Transport Research Laboratory

Pedestrian Countdown at Traffic Signal Junctions (PCaTS) - Road Trial

by Iain York, Simon Ball, Rachel Beesley, David Webster, Phil Knight and Jean Hopkin

TfL 2481

PROJECT REPORT

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Prepared for: Project Record: TfL 2481

Pedestrian Countdown at Traffic Signal Junctions (PCaTS) On Street Perception and Behavioural Analysis

Client: TfL,

Ben Giles

The views expressed are those of the author(s) and not necessarily those of TfL.

Contents

1 Introduction

This report describes an analysis and overview of research findings from TRL's monitoring of Transport for London's (TfL's) eight trial sites for Pedestrian Countdown at Traffic Signal junctions (PCaTS).

PCaTS is one of the measures included in the Mayor of London's Transport Strategy (TfL, 2010) for smoothing traffic flow, as it has the potential to improve junction efficiency and help optimise the allocation of 'Green time' between pedestrians and road traffic. It was developed following a previous trial of the effects of re-timing pedestrian crossings at junctions. The previous study found that, while there were no adverse impacts on safety, some pedestrians (mainly mobility impaired) reported feeling rushed and had concerns about the time available for safe crossing. These concerns could have stemmed from the considerable confusion about the meaning of each signal presented to pedestrians wishing to cross at junctions. In particular, the study found that the meaning of the 'Black-out' period (the time between the 'Green Man' invitation to cross and 'Red Man', where no information is displayed) is poorly understood by pedestrians. In practice, the 'Black-out' period allows sufficient time for pedestrians to safely complete their crossing but without further information pedestrians can feel uncertain.

The PCaTS system used in the trials was selected following a review of international research, discussions with the Department for Transport (DfT) and opinion research of road users. It consists of a far-side digital count-down time display fitted next to the pedestrian signal heads. The pedestrian signal phases for PCaTS and standard crossings are compared in Figure 1 below.

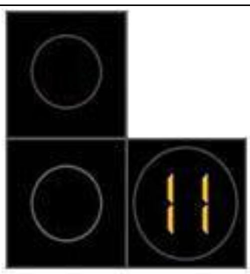
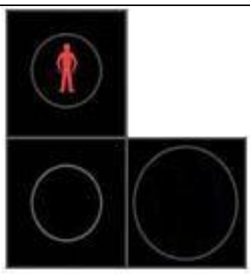
Standard pedestrian crossing at signalised junction (Before Sequence)	**Pedestrian signals with PCaTS (After sequence)**	**Meaning**
Green Man 	**Green Man** 	Invitation for a pedestrian to cross
Blackout 	**Countdown** 	Time between the end of the 'Green Man' and the start of the 'Red Man', the clearance period for pedestrians already on the crossing to reach the other side.
Red Man 	**Red Man** 	Time when pedestrians should not cross, including the All Red period (both a Red Man shown to pedestrians and a Red Signal shown to Traffic) and when traffic has or will shortly gain priority.

Figure 1 Pedestrian signal phases for a standard crossing and PCaTS compared

By providing a visible countdown of the time remaining before the appearance of the 'Red man', PCaTS is intended to give pedestrians a better understanding of the time available for them to complete crossing, reducing anxiety once the Green Man is no longer displayed. This additional information is intended to help people to make more informed crossing choices.

The trial sites included the installation of a Countdown timer alongside changes to the signal timings at the junctions. This is referred to as the "PCaTS package of measures" and included:

- Reduction in Green Man time to a standard 6 seconds (aligned to DfT guidance)
- Increase in 'Blackout' time (with a countdown timer)
- Reduction in 'All Red' time (to a standard 3 seconds, with a 2 second starting amber to traffic)
- Increase in traffic green time (as a consequence of the above changes).

The trial involved conducting video-based observational surveys, as well as interviews with groups of pedestrians, before and after the installation of the PCaTS package, to assess how it influenced both attitudes and understanding of pedestrians, and the behaviour of pedestrians and drivers.

This report describes an outline of the surveys conducted (Section 2), the results of the surveys (Sections 3 to 6) and then interprets their meaning (Section 7).

Further details of the methodology and detailed findings are provided in the Technical Appendix to this report.

2 Methodology

The Countdown timers were installed at the eight sites during the summer months of 2010. A series of surveys was conducted at each site before and after the installation of the PCaTS package. This report focuses on changes between the before situation and situation after a 3 month settling in period. This is described as the 'After 2' survey in the technical appendices where details of the initial 'After 1' survey can also be found.

Two types of surveys were carried out at each site:

- Face-to-face questionnaire surveys of pedestrians' perceptions
- Video surveys: examining behaviour of pedestrians and drivers and their interactions

In addition, accompanied walk surveys were performed at one site with a group of mobility impaired pedestrians and with children. This included a questionnaire to obtain opinions about the crossing experiences at PCaTS and Standard crossings. To differentiate results from different surveys, the term participants is used for those taking part in the main surveys, whilst mobility impaired and children are used to refer to those taking part in the accompanied walks.

2.1 Face-to-face questionnaires

The questionnaire surveys were carried out just after people had used the crossing and collected information on understanding and perceptions, including:

- Preferences for type of crossing
- Perception of the time they have available to cross the road
- Perception of safety while crossing the road
- Their interpretation of the information and how it would affect their crossing decisions

  In these surveys members of the public were selected at random as they completed using the crossing and asked to take part in a questionnaire survey.

2.2 Video Surveys

The video surveys were used to record the movements and interactions between the drivers and pedestrians at one arm of each of the junctions in the trial.

2.3 Video data collection

The video surveys were used to obtain information on:

- Pedestrian flows according to the pedestrian signal phases
- Pedestrian delay, crossing decision and speeds
- How pedestrians used the crossing
- Interactions and conflicts between pedestrians and vehicles
- Vehicle flows
- Time vehicles started to move and their delay

2.4 The sites

The sites selected for the trial were chosen by TfL with the aim of including a range of crossings representing the different situations expected. These included crossings with varying widths (i.e. number of traffic lanes) and crossings with and without a central pedestrian island; and sites near to schools, hospitals, tourist attractions and transport hubs. The eight sites were located in five London Boroughs: Camden, Islington, Southwark, Wandsworth and Westminster. The details of the sites are shown in Table 1 below.

TfL Site Number	Roads at Junction	Borough
01/000212	Oxford Street - Regent Street - Oxford Circus	Westminster
02/000045	A4200 Kingsway - A40 High Holborn - A4200 Southampton Row	Camden
03/000029	Finsbury Square - Finsbury Pavement - Chiswell Street	Islington
08/000028	A201 Blackfriars Road - B300 The Cut - B300 Union Street	Southwark
10/000008	A24 Balham High Road - Chestnut Grove - Balham Station Road	Wandsworth
08/000003	A100 Tower Bridge Road - A200 Tooley Street	Southwark
08/000211	Old Kent Road - Surrey Square - Penry Street	Southwark
10/000160	A306 Roehampton Lane - Queen Marys Hospital Main Entrance	Wandsworth

Table 1 Location of the PCaTS Implementation Sites

The signal changes introduced through the PCaTS package are illustrated in Figure 2.

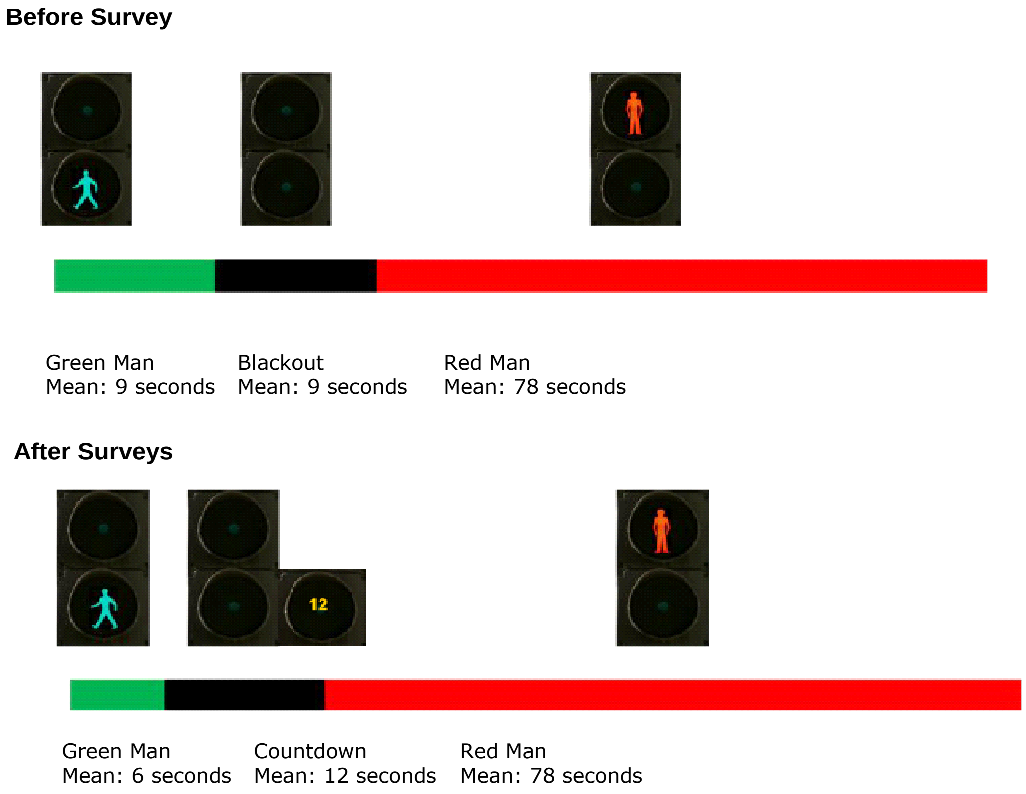


Figure 2 Illustrative before and after signal phases at trial sites

Results varied between sites; however, where common trends were evident an overall change has been reported. It should therefore be noted that the magnitude of reported changes were site dependent, and reported averages should not be considered representative of all sites.

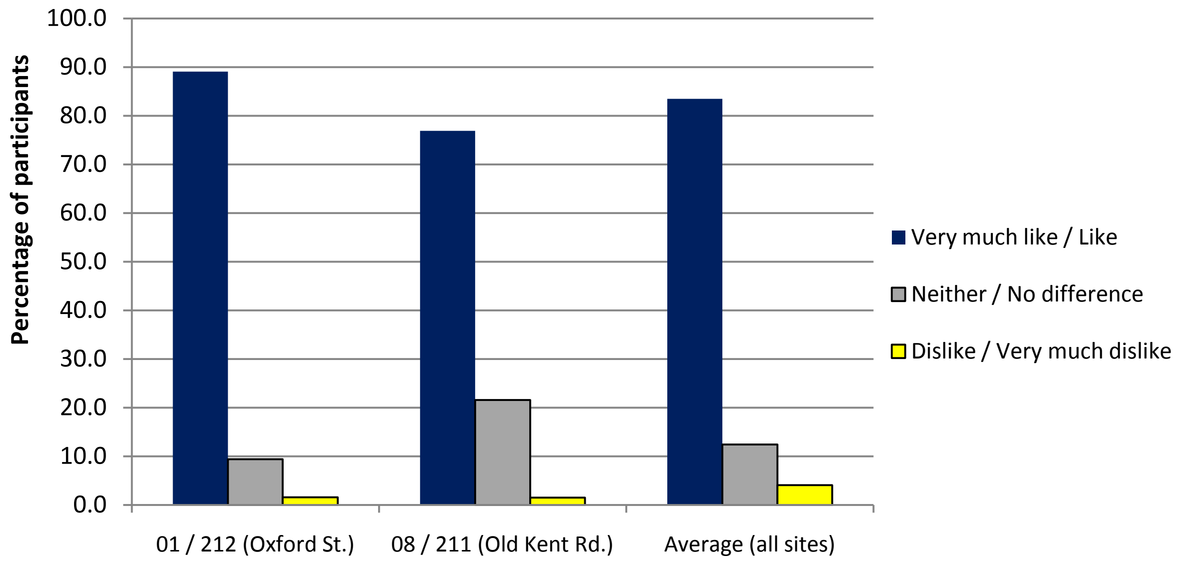
3 Pedestrian Attitudes

PCaTS increases the amount of information available to pedestrians: by informing them of the amount of time remaining until the impending change of priority to vehicles at the junction. Providing such information could affect how people use the crossing and their opinions of their crossing experience.

In addition, questionnaires were administered to groups of mobility impaired and children after they had taken part in an accompanied walk. The walks included crossing both a standard crossing and a PCaTS crossing a number of times. The questions focussed on the relative opinions of the two types of crossings.

