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Non-prescribed zebra crossings at side roads

Technical Annex 4: Road user perceptions and understanding

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Executive Summary

This document forms a Technical Annex to the report *Trials of non-prescribed Zebra crossings at side roads: Final Report* and presents the methodology and findings from on-street trials.

Transport for Greater Manchester (TfGM) is seeking to understand how non-prescribed zebra crossing markings, positioned flush against the mouths of side roads in urban areas, can be used to provide direct but safe crossing options for pedestrians. TfGM commissioned TRL to conduct research into the proposed crossing which involves desk-based research and behavioural studies followed by on-street trials. This technical annex sets out the methodology and findings from attitudinal research into the perceptions of drivers and pedestrians, using simulated images and video representing different scenarios and turning movements.

Method

The study consisted of two online questionnaires – one from a driver’s perspective, and the other from a pedestrian’s perspective. Participants were directed to either the driver’s perspective questionnaire or the pedestrian’s perspective questionnaire depending on whether they held a driving licence. The questionnaires used either a series of 6 embedded videos (driver’s perspective) or 12 still images (pedestrian’s perspective) followed by questions around perceptions and anticipated behaviour. Questions were presented in various forms: multiple choice, Likert scales, and open-ended questions. Data was collected from a sample of 177 participants in total.

Main findings

Both drivers and pedestrians recognised a non-prescribed zebra crossing as a crossing where pedestrians have priority on the road. Drivers were more likely to give way to pedestrians who were waiting on the pavement and pedestrians were more likely to assert their priority by positioning themselves where they can be seen by drivers. However, the views of the two groups of participants differed in many respects. While the pedestrians found the non-prescribed crossing to be safer, the drivers considered it to be less safe.

For drivers, perceived safety and willingness to give way varied considerably with the turning movement of the vehicle: both being lowest for right turns into the side road. Drivers feeling unsafe commonly expressed concerns about obstructing traffic on the main road and their visibility of the crossing.

For pedestrians, participants that considered the non-prescribed crossing to be safe commented on the crossing alerting drivers to their presence, while those that considered it to be unsafe were concerned that drivers might not be expecting a crossing at that location.

The two most common suggestions from both drivers and pedestrians to improve non-prescribed zebra crossings was adding signs or road markings to warn drivers and moving the crossing away from the junction. However, it should be noted that only a small minority of pedestrians said that they would look for somewhere else to cross. Some participants

also suggested adding Belisha beacons, which may reflect the participants' unfamiliarity with zebra crossings at such locations.

When considering the implications of this study, it should be noted that the images and videos shown to participants reflect only one point of view, which is different than what would happen in a real-life situation, where people can move their head position to improve view. In addition, the images and videos represented broad day light and situations without traffic.

The analysis presented in this report forms an important part of the research into non-prescribed zebra crossings but should not be considered in isolation. It is one step in a programme of research that will culminate in on-street trials. Each research project informs the design of the following ones which helps to ensure that risks are understood and managed.

The risks can only be fully assessed from trials; however a precautionary conclusion from this study would be to conduct trials initially in locations where traffic speeds and flows on the main carriageway are already relatively low, to minimise the risks, perceived or otherwise, of following traffic. This study also highlights the importance of turning movement as a factor in drivers' perception of risk and willingness to give way. The proposed on-street trials will analyse video observations of crossing events classified by turning movement, so will enable this to be investigated further using real-world data.

1 Introduction

1.1 This document

This document forms a Technical Annex to the report *Trials of non-prescribed Zebra crossings at side roads: Final Report*, which presents the findings of a programme of user research and trials into the proposed use of a non-prescribed form of zebra crossing at side-roads. Technical Annex 4 sets out the methodology and findings from attitudinal research with pedestrians and drivers. The overall conclusions from the research programme are set out in the Final Report.

1.2 Background

The markings, equipment and signs used to denote a zebra crossing in the UK are prescribed in statutory government regulations. Key differences between a prescribed and non-prescribed zebra crossing are shown in Table 1. A prescribed zebra crossing is indicated by a series of alternate black and white stripes on the carriageway; a yellow globe is positioned at each end of the crossing (commonly referred to as a Belisha beacon); and the crossing area is marked with a line of studs; give ways lines and zigzag markings. The requirement for at least two zigzag markings means the minimum a zebra can be set-back from the mouth of a side road is about 5 meters.

Conversely, non-prescribed crossings exclude some or all the following: studs, zigzag markings and Belisha beacons. A simplification in the crossing could lower implementation and maintenance costs for TfGM and local authorities. In addition, removing the requirement for zigzag markings (and therefore the need for a 5-meter set-back) has the advantage of keeping pedestrians on their desired walking line, giving them a more direct route across the mouth of the junction.

Table 1: Key differences between a prescribed and a non-prescribed zebra crossing

Design feature	Prescribed zebra crossing	Non-prescribed zebra crossing
Crossing markings	Black and white stripes and give way markings	Black and white stripes
Peripheral markings	Line of studs Zigzag markings	May include zigzag markings on one or both sides of the crossing
Set-back distance from junction	The requirement for at least two zigzag markings creates a minimum set-back distance of around 5 meters	No minimum distance, could be flush with the end of the side road
Additional equipment	Yellow globe on a black and white striped pole (Belisha beacon)	

Both prescribed and non-prescribed crossings are intended to give pedestrians wishing to cross the side road priority over vehicles; this applies to vehicles on the side road approaching the junction, and to vehicles on the main road wishing to turn into the side road. Drivers (and to a lesser extent pedestrians) have a short time in which to determine what to do when confronted with an unfamiliar road layout. They key to effective road

markings is the ability to quickly and accurately convey the intended message to road users, so that both drivers and pedestrians can intuitively take appropriate action.

This study aimed to explore general public understanding of the meaning and purpose of the side road zebra crossing and how they should behave around them. This study, therefore, aimed to address the following research question:

How do pedestrians and drivers comprehend and anticipate behaving around non-prescribed side road zebra crossings?

1.3 The impact of COVID-19

This study was due to kick-off at the beginning of April 2020. In March 2020, the spread of COVID-19 initiated social distancing policies, followed by a nationwide lockdown. For this reason, the study could not be carried out using our initial proposed method. This report describes the methods and findings for the research question: How do pedestrians and drivers comprehend and anticipate behaving around non-prescribed side road zebra crossings?

TRL's original proposed methodology involved conducting an on-street questionnaire. Using an opportunity sampling strategy, it was intended that questionnaires be administered in person by TRL researchers at an agreed junction in Manchester. Due to COVID-19 and the need for social distancing, TRL and TfGM agreed a revised approach for this research project, adapting the methodology to an online questionnaire.

