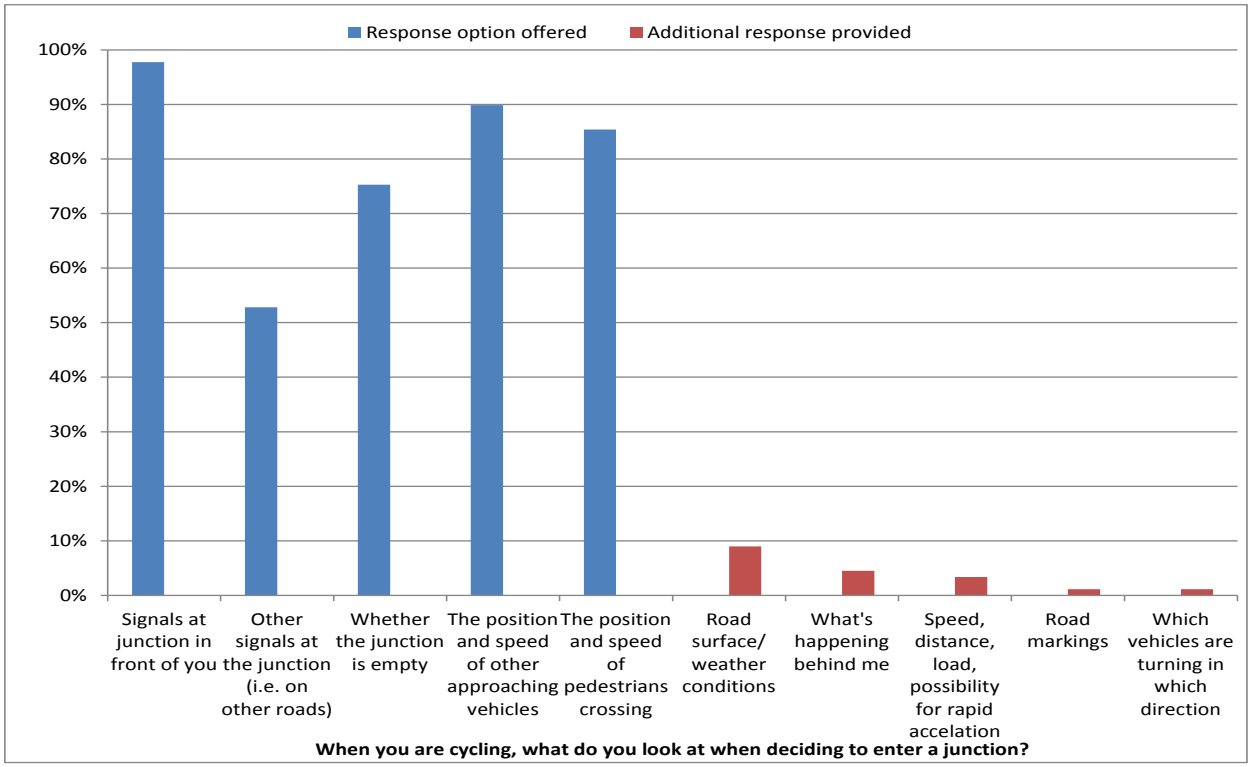


Figure 22 – Questionnaire: information used when deciding to enter junction

The types of other information used in assisting with the decision to enter a junction most commonly recorded were: actions of pedestrians (82%), momentum of cycling (78%) sound of approaching vehicles (75%) and actions of other cyclists (62%). (Note these response options were offered for this question. Other responses recorded are summarised below and indicated in red on the graph.)

A few mentioned other factors such as drivers, road and weather conditions, road geometry and length of time for which the amber signal has been showing.

