London Road Safety Unit

Research Summary No 16
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The effect of re-timed invitation to cross periods on road user behaviour at signalised junctions in London

Overview

This report summarises the findings of a research report by Transport Research Laboratory (TRL) entitled 'The effect of re-timed invitation to cross periods on road user behaviour at signalised junctions in London' (Sterling et al, 2009). Transport for London (TfL) is the traffic authority for all traffic signals in Greater London. There are over 6,000 traffic signal locations in London and some 3,000 are computerised as part of the Urban Traffic Control (UTC) network. Traffic signal timings follow national advice with some scope for local interpretation (DfT, 2006).

Currently, TfL's Directorate of Traffic Operations (DTO) base the invitation to cross period (the green man) on carriageway width, without explicitly taking account of pedestrian density at a site. This results in some junctions having timings higher than is required according to advice provided by the DfT in the Traffic Advisory Leaflet 5/05.

An experimental trial was designed to evaluate what effects setting the invitation to cross period at the minimum national guidance level would have on road users in London, in particular on pedestrian safety and vehicle throughput. This research used before and after observations of pedestrian behaviour, pedestrian interviews and accompanied pedestrian walks to indicate effects that might arise from the re-timing of signals.

The blackout period was not changed in this study (the blackout period, which follows the green man invitation to cross period, provides enough time for pedestrians who have started to cross the road when the green man goes out to complete their crossing safely assuming a walking speed of 1.2 metres per second).

The study reported changes to indicators of pedestrian safety following the traffic signal timing changes; both adverse and beneficial effects were indicated. Overall, there was no significant effect on pedestrian safety. There was a recorded increase in vehicle throughput of 6.5% on the priority arm observed (vehicles includes buses, taxis, lorries and private motor vehicles).

Objectives

The objective of the study was to investigate any effect on road users from changing the time of the green man invitation to cross period. In particular the study investigated:-

- Pedestrian experiences and views on junction safety and accessibility
- The effect of re-timing on pedestrians with different impairments

- Pedestrian compliance with signals
- Frequency and severity of conflicts between pedestrians and vehicles
- Changes to vehicular flow

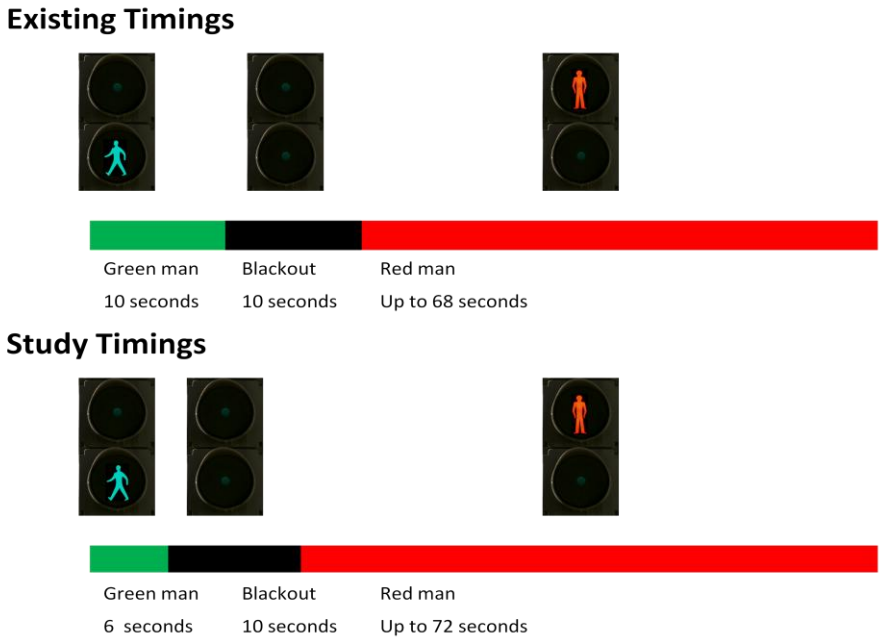

Figure 1: Illustration of the before and after study traffic signal

Method

Nine study sites at signalised junctions were selected that had 'all-red' pedestrian phases. An 'all red' phase is when all vehicles are stopped on red when pedestrians receive the green man invitation to cross. An indicative illustration of the signal timings in this research project is shown in Figure 1. Three sets of data were collected in the before period (January 2009) and in the after period (February 2009). The sets of data were:

- Observations of pedestrian behaviour
- Pedestrian interviews
- Pedestrian accompanied walks for people with a variety of impairments

Collision data was not available for analysis because of the normal delay from a collision occurring, to it being provided to the London Road Safety Unit and because the duration of the study was too short for enough collision data to be available. Instead conflict analysis was used as an indicator of safety and has been used in this study to compare any changes in the period after the re-timing of signals compared with the before timings. Conflict analysis using video footage requires 'near misses' between road users to be recorded and evaluated as to their severity, or how close to being a collision the interaction was. Conflicts between road users are rare and therefore the less severe classification of 'encounter' from Walker et al (2005) was also used (See Table 1).

Table 1: Conflict grades and description

Grade	Conflict	Example of pedestrian, driver or rider behaviour
1	Encounter	Stops in carriageway to allow vehicle to pass
2	Controlled action	Deviates from route or vehicle undertakes controlled braking
3	Near miss	Rapid deceleration, lane change or stopping
4	Very near miss	Emergency braking or violent swerve
5	Collision	Contact between two parties

Figure 2 shows an example of a grade 3 conflict from this study. In this case several pedestrians are crossing the road under a red man. The taxi has turned left and has to brake while the nearest pedestrian rapidly changes the direction and pace they are walking to avoid a collision with the taxi.

Interviews with pedestrians were carried out at the nine experimental junctions and lasted for five minutes. Questions were designed to assess pedestrian feelings of accessibility, comfort and safety at the junctions before and after the re-timing. Random sampling was used to recruit interviewees and quotas were set to ensure a range of demographics were interviewed. Six hundred pedestrians were interviewed in the before period and six hundred in the after period.

Figure 2: Example of a conflict (grade 3)

The accompanied walks collected qualitative data from participants who had a range of visual or mobility impairments. The participants were recruited through relevant disability organisations and charities. Participants were accompanied on a route that included two experimental junctions and two control junction arms.

Results

Compliance with pedestrian signals

More people crossed in the red man phase after the signals were re-timed.

Pedestrian behaviour was analysed from the video footage and comparisons made between the before and after periods for changes. Overall the number of pedestrians observed remained statistically consistent with 13,095 observed in the before and 13,336 observed in the after period.

Across all junctions the number of pedestrians who started crossing when the red man was displayed increased in the after period by 13.8%. Correspondingly the number of pedestrians who started to cross the road in the green man phase decreased by 11.6% in the after period compared to the before period (Table 2). Faced with the red man displayed for longer, more pedestrians started to cross during the red man phase. Overall pedestrian compliance, by only starting to cross when the green man is displayed, decreased from 45% in the before period to 39% in the after period. Correspondingly, the proportion crossing on the red man increased from 46% to 51%.

Table 2: Pedestrian compliance with signal and use of central refuges

Pedestrians	Red Man			Green Man			Blackout		
	Before	After	% change	Before	After	% change	Before	After	% change
Starting crossing	6,039	6,875	13.8%*	5,844	5,165	-11.6%*	1,212	1,296	6.9%*
Using Central Refuge	2,531	2,886	14.0%*	48	112	133.0%*	48	44	-8.3%

* Statistically significant change (p<0.01)

Eight sites had central refuges present. Pedestrians who started to cross the road were most likely to stop in the central refuge if they had started to cross on the red man (Table 2). Overall 96% of pedestrians who stopped on the central refuge had started crossing with the red man displayed to them. Pedestrians who started crossing with a red man displayed to them and subsequently stoped in the central refuge increased in the after period by 14%. This is similar to the increase in the total number of pedestrians starting to cross on the red man. From a low base of 48, the number who started crossing with a green man display and stopped on the central refuge increased to 112.