3.1 Preference for type of crossing

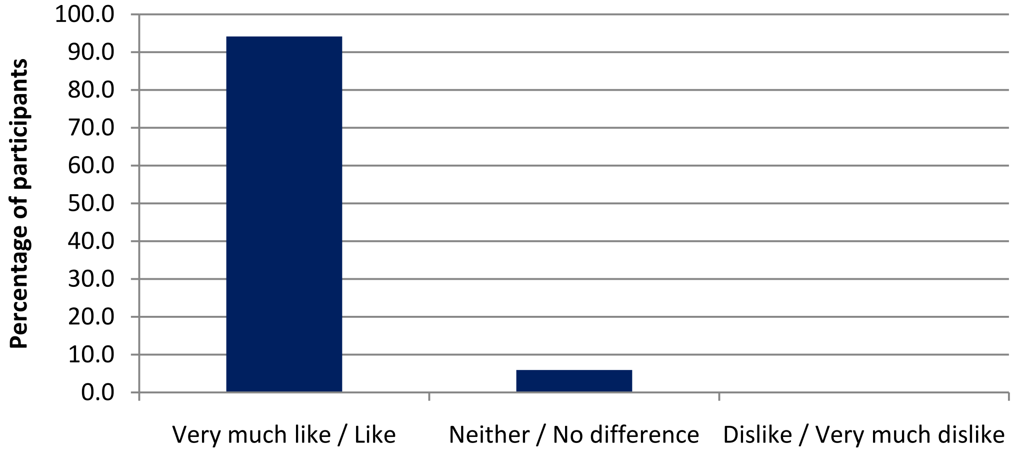
Pedestrians in the 'After' studies were asked whether they liked PCaTS. Their answers are presented in
Figure 3, for the sites with the least and most preference for PCaTS.



Number of participants	Very much like / Like	Neither / No difference	Dislike / Very much dislike
01 / 212 (Oxford St.)	57	6	1
08 / 211 (Old Kent Rd)	50	14	1
Average (all sites)	409	61	20

Figure 3 Whether pedestrians liked PCaTS ('After' Surveys only)

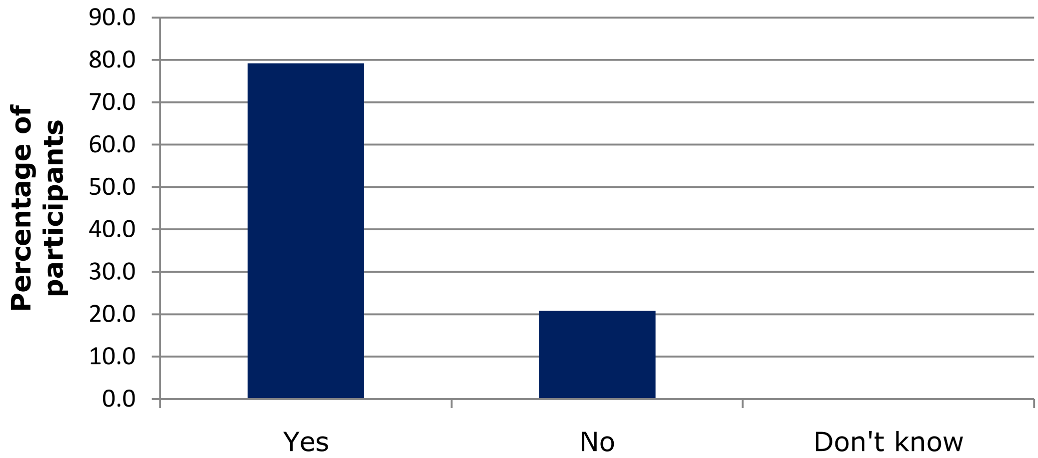
The mobility impaired participants were also asked the same question after their accompanied walk, see Figure 4.



	Very much like / Like	Neither / No difference	Dislike / Very much dislike
Number of mobility impaired participants	16	1	0

Figure 4 Whether the mobility impaired pedestrians liked PCaTS

However, the children were asked the simpler question as to whether they liked the 'Countdown numbers', see Figure 5



	Yes	No	Don't Know
Number of Children	19	5	0

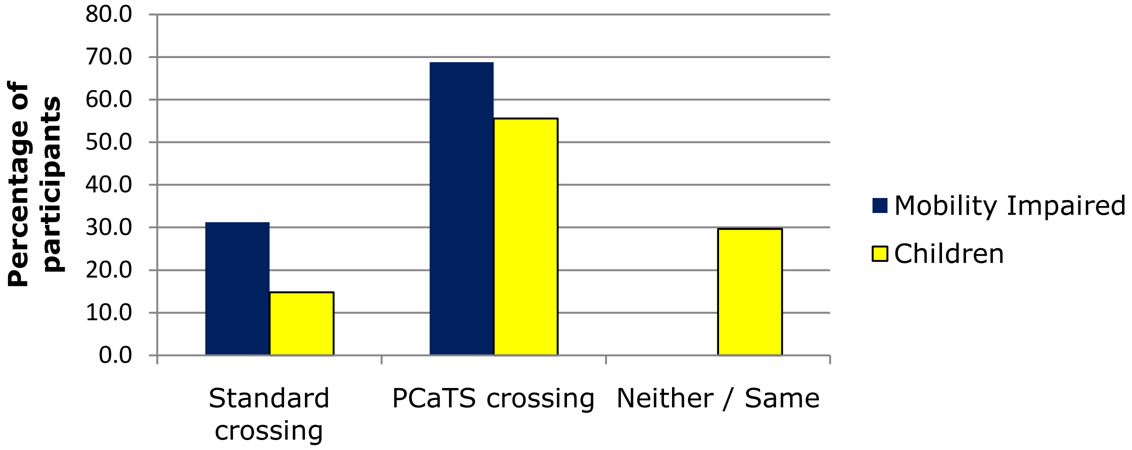
Figure 5 Whether the children liked the Countdown numbers

Most pedestrians using the PCaTS crossings across the eight trial sites liked them:

- This ranged from 77% to 89% depending on the site.
- On average 83% of the pedestrians liked PCaTS.
- Also 79% of the children who expressed an opinion liked PCaTS

- A higher percentage of the mobility impaired (94%), who expressed an opinion liked PCaTS.

Both the mobility impaired and children had the directly comparable experience of crossing with PCaTS and at a standard crossing. This consequently provided the opportunity to ask which they preferred, see Figure 6.



Numbers of participants	Standard crossing	PCaTS crossing	Neither/same
Mobility Impaired	5	11	0
Children	4	15	8

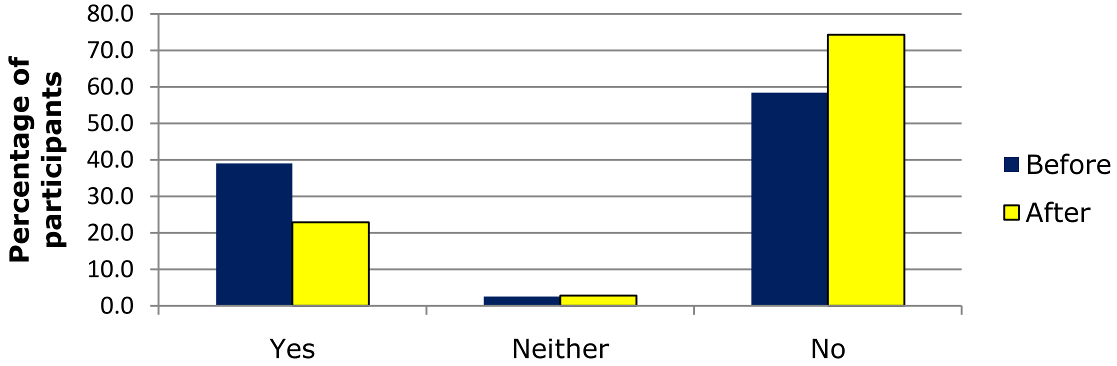
Figure 6 Whether the mobility impaired and children preferred PCaTS or the standard crossing

Most, 69% of mobility impaired, and 56% of children, preferred PCaTS over the standard crossing. The remainder (31%) of the mobility impaired, and 15% of the children, preferred the standard crossing.

3.2 Perception of time available for crossing

The package of measures accompanying the introduction of PCaTS included a number of signal timing changes, including a reduction in Green Man time and an increase in Blackout/Countdown time. Pedestrians who had just completed using the crossing were asked if they had felt rushed and whether they had sufficient time to cross. In addition, mobility and children taking part in the accompanied walks were asked to directly compare the two crossings.

The number of participants who reported feeling rushed in the before and after situations is summarised in Figure 7, across all sites.

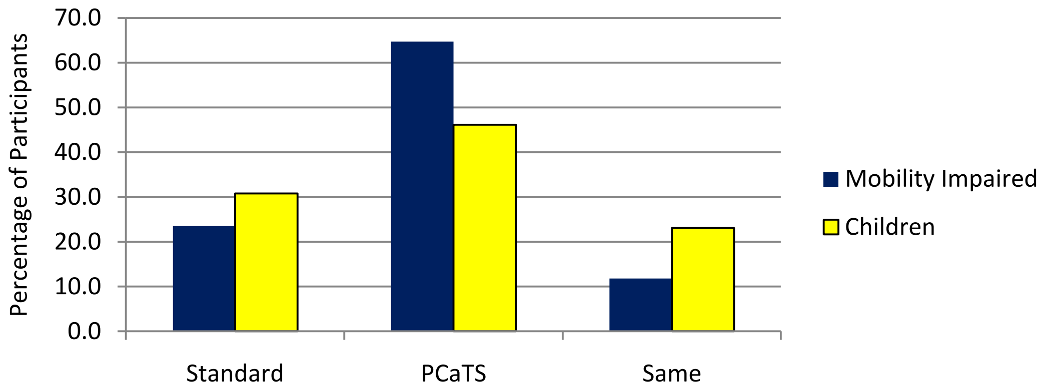


Number of participants	Yes	Neither	No
Before	213	14	319
After	112	14	364

Figure 7 Did participants feel rushed?

It was found that fewer pedestrians felt rushed with the package of measures installed. On average across all sites the percentage feeling rushed decreased from 39 to 23%. This percentage decreased on nearly all sites.

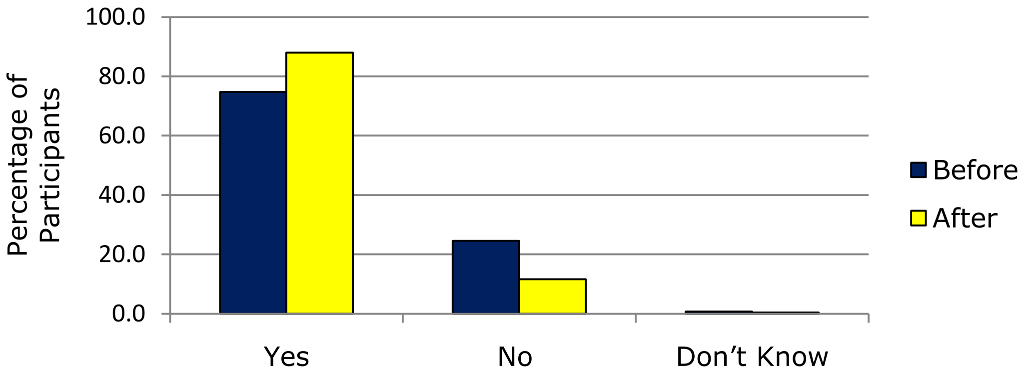
The same opinions of feeling less rushed with the PCaTS crossing was found from the mobility impaired and children accompanied walks, see Figure 8.



Number of participants	Standard	PCaTS	Same
Mobility impaired	4	11	2
Children	8	12	6

Figure 8 At which crossing did mobility impaired pedestrians and children feel less rushed?

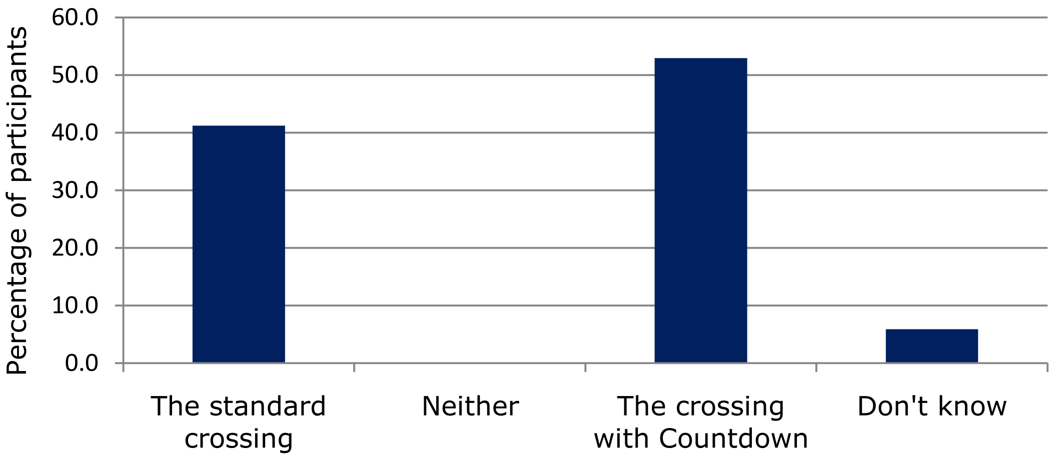
A similar, and highly related question was also asked, as to whether the participants felt they had sufficient time to cross, their answers are summarised in Figure 9.