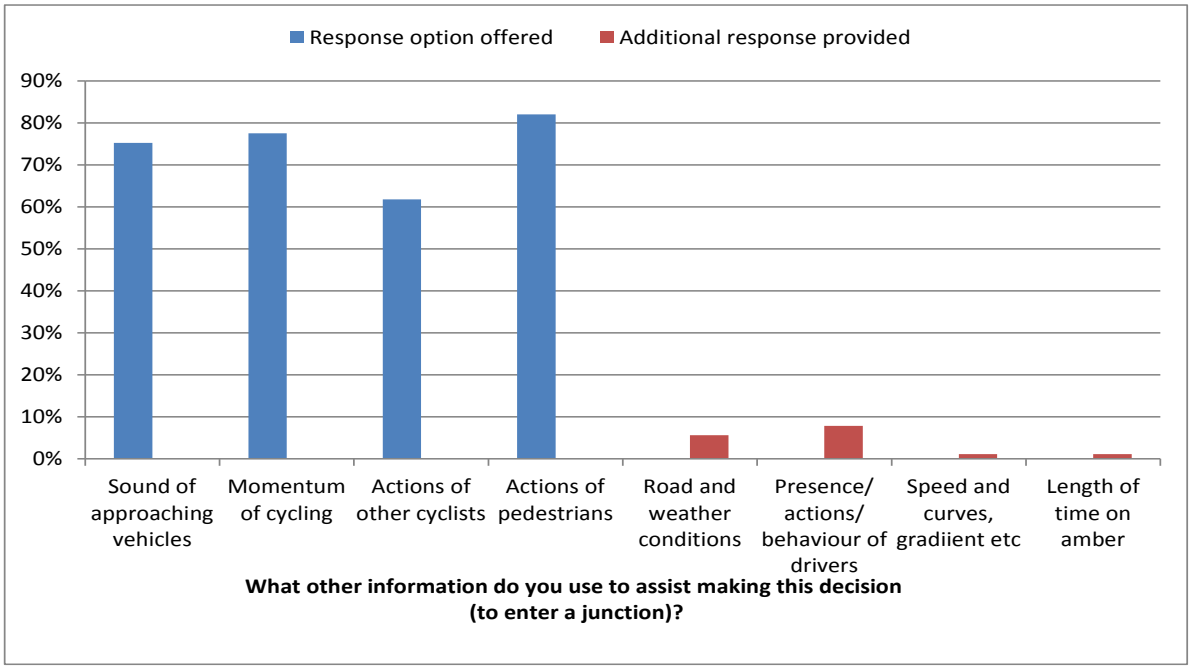


Figure 23 – Questionnaire: other information used when deciding to enter junction

5.7 Other comments about the scheme

At the end of the questionnaire, participants were given the opportunity to provide any further comments about the scheme they had used on the day. The comments could be divided into three broad categories: the signal configuration, other aspects of the scheme and the trial itself.

There were 17 participants (out of 89) who made comments about the trial. The number of comments received is relatively low compared to the total number of participants and so only limited emphasis should be placed on the findings.

Comments could be summarised as follows: there was a lack of realism in the trial (6); the trial could be improved by having a longer approach (5); positive general remarks (4); other comments (2).