2 Study design

2.1 Method

An online questionnaire was used to gain an understanding of public perceptions around safety and priority when using a non-prescribed zebra crossing. The questionnaire comprised of two distinct sections, with respondent's either answering questions from the perspective of a driver or answering questions from the perspective of a pedestrian. The questionnaire used a repeated measure, mixed methodology design, with each participant presented with either a series of simulated videos from a driver's perspective or still images from a pedestrian's perspective. The videos and images showed a junction with a side road meeting a main road. After being shown a video or image, participants were asked questions around their perceptions of priority and anticipated behaviour. The order in which participants were shown videos / images was randomised to eliminate any possible learning effects. The questionnaire included a mixture of multiple choices and open-ended questions. Participants were asked to select an option in multiple choice questions and then asked to explain their choice in an open-ended question. The questionnaire is provided in Appendix A.

The videos and images showed a junction with a side road meeting a main road. Each participant answered the questionnaire as either a pedestrian or a driver. After giving consent, participants were asked if they had a driver's licence. If they selected "yes", they were directed to the driver's perspective questionnaire. If they selected "no", they were directed to the pedestrian's perspective questionnaire. Due to the large initial response from people with driver's license, once the target of 60 responses from drivers was reached the online questionnaire was set to redirect individuals to answer the pedestrians survey regardless of whether they held a license or not. This ensured that we also collected responses from the pedestrian's perspective from individuals who have driving licenses.

2.2 Stimuli

The use of non-prescribed zebra crossing design on the side road was investigated in the questionnaire, along with a control condition in which no crossing was present. The simulated videos and images were developed using a virtual simulated environment¹. The simulated videos were from the driver's perspective of them approaching a junction in 6 different conditions. The images were from the pedestrian's perspective at a junction in 12 different conditions. A total of 12 images and 6 videos were created, varying in the following ways:

1. **Point of view:** from the viewpoint of either a pedestrian or car driver;
2. **Crossing type:** a non-prescribed zebra crossing or no crossing;
3. **Pedestrian movement:** from left to right, right to left, or both simultaneously;

¹ The virtual simulated environment was created by Agility3.

4. **Vehicle movement:** into the side road from the left, into the side road from the right or out of the side road.

The combination of these four variables across 18 stimuli is shown in Table 2 and Table 3.

Table 2: Conditions and variables for the videos

Condition (video) no.	Point of view	Crossing type	Pedestrian movement	Vehicle movement
1	Driver	No crossing	Both	Out of side road
2	Driver	No crossing	Both	Into side road (left)
3	Driver	No crossing	Both	Into side road (right)
4	Driver	Non-prescribed zebra	Both	Out of side road
5	Driver	Non-prescribed zebra	Both	Into side road (left)
6	Driver	Non-prescribed zebra	Both	Into side road (right)

Table 3: Conditions and variables for the images

Condition no.	Point of view	Crossing type	Pedestrian movement	Vehicle movement
1	Pedestrian	No crossing	Left to right	Out of side road
2	Pedestrian	No crossing	Left to right	Into side road (left)
3	Pedestrian	No crossing	Left to right	Into side road (right)
4	Pedestrian	No crossing	Right to left	Out of side road
5	Pedestrian	No crossing	Right to left	Into side road (left)
6	Pedestrian	No crossing	Right to left	Into side road (right)
7	Pedestrian	Non-prescribed zebra	Left to right	Out of side road
8	Pedestrian	Non-prescribed zebra	Left to right	Into side road (left)
9	Pedestrian	Non-prescribed zebra	Left to right	Into side road (right)
10	Pedestrian	Non-prescribed zebra	Right to left	Out of side road
11	Pedestrian	Non-prescribed zebra	Right to left	Into side road (left)
12	Pedestrian	Non-prescribed zebra	Right to left	Into side road (right)

2.2.1 Point of view

The point of view was from the perspectives of either a pedestrian or a car driver. Six videos were from the car driver's eye view. That view included the driver's view of the road and street environment and their view from inside the vehicle (e.g., steering wheel, dashboard and A-pillars visible). The perspective of the other 12 images were from the pedestrian's eye view.

When answering the questionnaire as a driver, the participants were shown 6 different videos. When answering the questionnaire as a pedestrian, the participant was shown 12

different still images. The order in which participants were shown the images or videos was randomised to eliminate any order effect.

2.2.2 *Crossing type*

There were two crossing type conditions. A control condition where no formal pedestrian crossing is present and a condition with a non-prescribed zebra crossing. A non-prescribed zebra crossing consists of black and white stripe markings only. It is aligned with pedestrians desired walking line, either flush with the mouth of the side road or in line with the footpath (see Figure 1 for an example).



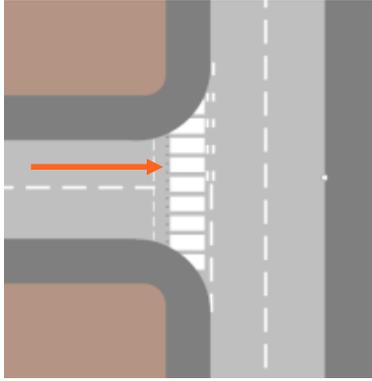
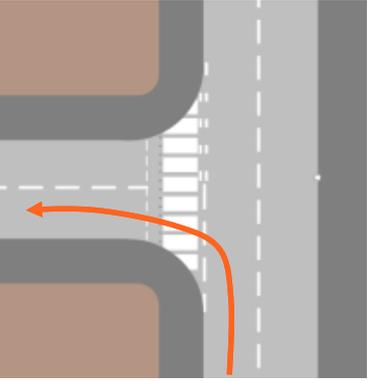
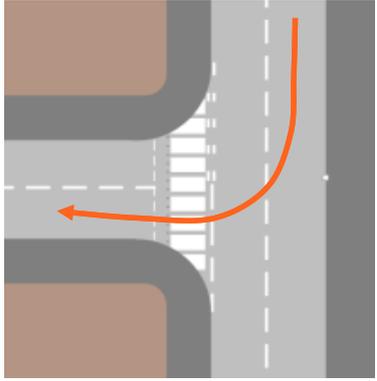
Figure 1: An image of a non-prescribed zebra crossing at the mouth of a side road.

2.2.3 *Vehicle movement*

There are three vehicle movements (see Table 4).

For the '1. Out of side road' movement, the car travels along the side road towards the junction with the main road, and then comes to a stop in front of the crossing. The video then ends shortly afterwards. For, the other two '2. Into side road (left)' and '3. Into side road (right)' movements, the car travels along the main road from either the left or the right, then begins to turn into the side road. The video ends before the vehicle reaches the crossing.