Number of participants	Yes	No	Don't Know
Before	408	134	4
After	431	57	2

Figure 9 Did participants feel they had sufficient time to cross?

The mobility impaired participants were asked which type of crossing required the most time to cross, as shown in Figure 10.



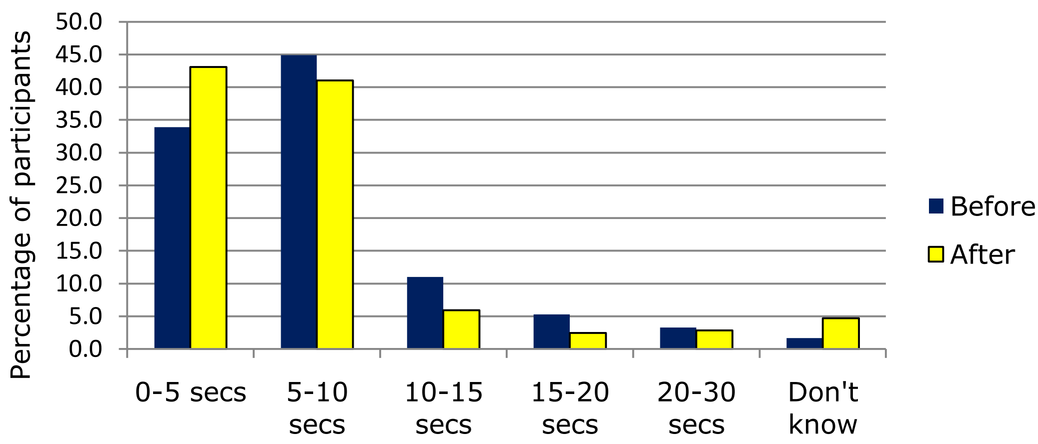
	The standard crossing	Neither	The crossing with countdown	Don't know
Number of mobility impaired pedestrians	7	0	9	1

Figure 10 Mobility impaired participants' assessment of the crossing requiring most time to cross

In line with not feeling as rushed with the PCaTS package of measures, more pedestrians (88% compared to 75%) felt they had sufficient time to cross. The percentage decreased slightly on one site (Finsbury) from 83% to 78%, but increased on all other sites by at least 4%, with the maximum increase being on Balham from 69% to 97%.

3.2.1 Ability to judge crossing time

Perception of time is not the same as the ability to assess the time correctly. Many external factors can influence a person to mistake the actual time taken. Participants were asked to state the time it had taken them to cross the road, as were the mobility impaired participants in the accompanied walks. Their answers are summarised in Figure 11.



Number of participants	0-5 secs	5-10 secs	10-15 secs	15-20 secs	20-30 secs	Don't know
Before	185	245	60	29	18	9
After	211	201	29	12	14	23

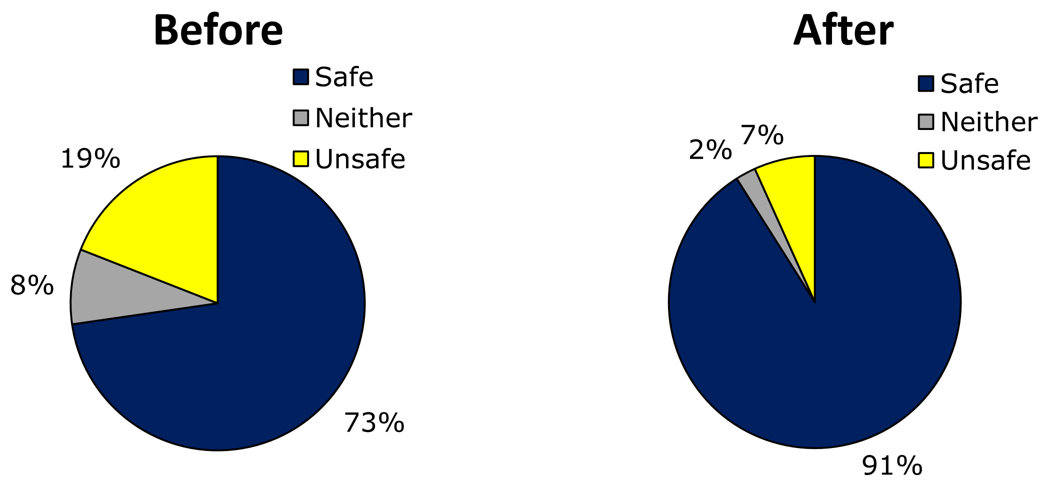
Figure 11 Participants assessment of their time to cross the road

It is highly unlikely that pedestrians actually crossed in 5 seconds or less, as this implies that they walked extremely fast or ran across the road: as 4 seconds to cross 14 metres implies a speed of 8 mph. Therefore, those stating that time are likely to have misjudged the time taken.

While more pedestrians stated that they had enough time to cross with countdown, pedestrians' ability to judge their actual crossing times appeared to have reduced with PCaTS at some sites, with an increase from 34 to 43% stating it took them at most 5 seconds to cross, and an increase in the number of 'Don't know' responses. This qualitative use of the countdown display is discussed further in section 8.

3.3 Perception of Safety

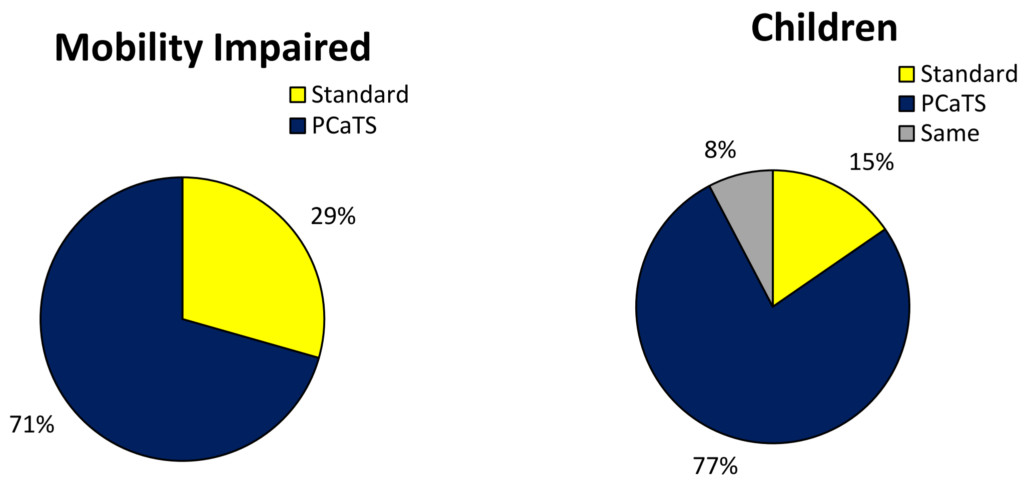
Participants in the questionnaire survey were asked how safe they had felt just after using the crossing, see Figure 12.



Number of participants	Safe	Neither	Unsafe
Before	397	45	104
After	446	11	33

Figure 12 Whether the pedestrians felt safe when crossing

The mobility impaired pedestrians and child participants in the accompanied walks were asked which crossing at which they had felt safest after using both a standard and a PCaTS crossing a number of times, as shown in Figure 13.



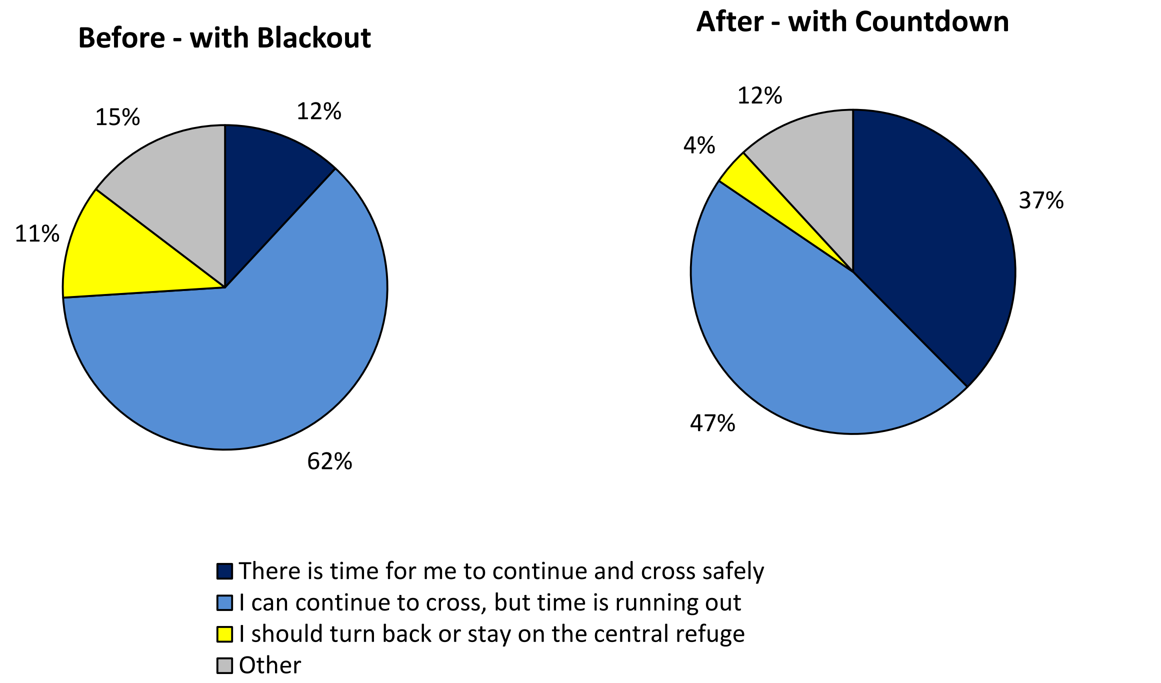
Number of participants	Standard	PCaTS	Same
Mobility Impaired	5	12	0
Children	4	20	2

Figure 13 Type of crossing at which the mobility impaired and children felt safest

The majority of participants felt safe at both types of crossing. However, more felt safe at the PCaTS crossing than the standard crossing. The average percentage of participants feeling safe increased across all sites from 73 to 91%, and the increases were statistically significant at seven of the surveyed sites. Also, 83% of children and 71% of the mobility impaired in the accompanied walks felt safer with PCaTS.

3.4 Stated ability to continue crossing during countdown

Participants in the questionnaire survey were asked to predict their actions if the Blackout (Before survey) or Countdown (After survey) started whilst they were on the crossing. Their answers are summarised in, see Figure 14.



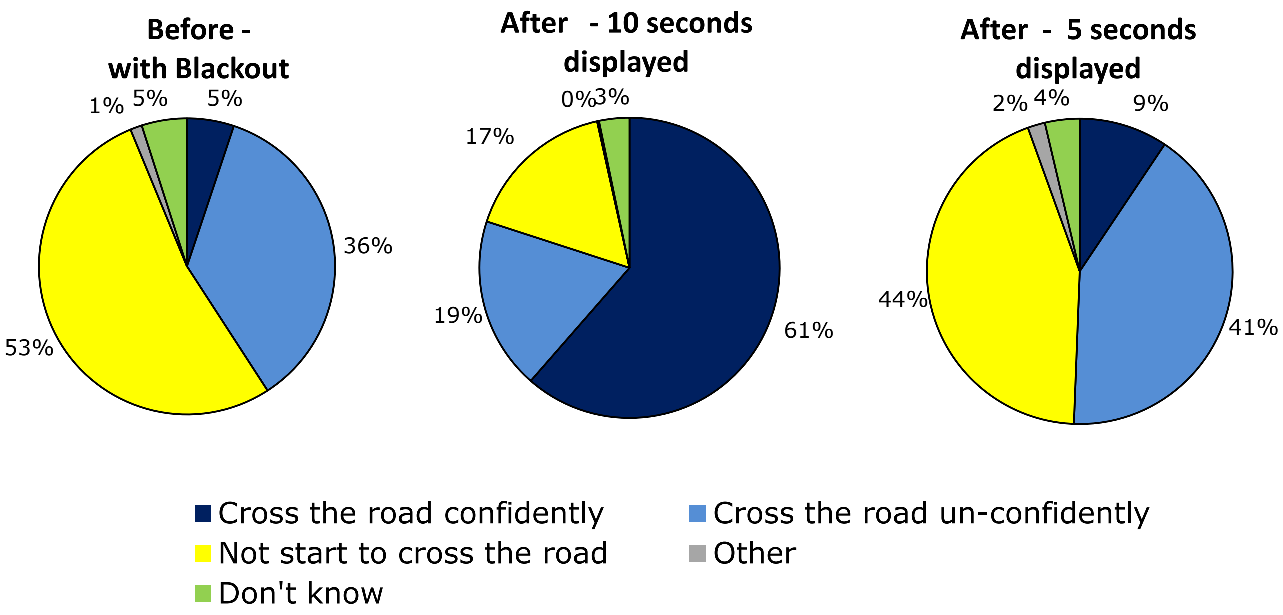
Number of participants	Before	After
Time to continue and cross safely	65	184
Can continue to cross, but time is running out	339	230
I should turn back or stay on the central refuge	62	18
Other	80	58

Figure 14 Participants' stated reaction to Blackout and Countdown when on the crossing

Pedestrians stated they were more likely to continue and cross the road safely: 12% with Blackout and 37% with Countdown.