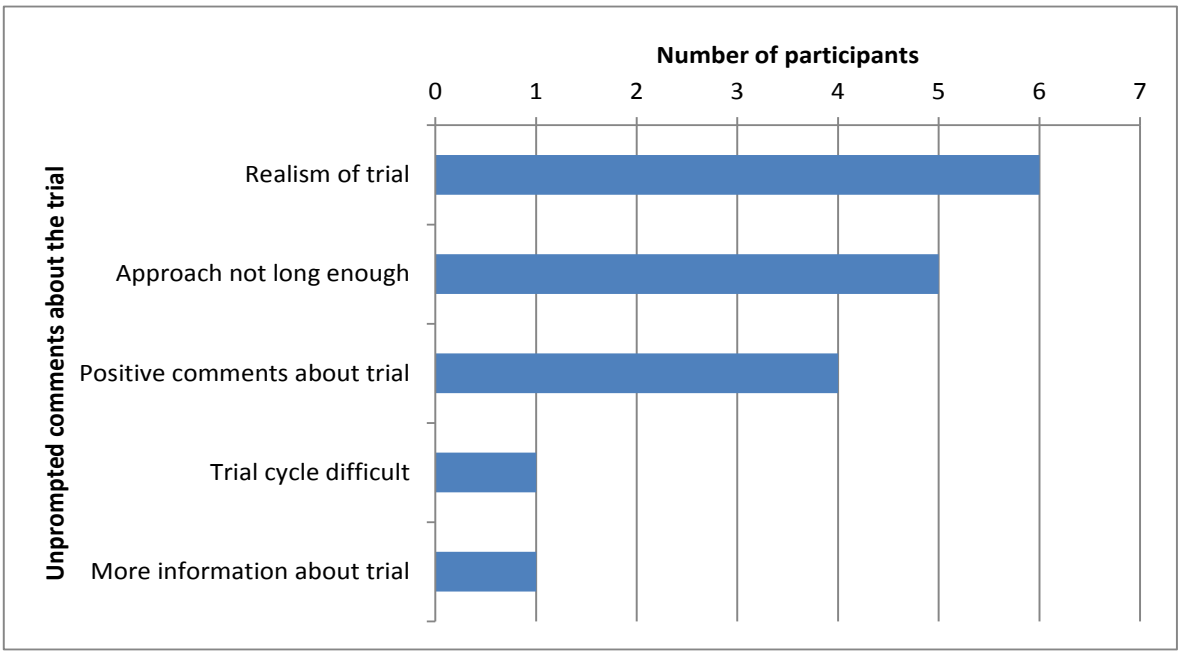


Figure 24 – Questionnaire: comments about the trial

The next most common group of responses was about the configuration of the signals – 10 commented on their height, additional signals and including a countdown timer.

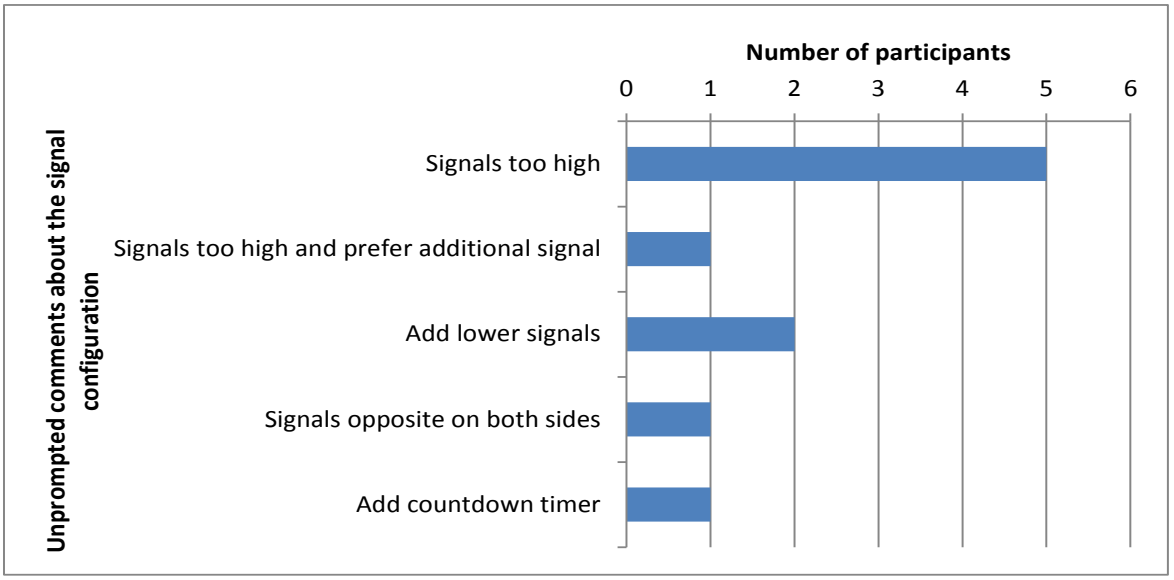


Figure 25 – Questionnaire: comments about the signals

The responses are quoted in groups below:

- Height:

  "I felt that the traffic signals were quite tall, it felt taller than normal and had to look up into the sun to see it. It would be useful to have the cycle signals maybe a little lower."