Table 4: Description of the three different vehicle movements

1. Out of side road	2. Into side road (left)	3. Into side road (right)
		
<p>The car approaches the junction from the side road and stops before the crossing.</p>	<p>The car begins to make a left-hand turn from the main road into the side road.</p>	<p>The car begins to make a right-hand turn from the main road into the side road.</p>

2.3 Recruitment

Participants were recruited from TRL's participant database of approximately 1,200 members based in Berkshire, Hampshire and Surrey (in the UK). The online questionnaire was sent out to the database via email and those that wished to participate followed the link to answer the questions. Due to a concentration of participants on the database living in the South-East an additional form of recruitment was utilised. The link to the questionnaire was also published on TRL's twitter site and retweeted by TfGM with an aim to attracting some respondents from a wider geographical area, including the North-West. The participants were required to be over 18 years old and were incentivised to take part by being able to enter a prize draw to win £200. The target sample size was at least 60 responses for both of sections of the questionnaire.

2.4 Data analysis

The questionnaire was made up of quantitative, multiple choice, questions as well as qualitative, open questions. This mixed methods study allows rich data to be captured and analysed in an effective manner with quantitative data analysis providing measurable and comparable results and qualitative data providing context and deeper understanding of participants responses.

The quantitative element of the survey data was analysed and tabulated/graphed for each question by crossing type, pedestrian movement and vehicle movement. Analysis is presented separately for the driver (section 3.1) and pedestrian (section 3.2) samples. Demographics of each sample are also presented. Due to the small sample size for this analysis, it is not possible to examine differences between groups of participants (e.g. by age, gender or region).

Where possible, statistical tests were carried out to test for a difference in responses between the two crossing types (non-prescribed zebra and no crossing). Due to the nature of the questions, non-parametric tests (which make no assumptions about the distribution of responses) were used: Cochran’s Q and McNemar tests² for the nominal survey questions and Friedman’s ANOVA and Wilcoxon signed rank tests for the ordinal survey questions. For all tests, p-values are presented, and results are deemed significant at the 5% level if the p-value was less than 0.05 (a frequent standard in the behavioural sciences).

The qualitative data, from the open questions, was collected and analysed for key themes. A thematic analysis approach was taken, where common themes were drawn across participants’ responses. This allowed for additional feedback and insight into the participants’ quantitative answers. Tables are used to show frequently used qualitative responses and quotes are provided to give examples of participants responses.

3 Results

3.1 Drivers’ perspective

3.1.1 Demographics of the driver sample

In total, 111 participants took the driver survey. Table 5 presents the age and gender distribution in the sample.

Table 5: Age and gender distribution of the sample (drivers)

Age	Female	Male	Total
17-24 years	0	0	0
25-34 years	2	6	8
35-44 years	6	11	17
45-54 years	10	12	22
55-64 years	5	18	23
65-74 years	9	22	31
75 years or older	1	9	10
Total	33	78	111

There was a good spread across most age groups, although there were fewer participants in the 25-34 years old group and no drivers aged 18-24 years. 70% of the sample were male.

² These were used for the pairwise comparisons between the corresponding scenarios for the ‘no crossing’ and ‘non-prescribed zebra crossing’ scenarios.

The tendency for the sample to be older was also reflected in the level of driving experience: the majority of the sample (98%) were experienced drivers who have held their driving licence for 10+ years.

Four participants reported factors or conditions that affected their mobility: three reported arthritis and two participants reporting that they use walking sticks.

Figure 2 shows the reported frequency of driving for the participants in the sample.

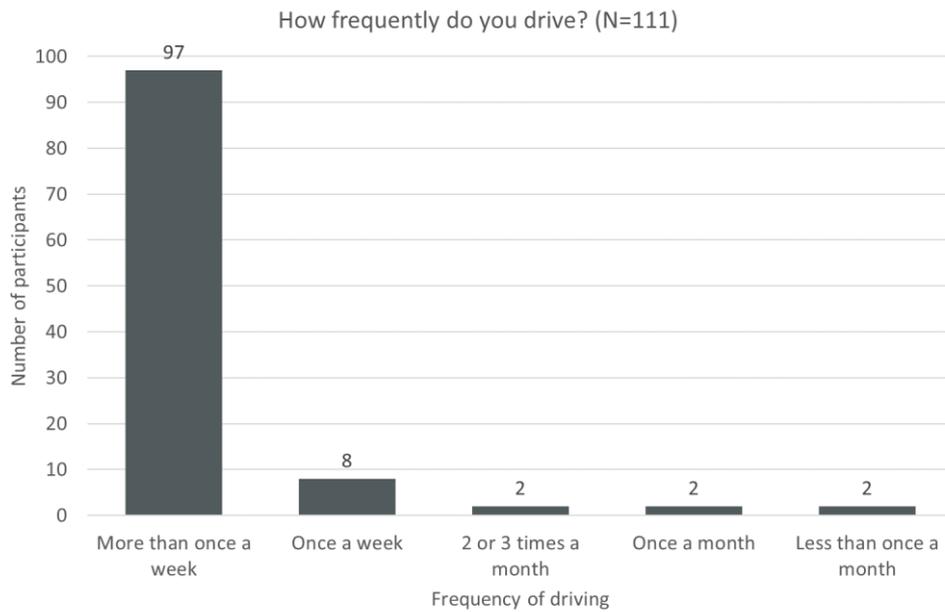


Figure 2: Frequency of driving

The majority (87%) of the sample drive more than once a week. The main reasons for driving are shown in Figure 3.

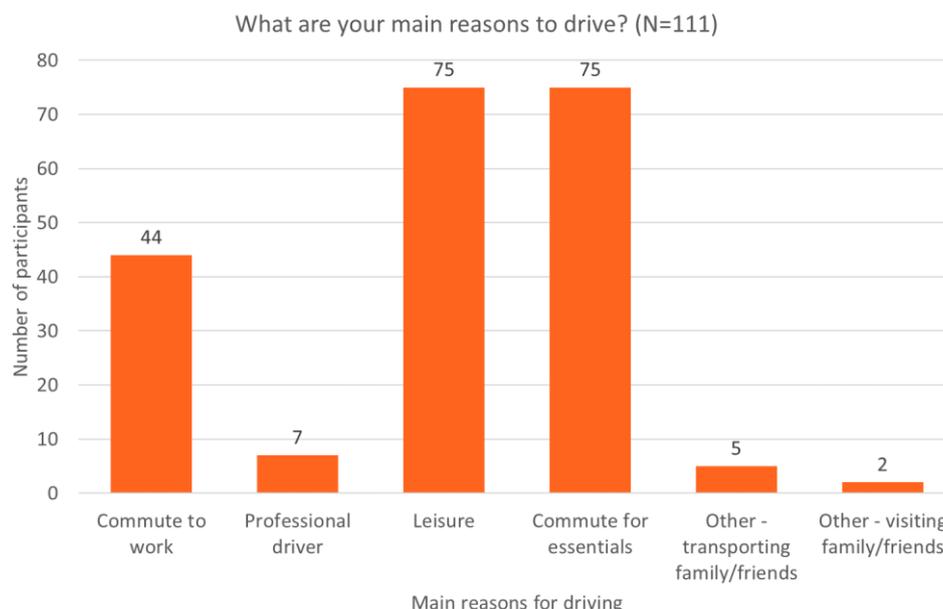


Figure 3: Main reasons for driving

Over two thirds (68%) of participants reported driving for leisure or for essentials. 40% reported driving to work. Seven participants reported they were professional drivers and when asked what type of vehicles they drove, gave the following responses: car (6), van (3), lorry (1), motorbike (1) and bus/coach (2).