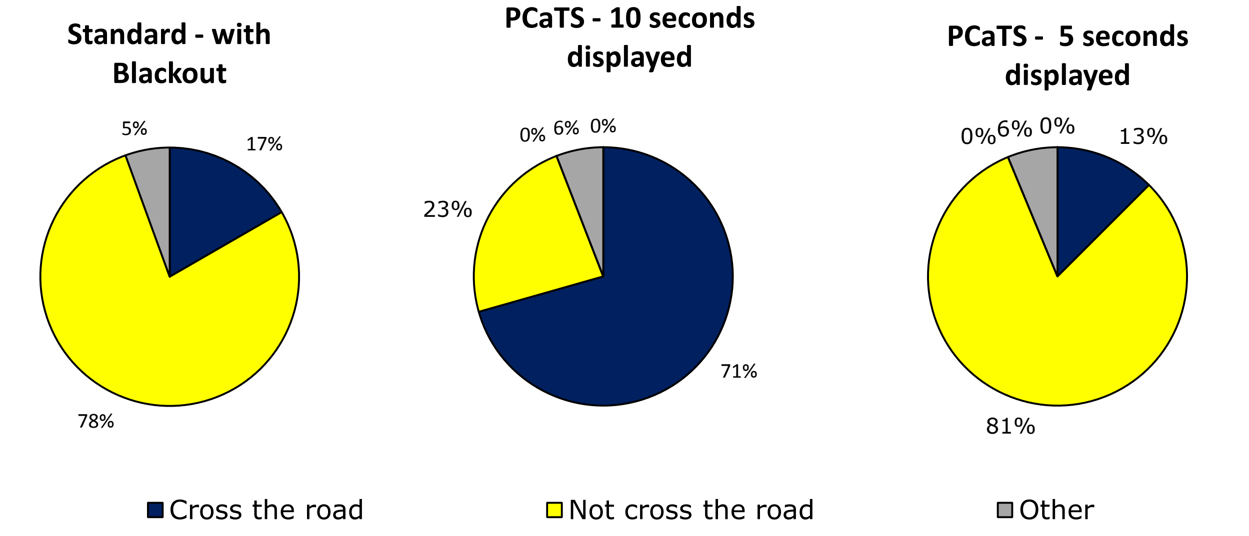
3.5 Stated crossing intentions during countdown

Participants in both the questionnaire survey and the accompanied walks (mobility impaired and children) were asked to predict their actions if they arrived at a junction crossing and Blackout, a 10 second Countdown, or a 5 second Countdown were displayed. This therefore provides an insight into how they might interpret such information. Their answers are summarised in Figure 15 to Figure 17.



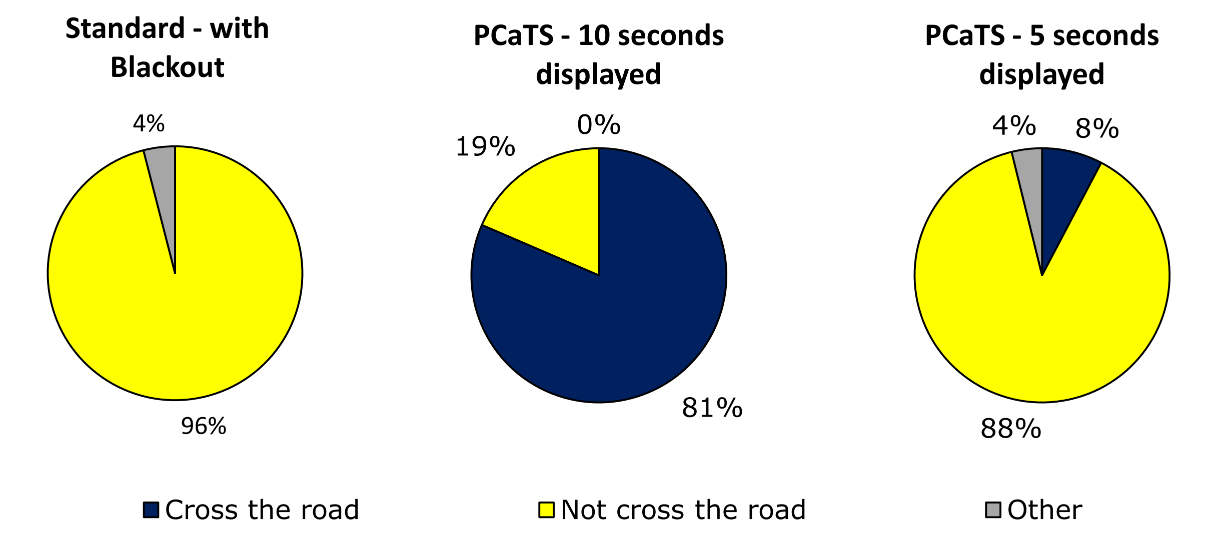
	Before – with Blackout	After – 10 seconds displayed	After – 5 seconds displayed
Cross the road confidently	28	301	46
Cross the road unconfidently	195	91	202
Not start to cross the road	289	81	215
Other	7	1	9
Don’t know	27	16	18

Figure 15 Participants’ stated reaction to Blackout and Countdown at 10 and 5 seconds being displayed



Number of participants	Before – with Blackout	After – 10 seconds displayed	After – 5 seconds displayed
Cross the road	3	12	2
Not cross the road	14	4	13
Other	1	1	1

Figure 16 Mobility impaired pedestrians' stated reaction to Blackout and Countdown



Number of participants	Before – with Blackout	After – 10 seconds displayed	After – 5 seconds displayed
Cross the road	0	22	2
Not cross the road	24	5	23
Other	1	0	1

Figure 17 Children's stated reaction to Blackout and Countdown

A larger percentage of all interviewed groups of pedestrians stated that they were prepared to start crossing during the early part of the Countdown phase (10 seconds being displayed) than during the Blackout phase. This difference diminished with the time displayed and there was no significant difference between the willingness to cross towards to the end of the Countdown phrase (with 5 seconds being displayed) compared to the Blackout.

This was also in agreement with the higher percentage stating that the meaning of Countdown was that they could start to cross compared to Blackout: 72% on average compared to 22%.

4 Pedestrian Observations

4.1 How long pedestrians wait to cross

Detailed observations were made of the exact time a sample of pedestrians arrived and when they started to cross. This provided their waiting times, summarised in Figure 18.

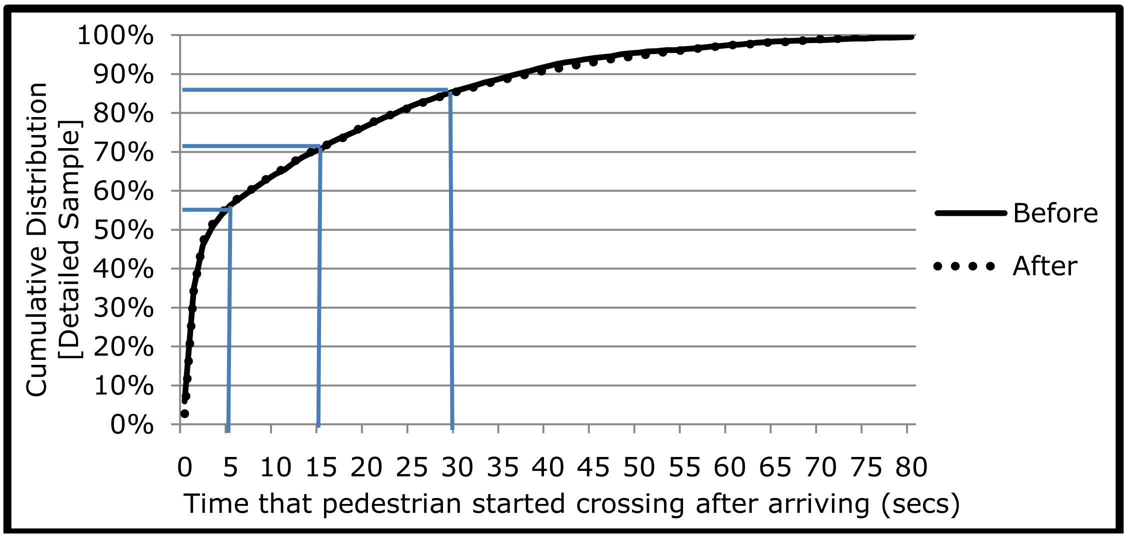


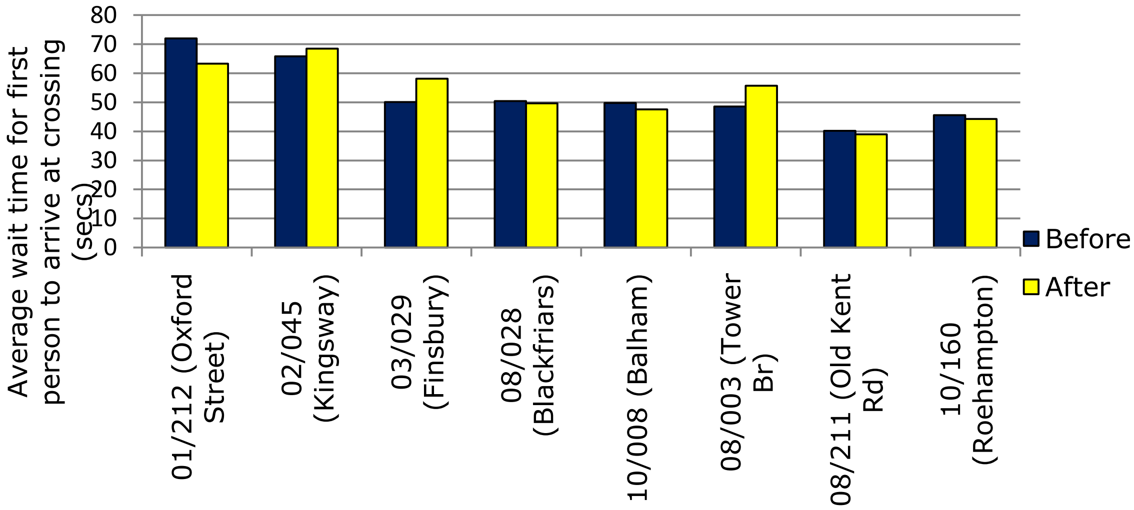
Figure 18 Time that pedestrians started crossing after arriving (seconds)

Irrespective of the type of crossing (PCaTS or standard) the majority of pedestrians tended to cross as soon as possible after their arrival. Over 54% crossed within 5 seconds of arriving, 70% within 15 seconds and approximately 85% within 30 seconds, regardless of the pedestrian signals displayed.

4.2 Pedestrian delay

This study used 'first person wait time' as a consistent measure of how the PCaTS Package impacted pedestrian waiting times, compared to the before situation. 'First person wait time' is calculated by observing individual pedestrians approaching the crossing from the start of the Red Man, and recording the time at which the first person stopped and waited. The time then remaining to the next Green Man is then calculated for each and the average value for the observed sample provides a measure of the maximum pedestrian delay likely to be experienced.

The average values of these times are summarised in Figure 19.



	Before Wait time (seconds)	After Wait time (seconds)
01/212 (Oxford Street)	72.0	63.3
02/045 (Kingsway)	65.9	68.5
03/029 (Finsbury)	50.1	58.2
08/028 (Blackfriars)	50.4	49.6
10/008 (Balham)	49.7	47.6
08/003 (Tower Br)	48.6	55.7
08/211 (Old Kent Rd)	40.2	39.0
10/160 (Roehampton)	45.6	44.3

Figure 19 Average pedestrian delay

Delay changes experienced by pedestrians, measured as 'first person wait times' initially appear variable. At four of the sites the changes were too small to be statistically different. At the four sites where statistically significant changes in delay did occur, the delay had increased at three of these sites and reduced at one. The largest increase in delay was 9 seconds at Finsbury, the site that experienced the largest change in pedestrian green time.