Conflict analysis

Overall, the results for the indicators of safety used in this research suggest that there was no significant effect on safety from the re-timing of the signals. Conflicts were graded from 1 to 5, with increasing severity. There was a reduction in grade 1 conflicts; an increase in the grade 2 conflicts; a reduction in grade 3 and 4 conflicts, and a continuing absence of grade 5 severity conflicts. Of these, the changes to grade 1 and 2 severity conflicts were statistically significant.

There were 813 conflicts in the before period and 810 in the after period (Figure 3). Following signal timing changes, there was a statistically significant reduction in grade 1 conflicts, from 739 to 714. There was an increase in the number of grade 2 conflicts in the after period from 51 conflicts to 78. There was an improvement in the more serious grade of conflicts after the change (grade 3 conflicts improved from 15 to 13, and grade 4 conflicts improved from 8 to 5). No grade 5 conflicts were reported either before or after the signal re-timing. Both before and after the signal timing changes, the vast majority of conflicts occurred in the lowest severity category, grade 1 (encounter).

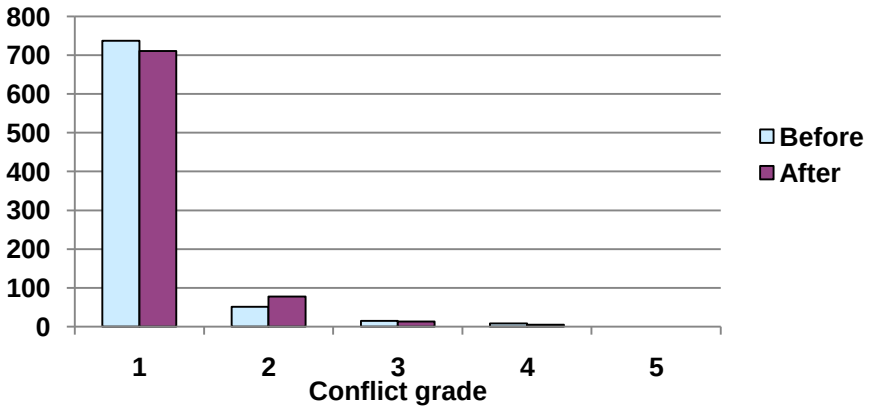

Figure 3: Conflict frequency and severity, before and after (all sites)

The vast majority (90%) of conflicts occurred when the pedestrian started to cross the road against the red man in the before and after periods (Figure 4).

Table 3: Time of occurrence of conflicts involving a pedestrian during the signal cycle

Conflicts	Red Man			Green Man			Blackout		
	Before	After	% change	Before	After	% change	Before	After	% change
Grade 1	686	691	0.7%	39	19	-51.3%	39	28	-28.2%
Grade 2	40	66	65.0%	6	1	-83.3%	4	2	-50.0%

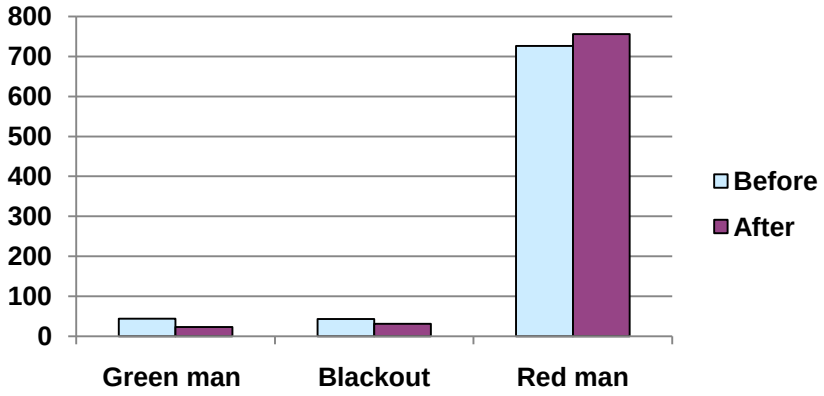

Figure 4: Conflict occurrence and display to pedestrians when they started crossing, before and after (all sites)

Network operation

There was a significant increase in vehicle throughput (comprising buses, taxis, lorries and private motor vehicles) after the signal re-timing.