3.1.2 Questions about the junction videos

3.1.2.1 Anticipated behaviour

After watching each of the videos, drivers were asked to imagine they were faced with the junction presented and select what they would do next from a list of options (Figure 4). They were given the following four options to choose from:

1. I would proceed to turn into the main road if the way is clear.
2. I would look out for pedestrians waiting on the pavement or starting to cross and slow down or stop to let them cross
3. I would slow down or stop for pedestrians that have started to cross, but not if they are waiting on the pavement
4. Not sure

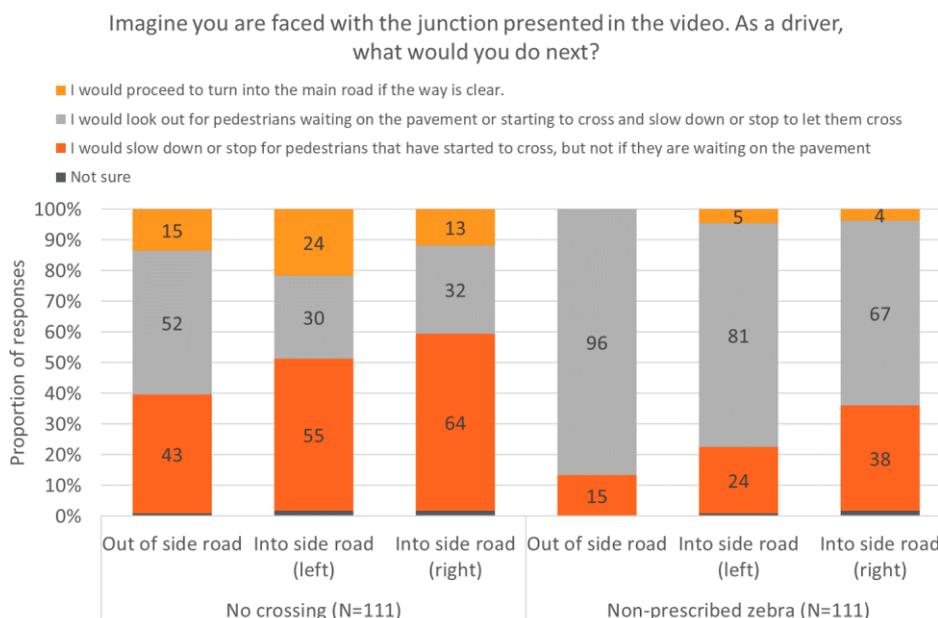


Figure 4: Reported driver action when presented with each junction scenario

When presented with the videos of the non-prescribed zebra crossing, over 60% of the sample of drivers selected the option that they would ‘look out for pedestrians waiting on the pavement or starting to cross and slow down or stop to let them cross’. This figure was smaller for the videos with no crossing (47% when the car was coming out of the side road, 27% when pulling into the side road with a left hand turn and 29% when the vehicle was pulling into the side road from a right hand turn). Statistical tests show that there was a significant difference in these proportions across the six scenarios ($p < 0.001$) and pairwise comparisons between the ‘no crossing’ and ‘non-prescribed zebra crossing’ scenarios for each vehicle movement showed that the response was significantly different between crossing types ($p < 0.001$).

More drivers would look out for pedestrians waiting on the pavement when a non-prescribed zebra crossing was present, compared to when no crossing was present.

For the ‘into side road’ and ‘no crossing’ scenarios, it was more common for drivers to select the option that they would ‘slow down or stop for pedestrians that have started to cross, but not if they are waiting on the pavement’ (50% when the vehicle was doing a left hand turn and 58% when completing the right hand turn).

3.1.2.2 Reasons for anticipated behaviours selected

Participants were asked to comment on their reasons for the choices they made. These comments are analysed below, distinguishing between those whose comments imply that pedestrians have priority and those whose comments imply that drivers have priority.

Looking out for pedestrians waiting

Participants who selected that they would “look out for pedestrians waiting on the pavement” at a non-prescribed zebra crossing, provided comments that implied that the

pedestrian had the right of way at the junction. Table 6 shows participants' comments for this perception (using a count of the number of times it was mentioned). Below are examples of their responses:

"The crossing stripes provide the pedestrians priority on the road"

"There were 2 pedestrians visible so I would automatically slowdown in case they stepped into the road"

"Must give way to a pedestrian on a crossing"

"There is a zebra crossing so I would be looking out for pedestrians"

"Because that is the right thing to do. They are at a zebra crossing"

Participants who selected that they would "look out for pedestrians waiting on the pavement" at a junction with no crossing commented that this was because they could see the pedestrian in view, or were worried that the pedestrian would not look out for cars, as shown in Table 6. Below are examples of their responses:

"I have no wish to injure any pedestrians. I saw two who looked as if they were going to cross the road."

"correct thing to do and safest for all"

"Even without a marked crossing, if the pedestrians start to cross and I turn in I put myself in a dangerous position."

"Pedestrians don't always look for traffic when crossing a side road"

Table 6: Reasons given for driver selecting 'I would look out for pedestrians waiting on the pavement or starting to cross and slow down or stop to let them cross'

Video scenario						
Response themes	Out of side road		Into side road (left)		Into side road (right)	
	NPZC	NC	NPZC	NC	NPZC	NC
Crossing in view	56	0	46	0	25	0
Pedestrian in view	12	19	13	16	17	11
In case pedestrians don't look	0	17	0	10	0	12
Pedestrian has right of way	7	3	10	1	9	6
Pedestrian <u>on the road</u> has right of way	0	3	0	1	0	2
General safety reasons	9	1	5	2	9	2
NPZC: Non-prescribed zebra crossing						
NC: No crossing						

Slow down or stop for pedestrians that have started to cross

With the non-prescribed zebra crossings, some participants stated that pedestrians who were already on the crossing would have priority and as a driver they would slow down or stop for pedestrians, but not if the pedestrian was waiting on the pavement. When asked to give reasons for their choice most of these participants explained that they would 'slow down or stop for pedestrians that have started to cross' because they could see a marked crossing and/or the pedestrian in view (see Table 7). As shown in the chart in Figure 4, this was more common when turning right into the side road. Below are examples of participants responses:

"Pedestrians on crossing have right of way"

"Priority is to the vehicle until the pedestrian is in the road."