4.3 When pedestrians start to cross

The number of pedestrians crossing in each phase of the signals (Green Man, Blackout/Countdown and Red Man) was recorded. This information is displayed for the two sites with the minimum and maximum percentage of pedestrians crossing in the Red man, see Figure 20, Figure 21 and Figure 22 below.

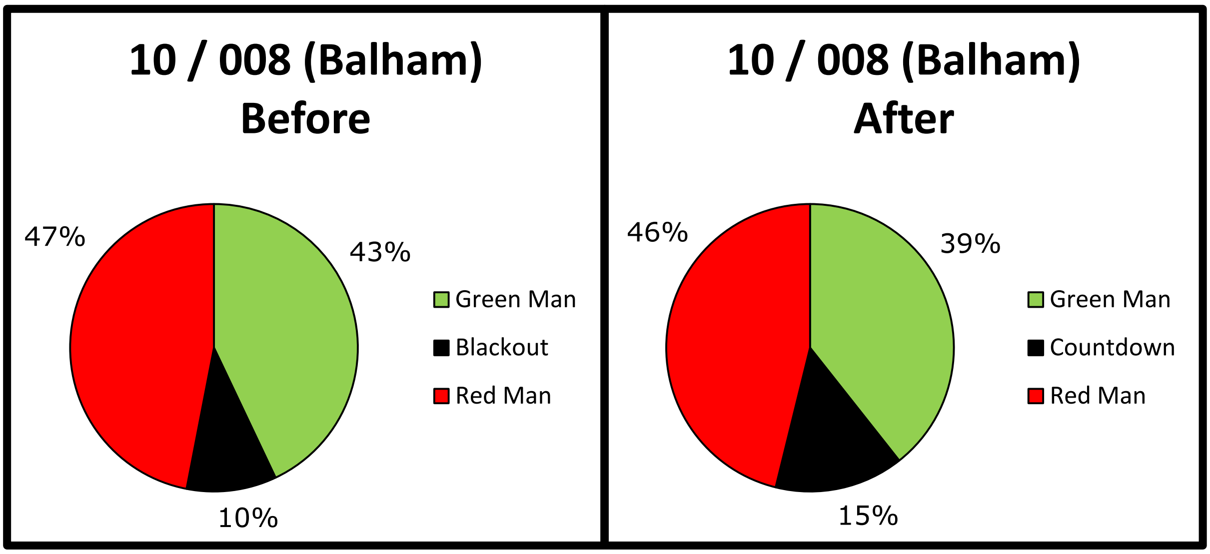


Figure 20 Percentage of pedestrians crossing in different pedestrian phases – minimum in Red Man

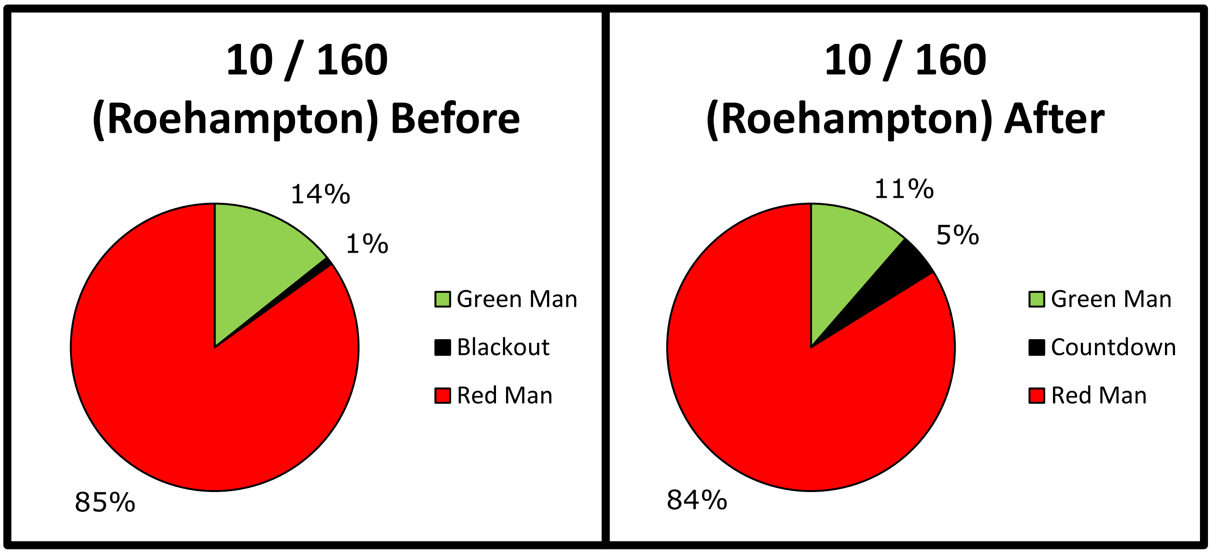


Figure 21 Percentage of pedestrians crossing in different pedestrian phases – maximum in Red Man

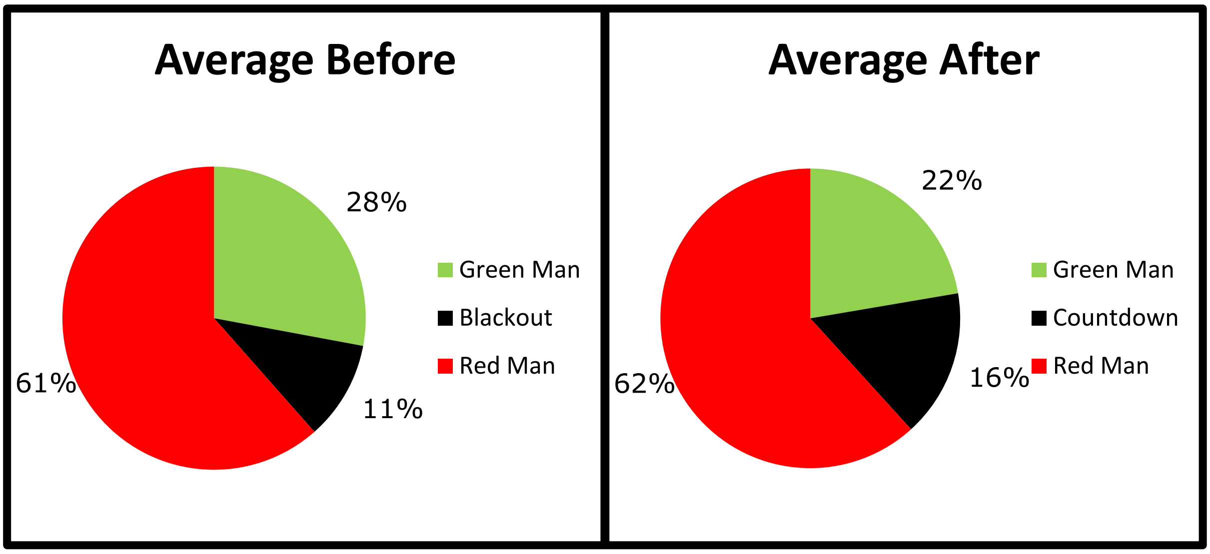


Figure 22 Percentage of pedestrians crossing in different pedestrian phases – maximum in Red Man

A large percentage of pedestrians started to cross whilst the Red Man was showing: between 46 and 85%. The average across all sites and surveys was 68% of pedestrians crossing in the Red Man. Table 2 provides both the percentage of pedestrians crossing in the Red Man and the percentage of the pedestrian cycle when the Red Man was displayed.

Site	Percentage of Red Man Time			Percentage of Pedestrians Crossing in Red Man		
	Before	After	Difference	Before	After	Difference
01/212 (Oxford St.)	82.2%	78.6%	-3.6%	62.2%	68.5%	6.3%
02/045 (Kingsway)	81.3%	80.3%	-1.0%	54.7%	49.8%	-4.9%
03/029 (Finsbury)	77.2%	81.6%	4.4%	69.2%	72.2%	3.0%
08/028 (Blackfriars)	78.9%	78.3%	-0.6%	73.1%	74.3%	1.1%
10/008 (Balham)	83.3%	78.8%	-4.5%	46.9%	46.2%	-0.8%
08/003 (Tower Br)	82.4%	83.4%	1.0%	74.9%	79.1%	4.3%
08/211 (Old Kent)	88.5%	82.6%	-5.9%	70.0%	72.2%	2.2%
10/160 (Roehampton)	84.8%	83.8%	-1.0%	84.9%	83.8%	-1.0%

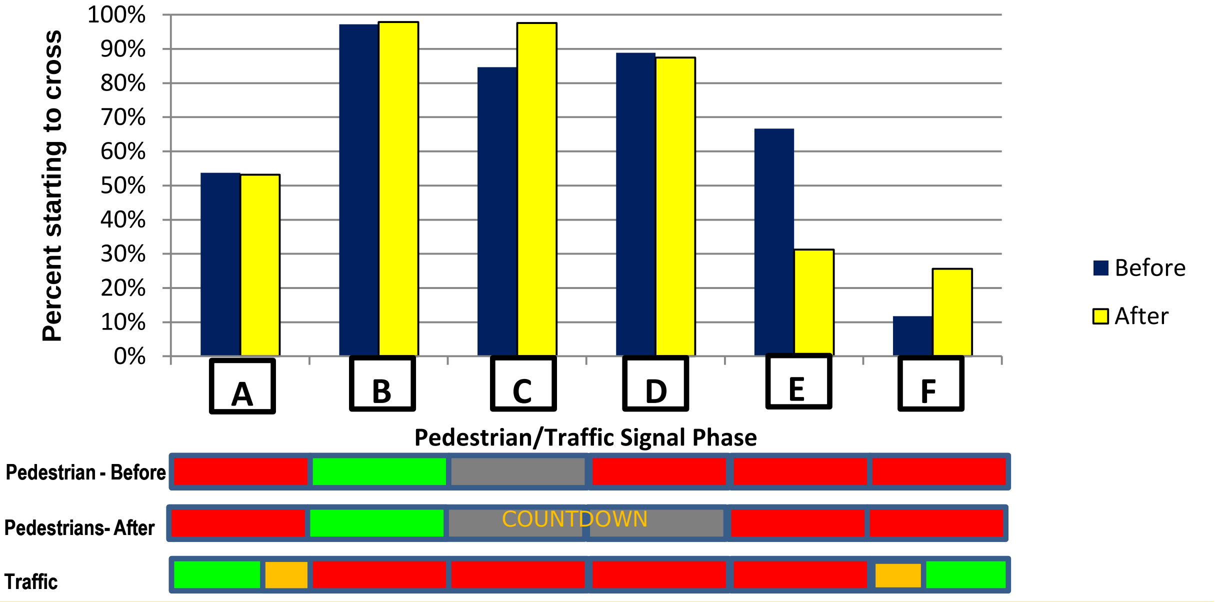
Table 2: Percentage of pedestrians crossing in the Red Man

The evidence indicates that a large percentage of pedestrians crossed in the Red Man, consistent with it being displayed for the most time and pedestrians being unwilling to wait at the crossing, as shown in Section 4.1: most (54%) waiting less than 5 seconds.

It will also be influenced by other site dependent factors, for example, the traffic flow, and hence the opportunities to cross. So, on the low flow site of Roehampton, the percentage crossing is approximately the same as the percentage of Red Man time as pedestrians can easily find acceptable gaps in the traffic. However, the percentages crossing in the Red Man are generally less where fewer acceptable gaps exist.

Analysis implied that when changes in pedestrian signal timings were taken into account, PCaTS did result in an increase in the percentage of pedestrians crossing during the Red Man of up to 6%. The reasons for this cannot be fully explained from this research. It could be that changes in traffic flow resulted in more suitable gaps for crossing, (as described above) although this was not evaluated in this study, or that other aspects of the PCaTS package resulted in this change in behaviour.

Detailed analysis was conducted into the crossing decision of a representative sample of pedestrians arriving at the crossing. Figure 23 shows the percentage that arrived and chose to cross within 3 seconds at different stages in the cycle at Finsbury where the traffic on the main road gained priority directly after pedestrians. There were a number of distinct differences in the crossing behaviour of pedestrians between the Before and After 2 surveys, as shown in the following figure and table.



Phase	Pedestrian phase with PCaTS	Pedestrian phase with standard crossing	Impact on proportion of pedestrians starting to cross with PCaTS
A	Red Man	Red Man	No change
B	Green Man	Green Man	No change
C	11 to 3 seconds showing	Blackout	More crossed with PCaTS
D	3 to 0 seconds showing	Red Man	No change
E	Red Man	Red Man	Fewer crossed with PCaTS
F	Traffic Green	Traffic Green	Slightly more crossed with PCaTS (change was not statistically significant[1])

Figure 23 Pedestrians starting to cross during different phases (Finsbury)

The above example was typical of low to medium flow sites. On the highest pedestrian flow sites PCaTS had little effect on pedestrian decisions to cross the road.