One study site had street works present in the after period closing one lane of traffic. Therefore this site was excluded from the analysis of vehicular throughput. Over the remaining eight sites, vehicular flow was measured by counting the throughput of

vehicles on the one arm of the junction being observed in the video footage. The re-timing of signals increased vehicle throughput by 6.5% on the priority arm observed where there was additional demand.

Pedestrian interviews

Pedestrians did not notice a change in the junction operation and most felt safe before and after the signal timing changes. Pedestrians with impairments felt less safe after the re-timings.

A large proportion of pedestrians felt safe using the junction crossing in the before and after periods. The proportion of pedestrians who felt safe increased from 76% to 78% (Figure 5). The number of pedestrians with impairments feeling safe reduced from 70% in the before period to 58% after the re-timing.

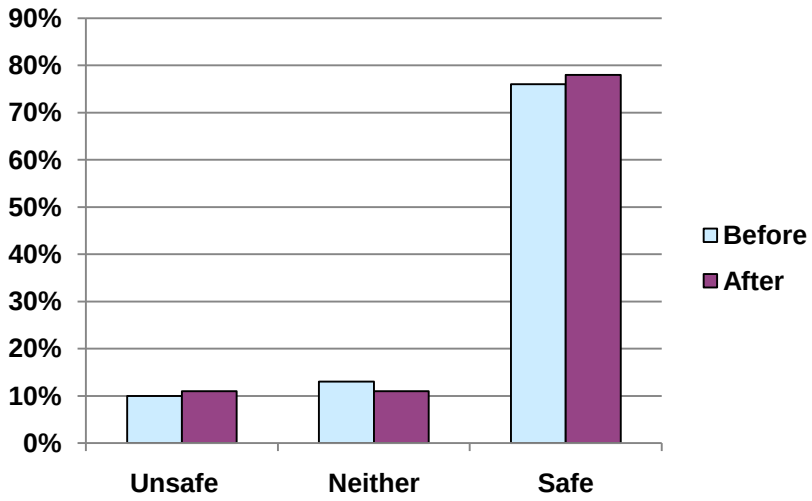

Figure 5: How safe or unsafe would you say you felt using this particular crossing? (before and after, all sites)

The proportion of pedestrians when asked how satisfied they felt with the time they had to cross the road changed from 83% of interviewees answering 'Satisfied' in the before period and 79% in the after period (Figure 6). In the after period the proportion of impaired pedestrians answering 'Dissatisfied' increased from 13% in the before period to 20% after the re-timing.

Overall, 36% of pedestrians noticed the blackout period. In the after period when asked 'What do you think this blackout period means?' 40% of pedestrians answered correctly and 60% either answered incorrectly or didn't know (Figure 7). The proportion of impaired pedestrians who did not know what the blackout period meant was larger at 68%.

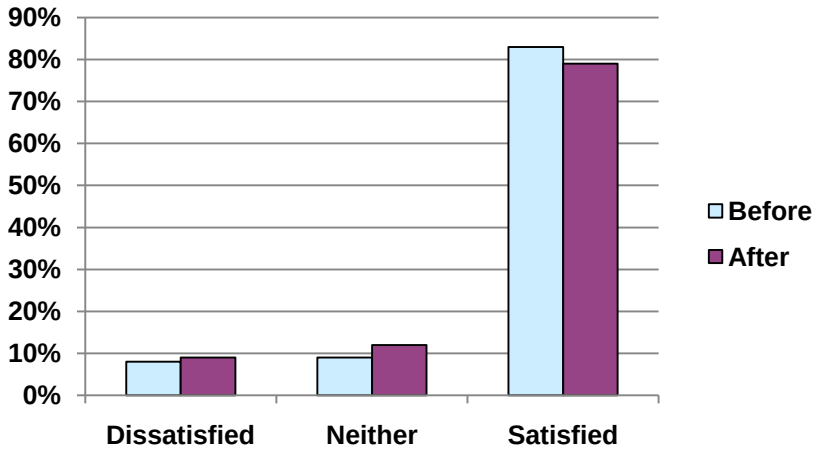

Figure 6: How satisfied were you with the amount of time you had to cross the road? (before and after, all sites)