"If people are waiting on the pavement with no intention of crossing I would proceed with caution and be ready to stop".

"Would want to make turn asap to prevent causing a hazard, however if no cars behind me, likely to let pedestrians who haven't yet stepped on the crossing to cross"

"If they are already on the road, they take precedence, and it would be manslaughter to run them over and continue my journey :) If they were still on the pavement, I would continue to turn. "

With junctions that had no crossing, many participants commented that as a driver they had priority on the road as there was no designated crossing point (see Table 7). Some also noted that while they would stop if they saw a pedestrian on the road, they felt that any pedestrians still on the pavement should wait until the road is clear for them to cross. The lack of a marked crossing indicated to drivers that they had the right of way. Drivers also acknowledged that it was a commonly encountered type of junction and they would keep a look out for pedestrians regardless of a proper crossing. Participants were more assertive about having priority over pedestrians when turning into the side road from the left or right. They explained that by stopping at the junction, they might cause confusion to other drivers or pedestrians and create possibility for a rear-end collision. Below are examples of their responses:

"As there is no pedestrian crossing then they do not have the right of way, however if they were in the process of crossing I would stop for them."

"I would be slowing for junction and aware of pedestrian already crossing"

"The pedestrians don't have right of way"

"Pedestrians should wait until road is clear before crossing as there was no designated pedestrian crossing."

"Would let pedestrian cross rather than run them over. Wouldn't stop otherwise as car may be rear ended by traffic on main road. It would be dangerous to stop there"

Table 7: Reasons given for driver selecting ‘I would slow down or stop for pedestrians that have started to cross, but not if they are waiting on the pavement’

Video scenario						
Response themes	Out of side road		Into side road (left)		Into side road (right)	
	NPZC	NC	NPZC	NC	NPZC	NC
Crossing in view	7	0	11	0	6	0
Pedestrian in view	1	10	4	6	18	17
Would be obstructing other drivers	0	0	7	8	6	15
Driver have priority	0	13	0	7	4	10
Pedestrian on the road have priority	0	4	0	6	0	10
Pedestrian should wait for cars	0	4	0	6	4	1
No marked crossing	0	6	0	15	0	11
For safety	0	1	4	1	8	23
NPZC: Non-prescribed zebra crossing NC: No crossing						

3.1.2.3 Recognition of features in videos

After each of the videos, participants were asked which of the following features they saw:

- traffic lights
- Belisha beacons
- pedestrian crossing
- STOP sign
- GIVE WAY sign,
- ‘Men at Work’ sign
- SLOW writing

Each option was presented with an image of the feature along with the words to ensure participants fully understood the features being discussed. Drivers’ responses can be seen below in Figure 5.

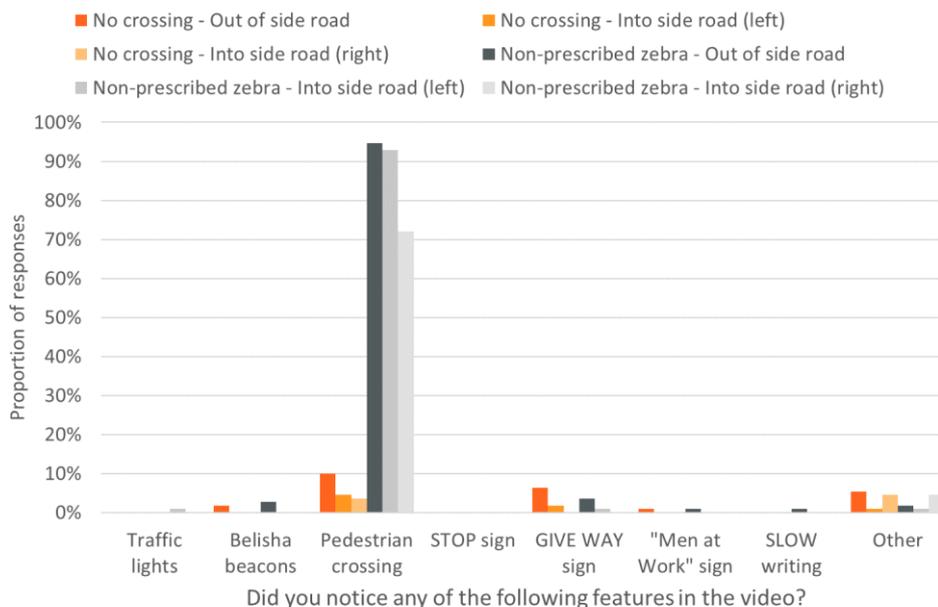


Figure 5: Features identified in each scenario (drivers)

The only named feature present in any of the videos was the pedestrian crossing in the non-prescribed zebra crossing videos (grey bars). Other than the pedestrian crossing, none of the other features were present in the simulated videos. 95%, 93% and 72% of the driver sample correctly identified the presence of the crossing for the three different vehicle movements, out of side road, into side road (left), and into side road (right), respectively. Drivers incorrectly identified a pedestrian crossing in the 3 videos where no formal pedestrian crossing was present between 4% and 10% of the time.

The majority of drivers correctly identified the presence of a pedestrian crossing when presented with videos showing a non-prescribed zebra crossing.

Figure 6 shows the reported ease or difficulty to identify the pedestrian crossing in the video.

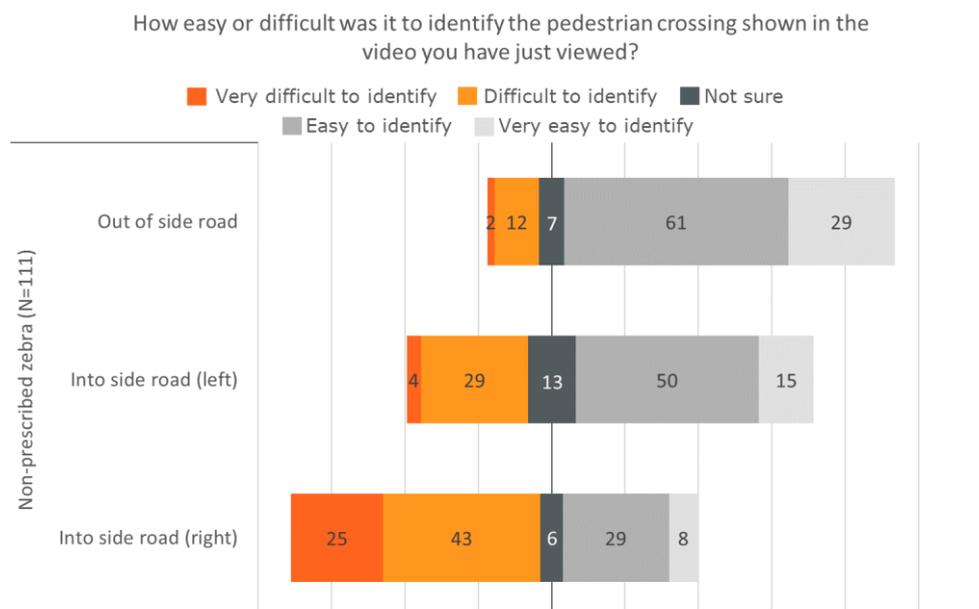


Figure 6: Ease or difficulty in identifying the pedestrian crossing in the non-prescribed zebra crossing videos (drivers)