[1] The difference was not statistically significant because of the relatively small change compared to the number crossing during the short time period represented by column F.

4.4 Pedestrians still on crossing near/at end of pedestrian cycle

The previous analysis examined pedestrians' decisions to start crossing the road. However, as it takes a certain amount of time to complete the crossing, it is also important to consider how many are still present on the crossing near the start of the traffic green, which is when they could be in conflict with traffic. Therefore, additional analysis was carried out to assess the extent to which there were pedestrians remaining on the crossing at the end of the pedestrian phase. The Tower Bridge and Finsbury sites were selected for this analysis because the traffic given priority immediately after pedestrians was the main road. Therefore these two sites had the greatest potential for conflict at the start of the green to traffic.

Analysis accounted for variations in pedestrian flows by measuring the percentage of pedestrians using the crossing (i.e. on the footway waiting to cross, on the crossing or on the pedestrian island) who were on the crossing, see Figure 24.

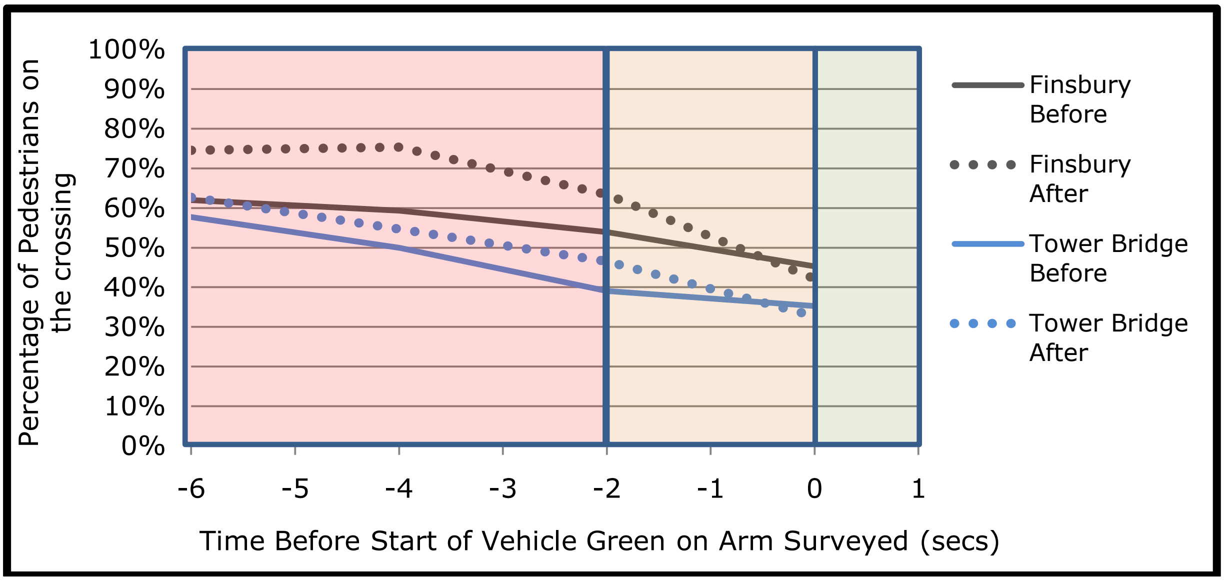
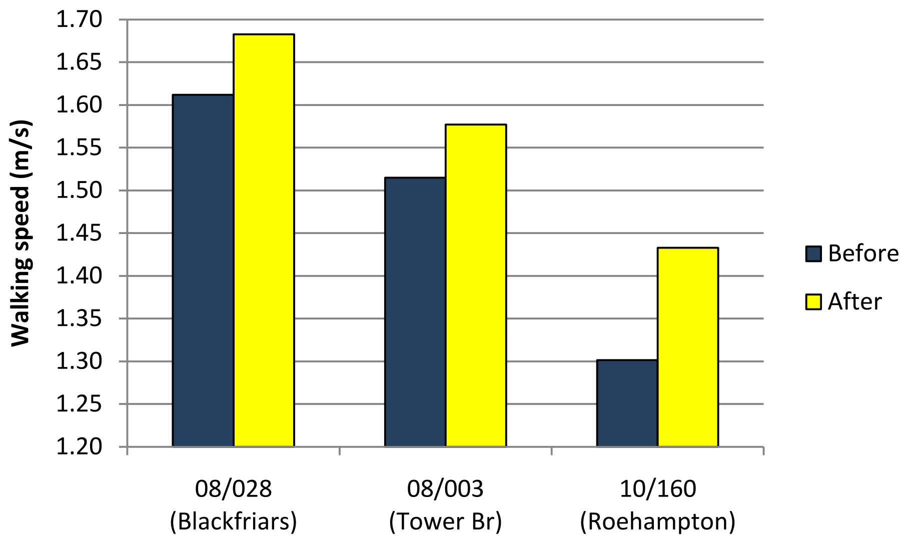


Figure 24 Pedestrians on the crossing at the end of the pedestrian phase

There were significantly more (up to 12%) pedestrians still on the crossing 6 seconds before traffic gained priority, and this difference remained fairly constant, such that there were up to 9% more on the crossing at the start of the traffic red/amber (i.e. at -2 seconds). However, this difference then rapidly reduced until there was no difference between crossing types at the point when the traffic signals changed to green (i.e. at 0 seconds).

5 Walking speeds

Pedestrians' walking speed indicates their reactions to the information supplied and their situation. Individual natural walking speeds vary from relatively slow speeds of approximately 1.2 m/s (2.7 mph), which is assumed in the design guidance of crossings, to more brisk pace of say 1.8 m/s (4.0 mph) or higher. Changes in average walking speed on a survey site indicates whether pedestrians are more likely to take their time crossing the road, or have increased their pace either through crossing in gaps between vehicles, or because they perceive they have less time available. Walking speed was measured for a random sample of pedestrians crossing throughout the cycle, using the video recordings to identify accurate measurements for the times at which they started and completed a crossing. The change in average walking speed before and after the installation of the PCaTS package of measures is summarised in
Figure **25**. The results shown only include those sites where the age and gender of the observed pedestrians was similar in the two surveys, which occurred at the three sites shown in the figure. This was necessary as on average men walk faster than women, and walking speed is affected by age. Also, it only includes sites where statistically significant changes occurred.



Walking speed, m/s	08/028 (Blackfriars)	08/003 (Tower Br)	10/160 (Roehampton)
Before	1.61	1.51	1.3
After	1.68	1.58	1.43

Figure 25 Pedestrian walking speeds

The statistically significant changes implied that walking speeds had increased in the 'After' surveys by between 3 and 10%. While this is an average speed that includes crossing times during the Red Man, a similar percentage increase in walking speed was observed when Red Man crossings were excluded from the average.

The average speed was calculated over the full width of the crossing[2]. The number of pedestrians who were observed to speed up whilst crossing was also recorded.

[2] Balham was not included in this calculation, as it was the only site without a pedestrian island

This was based on a qualitative judgement by the analyst. It was observed that a higher proportion of pedestrians sped up during the Countdown phase in comparison with Blackout; and that a greater proportion of those that sped up during the Countdown did so in the second half of the phase, which was not the case during the Blackout phase. The measured differences were as follows:

- With the Standard crossing, 14% of pedestrians who sped up, did so during the Blackout: 7% did so in the first half of the Blackout and 7% in the second half.
- With PCaTS, 33% of the pedestrians who sped up did so during the countdown: 12% did so in the first half of the Countdown and 21% in the second half.

The average Blackout time was 7 seconds, whilst the average Countdown time was 11 seconds across the 3 sites (in Figure 25); representing a 47% increase on average. The increase in the percentage speeding up during the countdown period was much higher than this, particularly during the second half of the countdown. This behavioural change cannot therefore be explained by the signal timing changes and was limited to the Blackout/Countdown period. Observations suggested that some pedestrians used the extra information provided by the countdown display to cross the road in the latter half of the countdown period by speeding up.

6 Vehicle Observations

All charts in this section report data from the same four sites, which were the sites with the highest pedestrian flows, chosen because these would represent the strongest test of the impact of signal timing changes.

6.1 Vehicle Delay

Vehicle delay was measured in a similar way as pedestrian delay. Times were collected for the first vehicle to stop after the start of the traffic red. The time each of these vehicles arrived 15 metres before the stop line and 20 metres after the stop line was recorded. This provided an indication of any maximum changes in delay experienced by drivers. The average delays are summarised for the four sites with the highest pedestrian flows in Figure 26, although similar changes were observed on the other four sites.

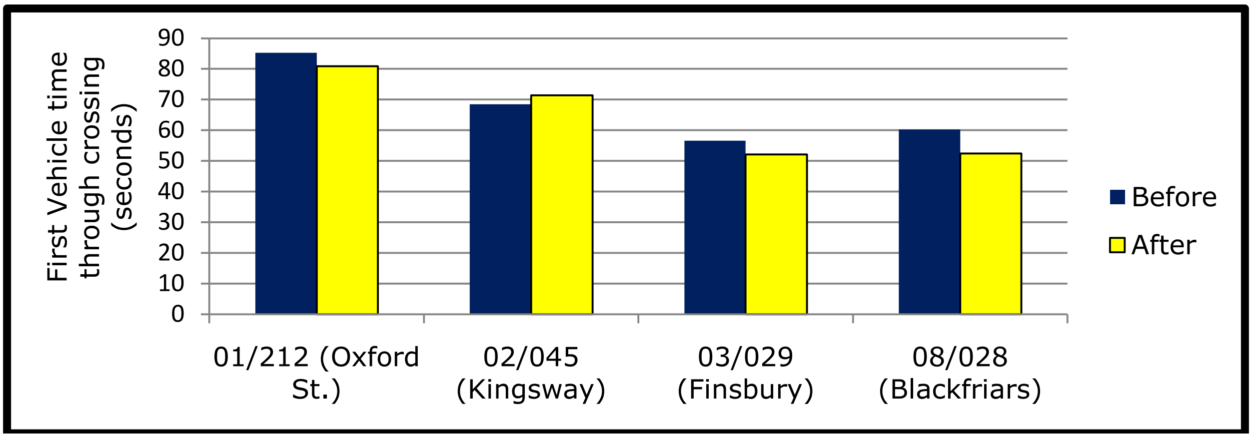


Figure 26 Average vehicle delay

The first vehicle wait times reduced on six of the sites in the 'After' surveys. As with the pedestrian delay survey, results were dependant on flow through the site and other factors. This resulted in vehicle delay not decreasing in line with the vehicle signal changes at two sites. The observed changes on the remaining six sites were in line with the reduction in vehicle red time that resulted from the signal re-timing element of the introduced PCaTS package of measures. Across the six sites where the vehicle delay decreased, the average delay decreased by between 2 seconds at Balham (a low flow site) and 8 seconds at Blackfriars. Therefore, although these are maximum delay reductions, as drivers arriving at other times in the cycle will be less affected, this analysis implies that the signal re-timing element of the PCaTS package of measures did result in reductions in delay for drivers.

The reductions in delay for vehicles observed in the trial conducted by TRL are consistent with changes in total vehicle green time reported by TfL. See Table 3

	Extra Green Time to Traffic (seconds per hour)
01/212 (Oxford Street)	61.4
02/045 (Kingsway)	112.5
03/029 (Finsbury)	270.5
08/028 (Blackfriars)	126.8
10/008 (Balham)	75.0
08/003 (Tower Br)	77.3
08/211 (Old Kent Rd)	76.2
10/160 (Roehampton)	40.9

The PCaTS package includes making adjustments to the timing of traffic signals, including setting the Green Man (Invitation to Cross) period in line with DfT guidelines. This generally results in a small reduction in the Green Man period, which can then be re-allocated to traffic.

When averaged over a one hour period the additional green time available to traffic ranged from just over 40 seconds at the Roehampton site, to several minutes per hour at the Finsbury site, as detailed in the table above.

This measure is useful to understand the potential traffic benefits of the PCaTS package.

Source: TfL analysis.

Table 3: Increase in vehicle green time per hour with PCaTS

6.2 Time of first vehicle starting to move

Using the video images, the first vehicle to stop after the end of the traffic phase was timed when crossing a number of lines at set distances from the junction. In addition, the time it started to move forward in order to enter the junction was recorded. These times were related to the signal phases at the junction. So, information was available on how soon before, or after, the change to traffic green each vehicle started to move, see Figure 27.

This information is important in understanding consequences, and explaining changes, in conflicts at the end of the pedestrian phase (or start of the traffic phase). Conflicts can only occur when a vehicle is moving in the same vicinity as the pedestrians. Consequently, if traffic starts to move at a different time, then this can assist in explaining changes in conflicts at that time.