  "I thought signals were a bit high so I had to stop further back from the line to see them."

  "The height and positioning of the lights, relative to the stop line, made them hard to see when stopped, I got a crick in my neck looking at them."

  "The height of the traffic lights made it hard to see the top red light [cycle symbol] when sitting on a bike. Had to look up a long way."

  "The traffic lights seemed to be too high for cyclists and if used often would cause pain problems in neck/shoulder area."

- Additional signals, e.g. signals on both sides and low level signals:

  "Sometimes I found it hard to see the signal as it was high. I felt there needed to be a signal across the other side of the junction as well."

  "I would prefer to also have either a low-level signal on the same post as the light (so can be seen when at the stop line without looking up) or across the junction."

  "Useful to have a visual sign lower down for cyclists, if you are close or slightly behind it is difficult to see the high lights."

- Adding a countdown timer:

  "Would work better if there was a timer counting down until the lights go red to help judge speed and timing."

A few made further comparisons between the two types of signal, and two commented on the layout – improving the junction by increasing the distance between the signals and the stop line or raising the crossing. This last comment implies that this participant

may have thought of the scheme as a cycle route crossing a road rather than going through a road junction.

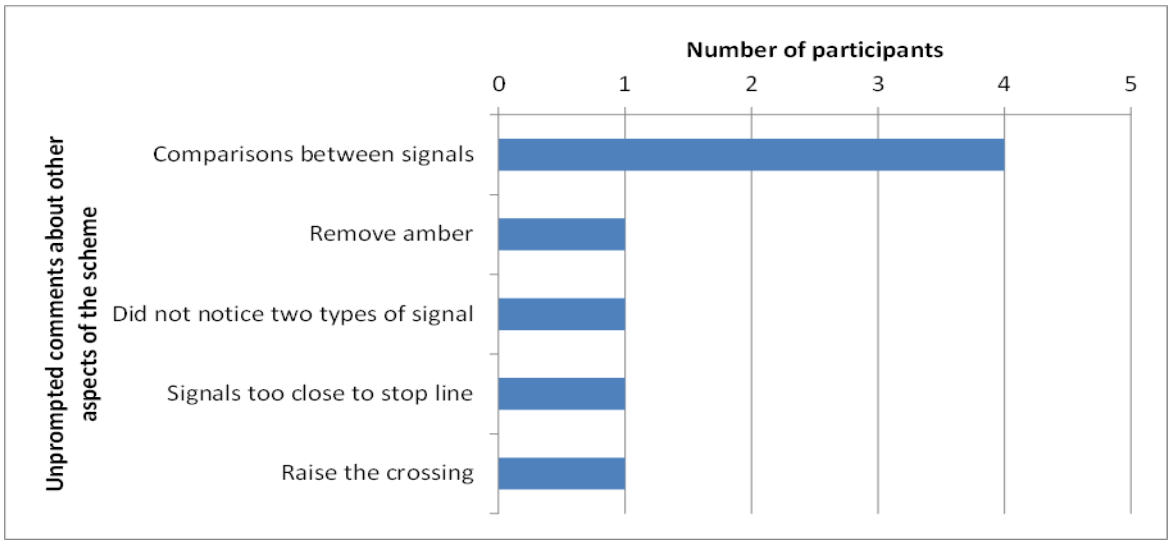


Figure 26 – Questionnaire: other comments

6 Conclusions

6.1 Findings against each research question

Research question 1: To what extent did the Cycle Red affect the compliance of cyclists to the stop line, in comparison with the full red?