When the vehicle was coming out of the side road, 81% of the sample of drivers reported that the non-prescribed zebra crossing was easy or very easy to identify. When the vehicle was pulling into the side road this figure was lower: 59% for a left-hand turn and 33% for a right-hand turn. Statistical tests show there was a significant difference in responses across the three scenarios ($p < 0.001$).

The non-prescribed zebra crossing was significantly easier to identify for drivers turning out of the side-road than for those turning into it. The crossing was most difficult to identify for those making a right-hand turn in.

3.1.2.4 Perceived level of safety

On a scale from 1 to 5, drivers were asked to select how safe they perceived the junctions shown in the videos to be:

- 1 - Very unsafe
- 2 - Quite unsafe
- 3 - Neither safe nor unsafe
- 4 - Quite safe
- 5 - Very safe

Figure 7 shows the reported level of perceived safety for each of the pedestrian crossing scenes in the videos.

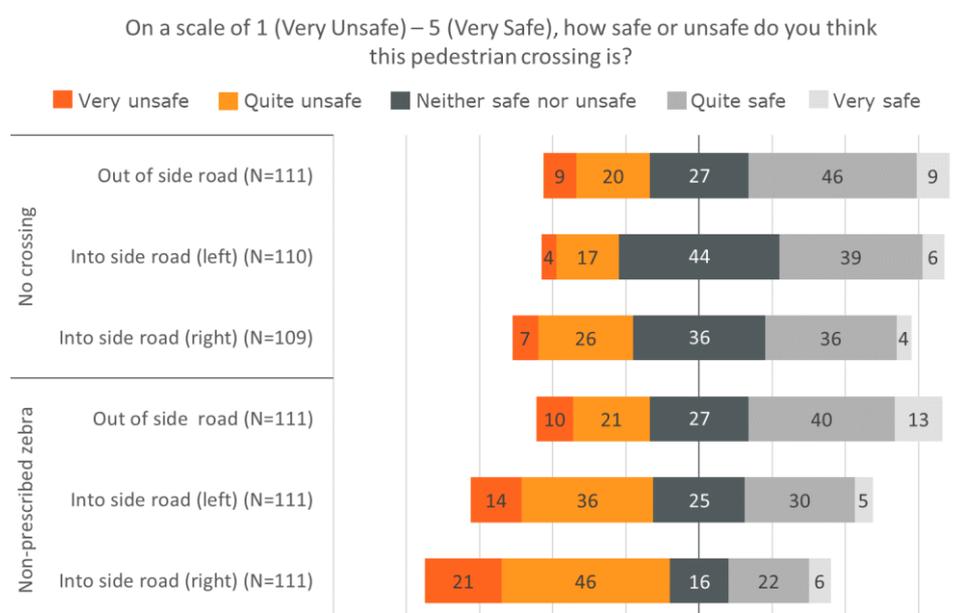


Figure 7: Reported level of safety for the pedestrian crossing (drivers)

Compared with no crossing, fewer participants reported that they felt the non-prescribed zebra crossing was safe ('quite safe' or 'very safe') and more reported this crossing was unsafe ('very unsafe' or 'quite unsafe'). The difference was most extreme for the right-hand turn into the side road with 60% of the sample reporting that the non-prescribed zebra crossing was unsafe, compared to just 30% for no crossing.

Statistical tests show there was a significant difference between the responses for the six scenarios ($p < 0.001$). Pairwise comparisons between the 'no crossing' and 'non-prescribed zebra crossing' scenarios for each vehicle movement showed that the response was significantly different for the two side road scenarios: $p = 0.995$ (not significant) for 'no crossing out of side road' compared with 'non-prescribed zebra out of side road'; $p = 0.002$ (significant) for the comparison between the two 'into side road (left)' scenarios and $p < 0.001$ (significant) for the comparison between the two 'into side road (right)' scenarios.

Drivers had more safety concerns about a junction with a non-prescribed zebra crossing, compared to junctions without a crossing. 60% of the driver sample reported that the non-prescribed zebra crossing was unsafe ('very unsafe' or 'quite unsafe'), compared to just 30% for junctions where there was no crossing.

3.1.2.5 Reasons for perceived level of safety

Drivers were asked to provide a reason for how safe they perceived the junction in each of the videos. Comments from participants who said that the junction with no crossing was safe ('quite safe' or 'very safe') included that they approached it as a regular junction that they would typically encounter daily. Some added that pedestrians do not have the right of way and should not be crossing here, hence they do not foresee pedestrians crossing at that junction. Some also attributed their feelings of safety to an unobstructed view and good visibility. Table 8 shows the reasons for drivers perceiving the junction to be safe. Below are examples of their responses:

"Typical junction"

"It's a normal junction used in everyday driving"

"Everything is visible, this is not a crossing point and is a normal T junction. pedestrians do not have a right of way and should not cross at this point"

"There is good visibility but there is no indication that pedestrians have priority."

Table 8: Reasons for drivers perceiving the junction to be safe³

Video scenario						
Response themes	Out of side road		Into side road (left)		Into side road (right)	
	NPZC	NC	NPZC	NC	NPZC	NC
It's a regular junction	0	11	0	9	0	16
Good visibility/no blockage	10	14	7	5	6	6
There is a marked crossing	14	0	9	0	7	0

NPZC: Non-prescribed zebra crossing
NC: No crossing

Comments from participants who said that the junction with no crossing was unsafe ('very unsafe or 'quite unsafe') included that the road leading up to the junction lacked warning signs. Some noted that if it was a busy junction, then a formal crossing point should be

³ Count of responses from both who selected 'quite safe' or 'very safe'

installed. Table 9 shows the reasons for drivers perceiving the junction to be unsafe. Below are examples of their responses:

"It's just a standard T junction"

"No signage to indicate type of junction or any crossing."