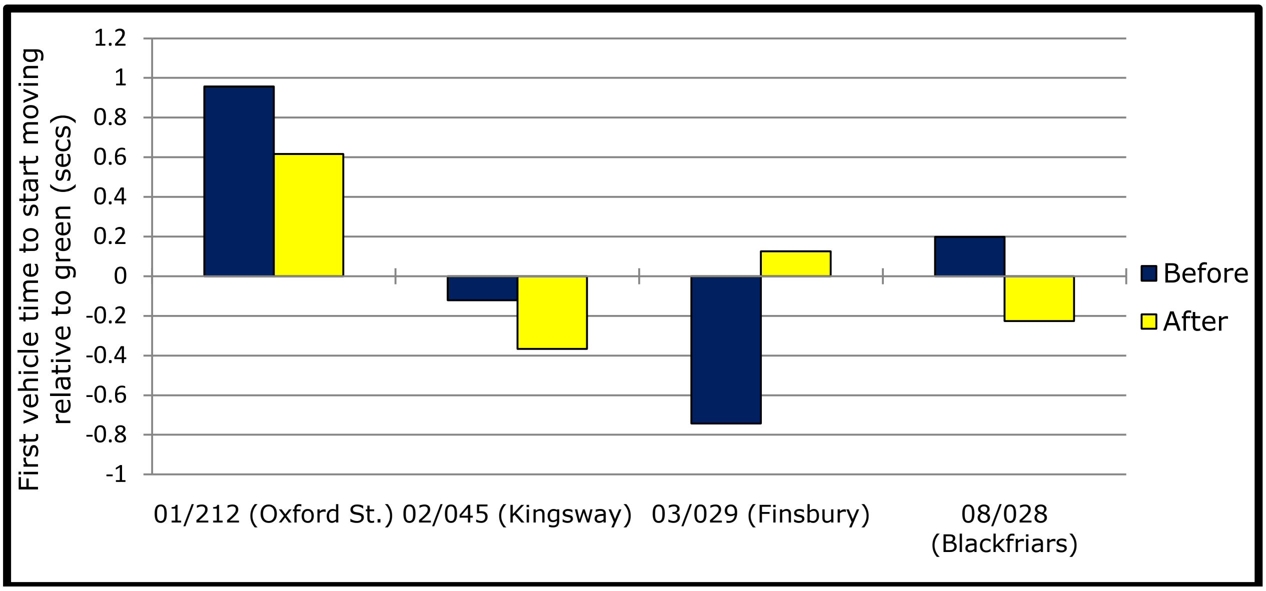


Figure 27 First vehicle time to start moving after the start of traffic green

The overall indications were that with PCaTS, vehicles started to move forward slightly earlier at the majority of sites, up to a maximum of 0.7 seconds earlier in the 'After' surveys.

Overall, traffic appears to be starting to move slightly earlier, which means that as there were a higher number of pedestrians deciding to cross after the All Red period, there is a potential increase in conflicts. This is investigated in the next section and in the discussion section consideration is given to the possibility that drivers are using the current un-shrouded countdown display design as an indicator that they are about to be given priority.

7 Interactions/Conflicts

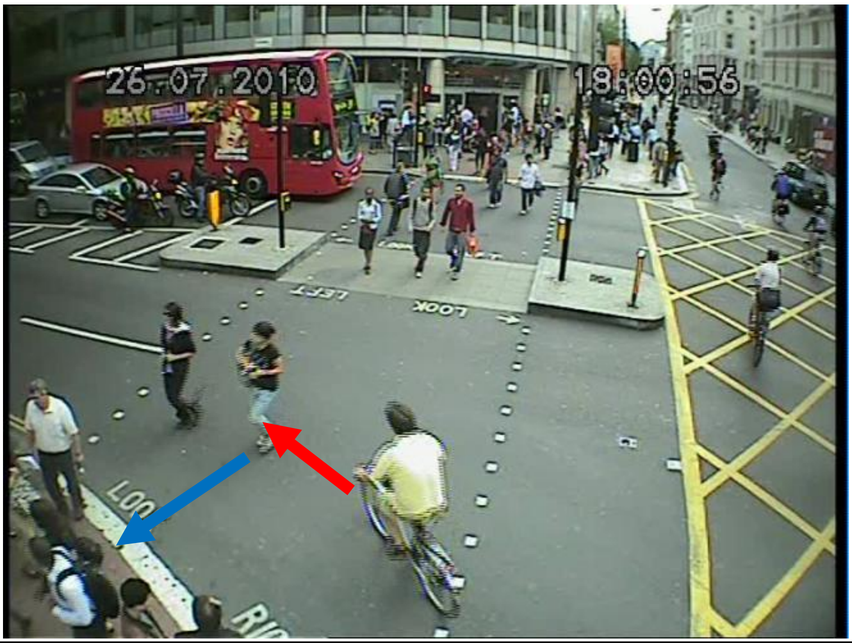
7.1 Severity and when they occurred

A conflict occurs when two people attempt to use the same space at the same time. In this project conflicts were recorded between pedestrians and vehicles (including cyclists) within the vicinity of the pedestrian crossing, and were used as precursors of a collision. That is, a collision involving pedestrians at the crossing can only occur if there was a conflict. However, a conflict in the main occurs without a collision. Conflict analysis therefore provides an indication of the relative safety of the crossings with and without PCaTS.

Conflicts were classified according to severity level:

- Level 1: Precautionary - for example stopping to allow the other road user to pass
- Level 2: Controlled – minor deviation from initial route, or controlled braking
- Level 3: Near Miss – rapid deceleration, lane change or stopping
- Level 4: Very Near Miss – emergency braking or violent swerve
- Level 5: Collision – actual contact between road users (none observed during trial).

Increases in conflicts of level 1 and above imply an increased level of interaction and therefore a higher probability of a collision. However, the higher the level of conflict the closer to an actual collision. Examples of conflicts are shown below:



Conflict Level 1. The cyclist started through the signals on green. Pedestrians were still crossing even though the red man is displayed. The slow moving cyclist modified their speed and course to a small degree (precautionary) to avoid a collision.

Conflict Level 2. The pedestrian crossed the road during the red man and was on the crossing when the taxi started to move from the stop line. The pedestrian adjusted his crossing speed in a controlled manner to avoid the collision.

Conflict Level 3. The pedestrian started crossing from the island during the red man. Vehicles were initially queued. The pedestrian had to stop abruptly as vehicles then started to move in the traffic green. Vehicle speeds were low as there were also queuing vehicles at the other side of the junction, but the conflict represented a near miss.

Conflict Level 4. The pedestrian started to cross during the green man period. The silver taxi was stationary in a previously formed queue. The taxi began to move as the queue downstream cleared. This caused the pedestrian to stop suddenly, as it was a very near miss.

The number of conflicts of each level observed on the survey sites with the highest pedestrian flows are shown in Figure 28.

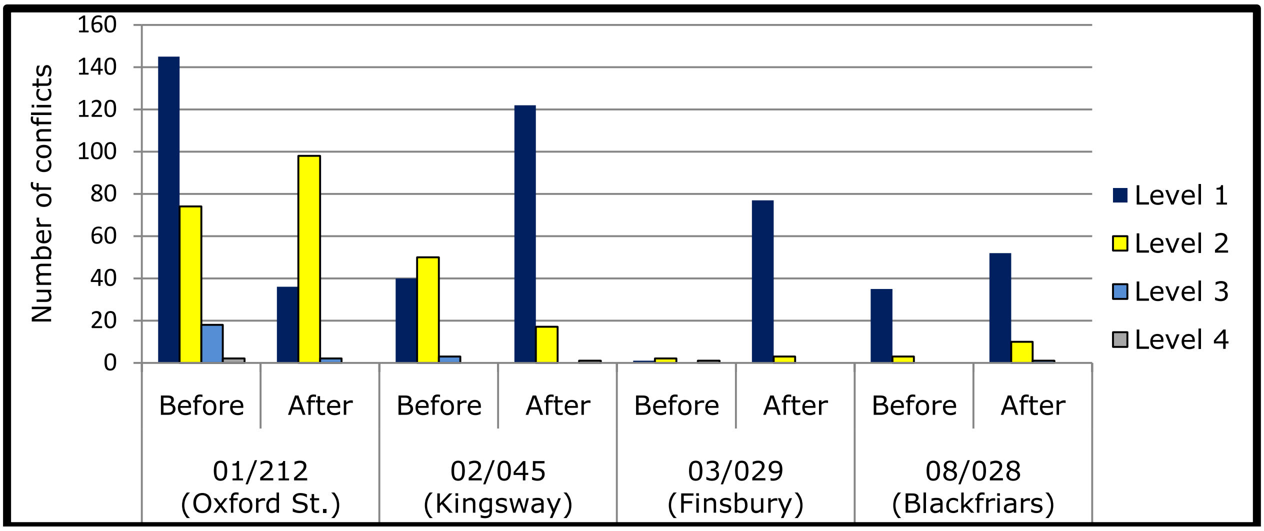


Figure 28 Observed Conflicts

Conflict rates significantly decreased at Oxford Street, the busiest crossing, but there were increases at the other sites, from 152 to 342 conflicts in total.

No actual collisions were observed during the surveys. Statistically significant changes in conflict numbers were only observed with the lowest categories of conflict levels, those at Levels 3 and 4 remained at very low levels. Large reductions in Level 2 conflicts (controlled) were observed at the two highest flow sites (Oxford St and Kingsway), from 124 to 28 conflicts; but there were small, but still statistically significant increases at two lower pedestrian flow sites, from 1 to 8 at Blackfriars, and 3 to 11 at Old Kent Road.

Most conflicts (over 84%) at all sites occurred during the Red Man phase. The remaining 16% occurred during the other signal phases including the All Red phase at the end of the pedestrian phase, the traffic Red/Amber and traffic Amber phase, which would therefore involve a degree of non-compliance by vehicles. Interactions could occur when there are changes in priority, for example it is possible that some of these conflicts may have been with cyclists either starting before receiving priority, or being unable to clear the junction before pedestrians received priority.

Overall, safety appears to have improved at the highest flow site, however the interactions between pedestrians and vehicles increased (albeit at low levels) at the medium to low flow sites. These changes could have been the result of a higher percentage of pedestrians deciding to cross at the start of the traffic phase, vehicles starting to move forward earlier, or more pedestrians deciding to cross during the Red Man.

7.2 Vehicle types

Information was collected on those involved in conflicts. This includes the type of vehicles involved. This was separately summarised for single conflicts (one pedestrian involved) and multiple conflicts (more than one pedestrian at the same time with the same vehicle), see Figure 29 and Figure 30