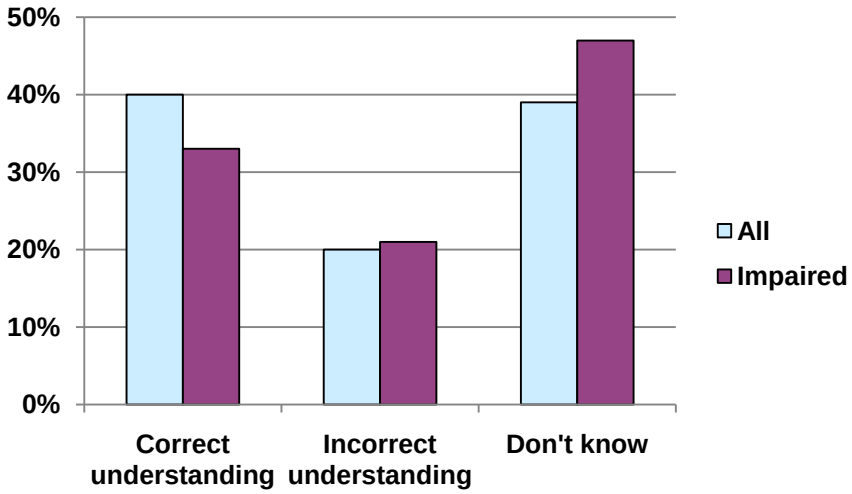

Figure 7: What do you think this blackout period means? (before and after, all sites combined)

Accompanied walks

Pedestrians on the accompanied walks felt rushed at crossings and uneasy crossing the road when the blackout period started.

All participants noted that they had to wait a long time for the green man to appear. Participants noticed a difference between the control junction arms and the re-timed signals. One participant observed *"It was quite fast and I only got halfway across before the green man went off".* Many participants reported feeling rushed and uncertain when the red man would appear, and often stopped to wait on the central refuge when the blackout period started.

Conclusion

The study investigated the effect of re-timing the invitation to cross periods (green man) on road user behaviour at signalised junctions in London. Overall, the signal re-timing had no significant impact on safety. When considering the results for the indicators of safety (the conflict analysis), the results were mixed. There was no overall change in the number of conflicts, and no grade 5 conflicts (collisions) either before or after the signal timing changes. Following the changes, there was a statistically significant decrease in the lowest severity grade 1 conflicts, a statistically significant increase in grade 2 conflicts, and a decrease in the small numbers of grade 3 and 4 conflicts.

Overall compliance with pedestrian signals was low, and more people crossed during the red man phase after the signals were re-timed.

Vehicle throughput on the priority arm observed increased in the after period by 6.5%.

Pedestrians were interviewed to investigate their perceptions of the crossings. Pedestrians did not notice any difference after the re-timing. Levels of satisfaction and feelings of safety remained broadly the same between the before and after periods. Many pedestrians did not correctly understand the meaning of the blackout period. There was a reduction in the proportion of pedestrians with impairments who were satisfied with the amount of time to cross the junction and they felt less safe. Many of the pedestrians with impairments felt rushed while using the crossings during the accompanied walks.

The research findings are useful in increasing TfL's understanding of pedestrian use of signalised junctions in London. It is important that they are taken into account in future decisions regarding the operation and re-timing of traffic signals in London.

Selected References

Department for Transport (2005) *Traffic Advisory Leaflet 5/05: Pedestrian facilities at signal controlled junctions Parts 1-4.*

Department for Transport (2006) *Traffic Advisory Leaflet 1/06: General Principles of Traffic Control by Light Signals Part 4 of 4*.

Sterling, T. Knight, P. Sharrat, C. Walter, L. and Narine, S. (2009) *The effect of re-timed invitation to cross periods on road user behaviour at signalised junctions in London.* TRL Report PPR411. Crowthorne: Transport Research Laboratory.

Walker R, Winnett M, Martin A and J Kennedy (2005) *Puffin Crossing Operation and Behaviour Study.* TRL Report PPR239. Crowthorne: Transport Research Laboratory.

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