"no signage on the approach to the junction"

Table 9: Reasons for drivers perceiving the junction to be unsafe⁴

Response themes	Video scenario					
	Out of side road		Into side road (left)		Into side road (right)	
	NPZC	NC	NPZC	NC	NPZC	NC
No signage/indication of junction/crossing type	8	13	5	10	10	14
Crossing too close to junction	18	4	30	2	28	3
Poor visibility/unclear crossing	10	0	7	0	19	5
Unsafe for other drivers/obstruction	3	0	14	0	6	1

NPZC: Non-prescribed zebra crossing
NC: No crossing

For videos with the non-prescribed zebra crossing, more drivers felt it was safe ('quite safe' or 'very safe') when turning out of the side road compared to the other approaches. This was largely attributed to clear visibility of the crossing marked on the road. Some stated that this was like any other zebra crossing where they would expect pedestrians so they would slow down. Below are examples of their responses:

"Visibility is good. The crossing is visible from the approaching vehicle."

"There is a ped crossing, which makes it feel safer."

Comments from participants who selected the unsafe options ('very unsafe' or 'quite unsafe') for the non-prescribed crossing included concerns about the proximity of the crossing to the junction. Some participants said that they felt that it was too close to the junction and unsafe (shown in Table 9). When turning into the side road, participants said that their lower level of perceived safety was due to the risk of obstructing other drivers and/or holding up traffic behind them. Participants also reported poor visibility of the zebra crossing when turning into the side road from the main road. This was more common when turning right into the side road than turning left into the side road. Some also added that safety was dependent on pedestrian movement and having a marked crossing gives pedestrian priority. Others said that there were no warning signs on the main road to warn

⁴ Count of responses from both who selected 'quite unsafe' or 'very unsafe'

oncoming traffic of the need to slow down or give way to pedestrians (see Table 9 above). Below are examples of their responses:

“Too close to junction. Not obvious enough.”

“not easily visible crossing, no road marking prior to junction warning about crossing”

“The left turning vehicle may stop suddenly and unexpectedly to allow pedestrians to cross causing issues for traffic following behind”

“The crossing is close to the corner and drivers already have enough to be aware of.”

“Stopping when turning left could cause an issue for cars behind crossing quite near road end”

“It looks as though you are turning from a main road onto a side road. In the video there is no other traffic on the road but if the road was busy the other traffic is likely to obscure the junction and pedestrians crossing.”

3.1.2.6 Design of Junction

Participants were asked if they would like to see any changes to the design of the crossing to improve safety. Figure 8 shows how drivers responded.

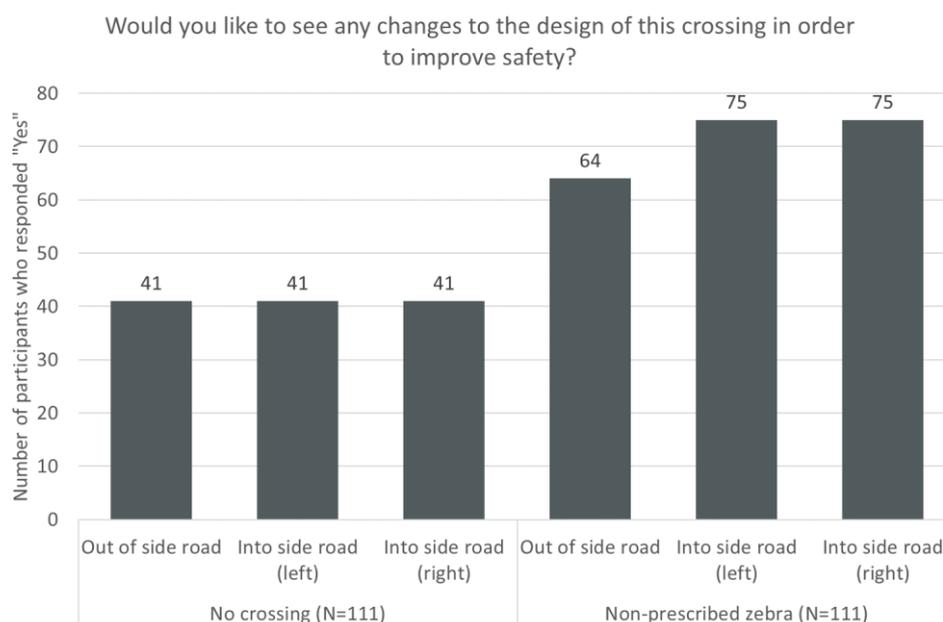


Figure 8: Number of participants reporting that they would like to see changes to the design of the crossing to improve safety (drivers)

Over one-third (37%) of the driver sample wanted to see changes to the ‘no crossing’ scenarios but this figure was significantly higher (between 58% and 68%) for the non-prescribed zebra crossing ($p \leq 0.002$ for the pairwise comparisons between the ‘no crossing’ and ‘non-prescribed zebra crossing’ scenarios for each of the three vehicle movements).

Recommendations for improving layout

Drivers, who answered that they would like to see improvements to the design of the junction, were asked to provide detail on what improvements they would like to see implemented.

When presented with a junction with 'no crossing', some participants suggested improving the layout by adding a pedestrian crossing (see Table 10). The second most common suggestion was to add signage or road markings to warn drivers about upcoming or a potential crossing point. Suggestions included "Give Way", pedestrian or speed limit signage and SLOW markings on the road. Below are examples of participants recommendations for improving the layout:

"Maybe lights before turning in and a proper crossing for pedestrians"

"crossing point, slow markings prior to junction, belisha lights"

"A pedestrian sign on left just before junction"

"Crossing further back and put Belisha lights"

In scenarios with the non-prescribed zebra crossing, the two most common responses for improving the junction layout, were adding signage or road markings to warn drivers and moving the crossing away from the junction. Other suggestions included adding the Belisha beacons for better visibility especially in bad weather or at night. Other suggestions included adding in a refuge island in the middle of the road, changing it to controlled lights, or remove the designated crossing entirely (shown in Table 10). Below are examples of their responses:

"Better visibility for users, maybe a crossing further from junction to encourage pedestrian to cross further from corner"

"Move crossing further away from junction"

"Improve the visibility of the crossing and add signs to promote its existence. Or, move it further away from the junction."

"Move the zebra crossing further away from the junction."

"Crossing should be situated further down the road to prevent a rear shunt. Alternatively, flashing lights should highlight its situation."