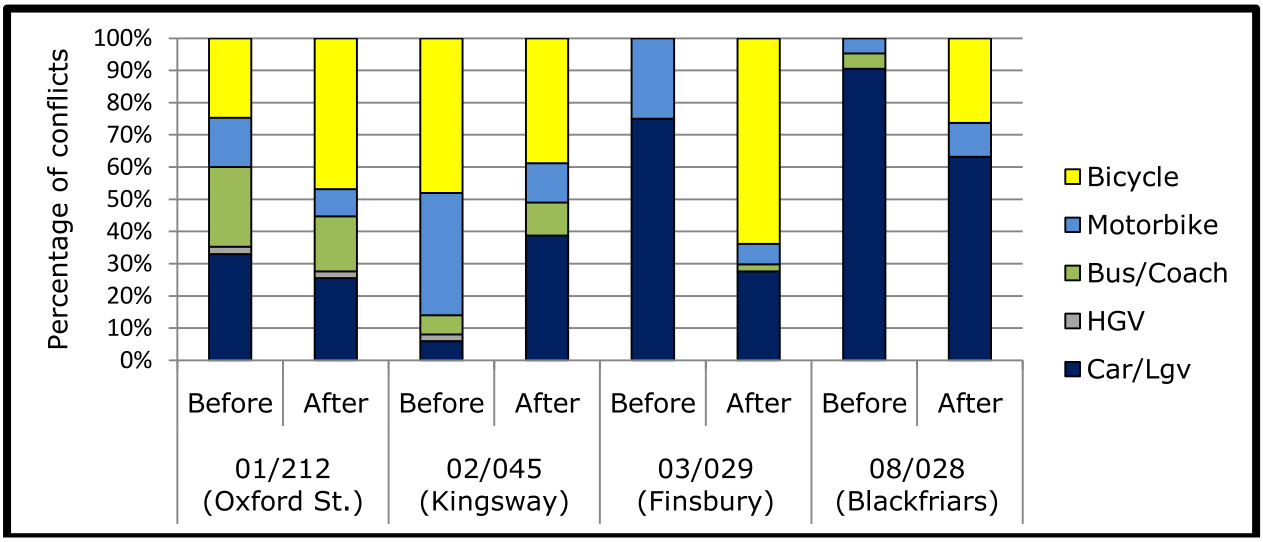


Figure 29 Vehicles involved in single person conflicts

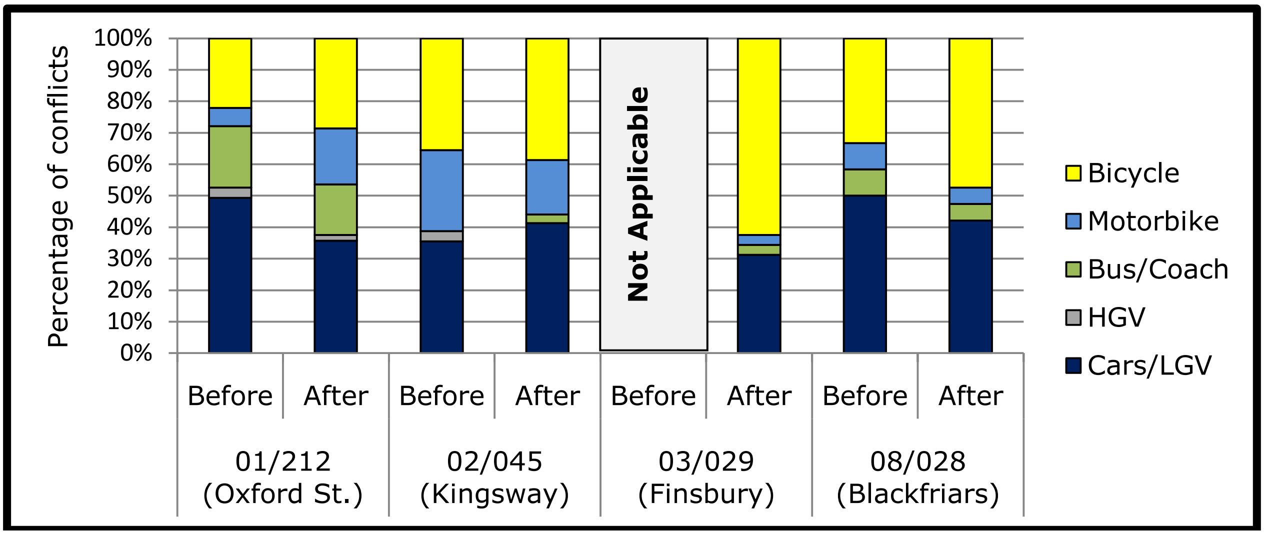


Figure 30 Vehicles involved in multiple person conflicts[3]

Most conflicts involved cars and light goods vehicles, but the proportion involving bicycles increased in the After surveys. Furthermore, the percentage of conflicts involving bicycles and motorcycles (on high flow sites) was greater than the percentage of the traffic flow they represented: for example 22% to 64% of the single-person conflicts in the 'After' surveys involved cycles whilst they represented less than 18% of the traffic flow at these sites. Also, 13 to 15% of all conflicts on the highest flow sites in the 'After' surveys involved motorcycles, whilst they represented 8 to 11% of the flow.

[3] No multiple person conflicts at Level 1 or above were observed at Finsbury

8 Discussion and Conclusions

The study used both face to face questionnaires and video data to assess how pedestrian perceptions and behaviour, and traffic flows, were affected by the installation of the PCaTS package. A summary of the key findings is given below. Further details on observations made are provided in the technical annex to this report.

Pedestrian Perceptions

The Countdown display provides information to pedestrians on the time remaining to cross before the Red Man appears, with the objective of overcoming the confusion that has previously been identified in pedestrians' understanding of the Blackout phase.

The main conclusion from the attitudinal surveys is that a majority of pedestrians liked Countdown: 83% of participants in the final 'After' study, 94% of mobility impaired pedestrians and 79% of children. PCaTS was preferred over standard crossings by 69% of mobility impaired pedestrians and 56% of children, who directly experienced both types of crossing. At all sites there was an increase in the percentage of participants stating that they felt safe using the crossing in the After survey, this was statistically significant at 7 out of the 8. The average increase was from 73% Before to 91% After across all sites. Furthermore, in the separate survey of children and mobility impaired pedestrians, 83% of children and 71% of mobility impaired stated that they felt safer with PCaTS.

At all trial sites fewer pedestrians reported feeling rushed when crossing the road with PCaTS despite a reduction in green man time. The greatest change was at Balham where the proportion feeling rushed fell from 45% before to 7% in the final after survey. Furthermore, even though green man invitation time had reduced, the percentage of pedestrians feeling they had sufficient time to cross the road increased from an average of 75% in the Before surveys to 88% with PCaTS. In addition, for pedestrians still on the crossing when the Green Man phase ends, a higher percentage of pedestrians stated they were able to continue crossing with PCaTS: the average across the survey sites increased from 12% Before to 37% After. This demonstrates that PCaTS was able to reduce uncertainty about being able to cross safely.

Interestingly, while more pedestrians stated that they had enough time to cross, pedestrians' ability to accurately report (or measure) their actual crossing times appeared to have reduced at some sites, despite the presence of a Countdown display. This suggests that people are using the displays qualitatively to help make crossing decisions but, once they have started crossing, are not using it to check their own actual crossing times.

The responses on willingness to cross at different phases suggest that pedestrians are interpreting the Countdown phase with PCaTS differently from the Blackout phase at standard crossings. Thus, while across all sites only an average of 22% arriving at the crossing during the Blackout phase considered that they could start to cross, an average of 81% of the main sample stated they could start to cross with the Countdown displayed. The influence on crossing decisions is illustrated by their stated willingness to start crossing with different amounts of time displayed. A greater proportion of respondents stated that they would start crossing during the early part of the Countdown phase (10 seconds or more displayed) than during the Blackout, however there was no difference in stated intention to cross with 5 seconds or less displayed. How this change in perception was reflected in actual crossing behaviour is considered in the following discussion of the observational studies.

Pedestrian crossing behaviour

Detailed analysis of the video footage was undertaken to provide an understanding of how pedestrian behaviour changed in response to the PCaTS package, in particular the extent to which it influenced crossing decisions, waiting time, crossing speeds and how people use the crossing space.

Irrespective of the type of crossing (PCaTS or standard) the majority of pedestrians tended to cross as soon as possible after arrival. Over 54% crossed within 5 seconds of arrival with both crossing types, 70% within 15 seconds and approximately 85% within 30 seconds. Furthermore, a majority (68% in the After survey) crossed during the Red Man, in line with what would be expected given that this is displayed for the greatest amount of time.

Analysis implied that when changes in pedestrian signal timings were taken into account, PCaTS did result in an increase in the percentage of pedestrians crossing during the Red Man of up to 6%. The reasons for this cannot be fully explained from this research. It could be that changes in traffic flow resulted in more suitable gaps for crossing, although this was not evaluated in this study, or that other aspects of the PCaTS package resulted in this change in behaviour.

At all but the highest pedestrian flow sites more pedestrians were observed starting to cross during the Countdown phase with PCaTS than during the Blackout phase with Standard crossings. However, the difference in crossing decisions between the PCaTS and Standard crossings diminished rapidly with time at the very end of the Countdown phase, so that by the point at which traffic is about to be given the Green phase, the number of pedestrians starting to cross with PCaTS was the same as with the standard crossing. These observations were consistent with the finding from the attitudinal surveys that while more pedestrians stated they would use the crossing at the start of the Countdown, there were no differences in their responses to the different crossing types by the end of the Countdown phase.

In addition to observations of the time at which pedestrians started to cross, additional analysis was carried out to assess the extent to which there were pedestrians remaining on the crossing at the end of the pedestrian phase. This was done at the Tower Bridge and Finsbury trial sites, where the pedestrian phase was followed by the major conflicting traffic phase. It was found that there were significantly more pedestrians remaining during the majority of the Countdown phase in comparison with the Standard crossing; however the difference between PCaTS and standard crossings reduced rapidly with time in the final seconds before vehicle green, so that there were no significant differences between the crossing types at the point when vehicles were released. The difference between the crossing types was 12% at 6 seconds before vehicles were given priority, falling to 9% at 2 seconds before, and declining rapidly to 0% by the start of the traffic vehicle.

At the highest pedestrian flow sites PCaTS had little effect on the decision to cross, with 75% of those arriving at the end of both Countdown and Blackout periods starting to cross shortly afterwards with both types of crossing.

At four of the sites observed changes in pedestrian delay were too small to be statistically significant. At the other four, pedestrian delay had increased at three of these sites and reduced at one. The largest increase in delay was 9 seconds at Finsbury, the site that experienced the greatest change in pedestrian green time.

The video analysis included a calculation of average walking speeds of pedestrians using the crossing. Excluding sites where walking speeds had been affected by other changes, and examining only the changes where there was a statistically significant difference, walking speeds had increased by between 3 and 10% in the After surveys. An estimate was also made of whether pedestrians changed speed while walking, to provide an indication of whether pedestrians start to hurry up while crossing if they feel they don't have enough time left to cross. This found that pedestrians did speed up to a greater extent towards the end of the countdown, although it had no observable effect at other times in the cycle. As noted earlier, pedestrians' responses to the attitudinal surveys showed that they felt less hurried with PCaTS, suggesting that those pedestrians that are walking faster have made a positive decision to do so, using the crossing time information provided.

Vehicle observations

Observations were made of the first vehicle to stop each cycle and assess actual delay time and the time within the phase at which they started to move forward. As actual delay time was measured, on those occasions when no vehicles were queuing at the junction then no delay time is measured and hence there can be no savings in delay. As would be expected from the increased green time given to road traffic, average delay, measured as first vehicle wait times, had reduced at six of the sites . The minimum average decrease in waiting time was from 53 to 51 seconds (a reduction of 2 seconds) and the largest was from 60 to 52 seconds at Balham (8 second reduction in delay). This measure provides an indication of the actual maximum delay saving obtained, as other vehicles later than the first one and therefore are delayed to a lesser extent. The reductions in delay observed are consistent with the increase in total green time given to vehicles.

There was some evidence that vehicles started to move forward slightly in advance of the green phase, in particular motorcycles and cyclists. This may be because they are able to use the Countdown displays as an indicator themselves.

Analysis of conflicts

A conflict occurs where two people attempt to use the same space at the same time. Where a conflict occurs frequently it provides an indication of a potential risk that might, over time, lead to actual collisions. Detailed observations were made of how the trial schemes affected the level of conflicting behaviour. In this study conflicts were categorised into 5 main levels of severity, ranging from 'precautionary' ones at the lowest level, where one road user has to give way to another, through more serious conflicts requiring emergency braking or steering. No actual collisions were observed during the surveys. Statistically significant changes in conflict numbers were only observed with the lowest categories of conflict levels, those at Levels 3 and 4 remained at very low levels. Large reductions in Level 2 conflicts (controlled) were observed at the two highest pedestrian flow sites (Oxford St and Kingsway), from 124 to 28 conflicts; however, they increased by a small but still statistically significant degree at two lower flow sites, from 1 to 8 at Blackfriars, and 3 to 11 at Old Kent Road.

Overall, the absence of any increase in higher level conflict types suggests that the PCaTS package does not introduce any serious risks to safety, which is consistent with the observation that there are no more pedestrians on the crossing at the time when vehicles are given priority. Site by site variations in the lower level conflicts suggest that local factors, in particular flow rates, can have an effect on the minor conflicts, which can be monitored and, if necessary, addressed on a scheme by scheme basis.

Considerations for future implementation

This trial has demonstrated that the PCaTS package can deliver benefits to both traffic and pedestrians:

1) PCaTS has had a positive response from the public

2) PCaTS has reduced pedestrian uncertainty and more informed crossing choices are being made

3) With the "PCaTS package" there are significant benefits to traffic

With any type of highway scheme it is necessary to take account of local circumstances, as is done through the standard safety audit process. PCaTS is no different: this trial has identified some changes in crossing behaviour, to be taken into consideration in future implementation. There were indications that some vehicles, in particular motorcyclists and cyclists, started to move forward slightly in advance of getting a green signal, which may be linked to the increase in lower level conflicts that were observed. As all of the trial sites implemented Countdown without a shroud at some sites it may therefore be appropriate to shroud the countdown display, limiting visibility of the timer to road traffic.

All sites surveyed as part of this study had "all round pedestrian" phases – a period of time when only pedestrians have priority and all traffic is held at a red signal. The levels of non-compliance with the pedestrian signals (the number of pedestrians crossing when traffic has the priority) observed during this study were very high both with and without the PCaTS package. This observed behaviour could warrant further research to understand how junction design could be adapted to improve compliance, or better meet pedestrian demand.

Overall, the trial has demonstrated that PCaTS is a popular measure that helps overcome pedestrian misunderstandings about the Blackout period, and so improves the pedestrian experience at junctions, whilst offering the opportunity to deliver benefits to vehicle traffic.