The video analysis shows that for participants approaching the signals as they changed from Green to Red, there were a low number of observations where the participants were non-compliant with the Red signal. Compliance is notoriously difficult to study accurately on a test track, because participants know their actions are being tracked and so are more compliant than usual; this is therefore not a surprising result. Nevertheless, of those that were non-compliant, the data suggests that the type of signal head, whether "Full Red" or "Cycle Red" had no effect on the compliance with the Red. Specifically, the non-compliance rate was 5.0% for the Full Red and 5.2% for the Cycle Red.

This finding is supported by the post-trial questionnaire results: when asked whether they would enter the junction on a red light, there was no substantial difference between the Full Red (9%) and the Cycle Red (11%).

Research question 2: To what extent did participants correctly understand the Cycle Red, in comparison with the Full Red?

There was a good level of understanding of the Cycle Red signal; understanding of the Full Red signal was also good, but two participants said it applied only to cyclists or cars.

Participants were asked to explain the difference in meaning between the two types of signal; this difference was most commonly explained as being that Full Red signal applies to all traffic and that the Cycle Red signal applies to cyclists only. 22% said there was no difference in meaning between the two signals and 5% stated that the solid red version is used when the traffic is mixed and the red cycle symbol is used on cycle facilities.

There were 3 participants who explained the difference with an explanation which could be interpreted as 'unsafe', saying that the Full Red means that cars are not allowed to enter or proceed, but cyclists can. This may have reflected some confusion in the way in which the symbols were presented without any contextual information to assist with interpretation, and without showing the complete signal sequence.

Research question 3: To what extent was the Cycle Red more or less noticeable to the cyclists, in comparison with the Full Red?

Video data was collected on the number of glances that the participants made at each of the signals: there was little difference in the number of glances made at the Full Red and Cycle Red signals.

In the questionnaire, participants were asked whether they noticed that both types of signal were used during the experiment, two-thirds (69%) said 'yes', 30% said 'no' and 1% said 'don't know'.

Some concerns were expressed by participants about the Cycle Red signal, these included: concerns about the visibility or brightness of the signal, and the way in which

the signal might be interpreted, particularly by other road users but also confusion because it is unfamiliar.

Other feedback from participants

There was a marginal preference from participants for the Cycle Red signal over the Full Red signal.

Those who preferred the Cycle Red symbol mainly preferred it because it is clearer that it applies to all cyclists and it demonstrates a willingness to differentiate cyclists.

Those who said they preferred the Full Red symbol mainly preferred it because it was more conspicuous, applies to all road users and is unambiguous.

Informal feedback from participants

At the end of the questionnaire, participants were given the opportunity to provide any further comments about the scheme they had used on the day. The comments could be divided into three broad categories: the signal configuration, other aspects of the scheme and the trial itself.

There were only a small number of comments about the trial; a few participants stated that there was a lack of realism, whereas others suggested that the approach up to the signals was not long enough.

Responses about the configuration of the signals were also received; some (9%) commented that the signals were too high, or that an additional lower signal would be useful.

6.2 Implications of findings against the trial objectives

The objective of the trial was to assess if cyclists responded differently to the Cycle Red signal compared to the Full Red signal. The trial studied whether they adapted their behaviour in response to the Cycle Red signal and also considered the implications that introducing a change might have for cyclists if the new signal were introduced on the street. The findings from this study suggest that the cyclists responded the same to the Cycle Red signals as to the Full Red signals.

Participants understood the meaning of the Cycle Red and Full Red signals to the same extent. The only (unprompted) criticism of the signals was that they were too high.

The trial findings provide sufficient confidence that the trials of Low Level Cycle Signals can progress safely. In addition, they provide evidence to support on-street trials of the Cycle Red signal.

Appendix A Additional questionnaire graphs

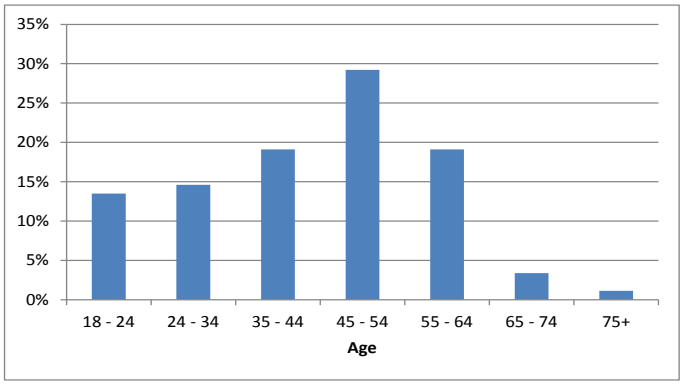


Figure 27 - Questionnaire sample: age

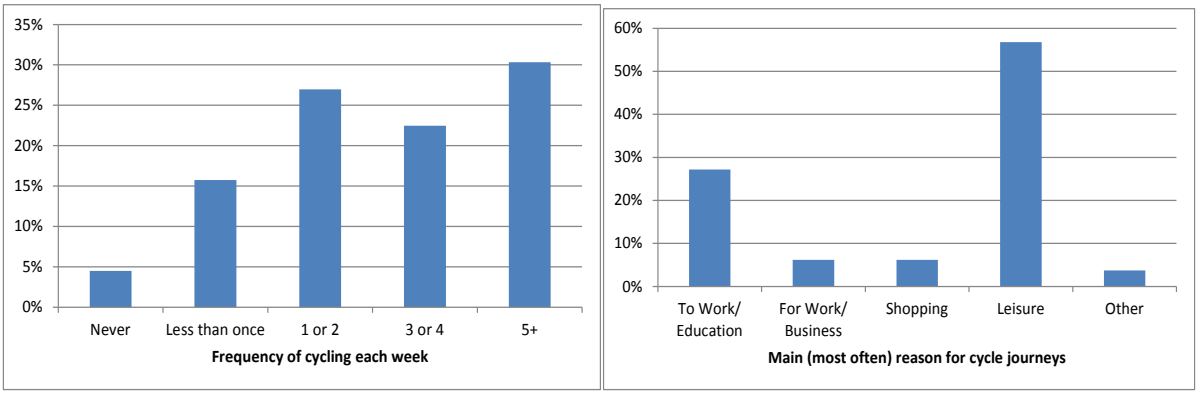


Figure 28 - Questionnaire sample: cycling habits (frequency, trip purpose, type)

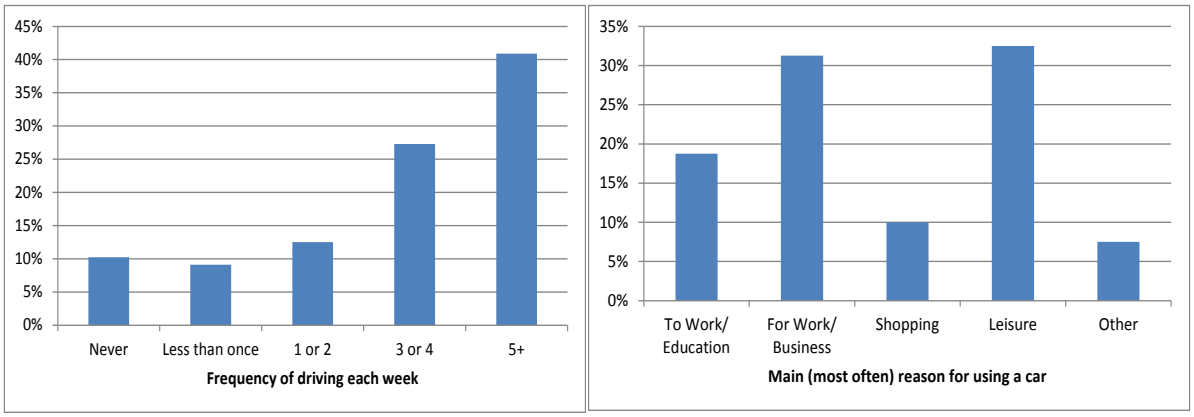


Figure 29 - Questionnaire sample: driving habits (frequency, trip purpose)