"More signage, pedestrian crossing moved back from the junction, lights indicating pedestrian crossing as it may not be seen in bad weather"

Table 10: Suggestions for improving layout (drivers)

Participant comments	Video scenario					
	Out of side road		Into side road (left)		Into side road (right)	
	NPZC	NC	NPZC	NC	NPZC	NC
Add pedestrian crossing markings	0	14	0	8	0	11
Add signage	21	13	14	15	13	13
Add Belisha beacons	19	1	9	4	8	0
Add a crossing further away from the junction	0	7	0	12	0	5
Move crossing further away from the junction	28	0	49	0	38	0
Traffic lights	0	3	0	7	0	1
Traffic lights instead	5	0	6	0	5	0
NPZC: Non-prescribed zebra crossing NC: No crossing						

Many drivers recommended making improvements to the layout of a non-prescribed zebra crossing, including adding Belisha beacons, traffic lights or signage. Depending on the scenario presented on the video, between 25% and 44% of drivers recommended moving the non-prescribed zebra crossing further away from the junction.

3.2 Pedestrians' perspective

3.2.1 Demographics of the pedestrian sample

In total, 66 participants took the pedestrian survey. Table 11 presents the age and gender distribution in the sample.

Table 11: Age and gender distribution of the sample (pedestrians)

Age	Female	Male	Prefer not to say	Total
18-24 years	1	1	0	2
25-34 years	5	5	0	10
35-44 years	4	7	1	12
45-54 years	9	4	0	13
55-64 years	6	9	0	15
65-74 years	5	5	0	10
75 years or older	0	4	0	4
Total	30	35	1	66

There was a good spread across all age groups and an approximately equal distribution by gender (30 female, 35 male and one who preferred not to specify).

Five participants reported factors or conditions that affected their mobility including:

- One was a blue badge holder
- One had depression, anxiety, post-traumatic stress disorder (PTSD) and emotionally unstable personality disorder (EUPD)
- One reported hemiplegia (paralysis) on their right side
- One required hearing aids for audible clarity
- One wore glasses for longer distance

3.2.2 *Questions about the junction images*

3.2.2.1 *Anticipated behaviour*

For each of the 12 pedestrian scenarios (shown in Table 3), participants were asked to imagine that they were faced with the junction presented and select what they would do next from a list of options.

1. I would step onto the edge of the road so that drivers will see me starting to cross so that they and give way to let me cross
2. I would stand just before the kerb so that drivers will see me waiting and give way to let me cross
3. I would wait on the pavement for a safe gap in the traffic before starting to cross
4. I would go somewhere else to cross the road
5. Not sure

Figure 9 shows how pedestrians responded for each of the scenarios.

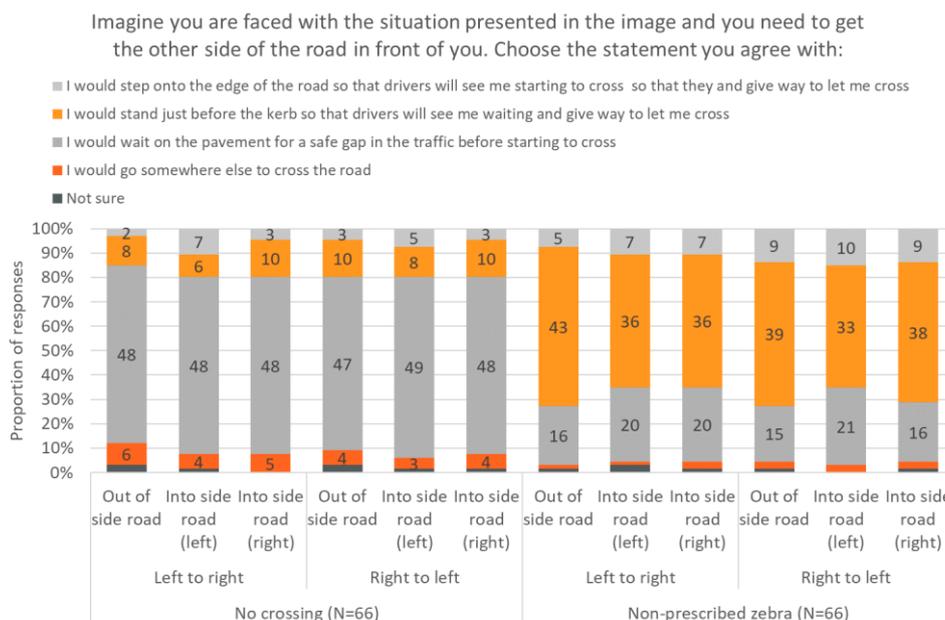


Figure 9: Reported pedestrian action when presented with each junction scenario

When presented with the images of the non-prescribed zebra crossing, over half of the sample of pedestrians (ranging from 33 to 43 participants out of 66) selected the response that they would ‘stand just before the kerb so that drivers will see them waiting and give way to let them cross’. This figure was smaller for the videos with no crossing (between 6 and 10 participants). Statistical tests show that there was a significant difference in these proportions across the twelve scenarios ($p < 0.001$) and pairwise comparisons between the ‘no crossing’ and ‘non-prescribed zebra crossing’ scenarios for each pedestrian/vehicle movement showed that the response was significantly different between crossing types ($p < 0.001$).

For scenarios where there was no crossing, it was more common for pedestrians to select the option that ‘they would wait on the pavement for a safe gap in the traffic before starting to cross’ (between 47 and 49 participants selected this option compared with between 15 and 21 for the non-prescribed zebra crossing scenarios). Only a small proportion of participants chose the option to look for somewhere else to cross – between 3 and 6 participants (4% - 9%) selected that they would look to cross somewhere else when presented with a junction with no crossing. The proportion was lower with the non-prescribed crossing – with only 1 or 2 participants selecting this option.

The presence of a non-prescribed zebra crossing affected the way pedestrians said they would behave at the junction, with more participants expecting cars to give way to pedestrians.

3.2.2.2 Reasons for anticipated behaviour selected

Participants were asked to provide a reason for their anticipated behaviour.

Stand just before the kerb

When asked to comment on their response, most participants shown a non-prescribed zebra crossing said that they saw a marked crossing which indicated to them that pedestrians had priority over the oncoming vehicle. However, participants also said they would also cross with normal caution - “standing just before the kerb to ensure visibility before crossing” (comments shown in Table 12). Participants also commented that they would be concerned that drivers may not see them or stop in time, hence, they wanted to ensure the driver has seen and/or acknowledged them before stepping onto the crossing. Below are examples of their responses:

“I have the right of way but need to ensure drivers will stop before I cross”

“Although the law is that if a person is on the crossing traffic must stop, I think I'd prefer to be seen first and cross when the traffic has stopped.”

“Dedicated crossing but traffic turning in so want them to see and be aware of crossing.”

Table 12: Reasons for selecting ‘I would stand just before the kerb so that drivers will see me waiting and give way to let me cross’

Image scenario	Out of side road		Into side road (left)		Into side road (right)		Out of side road		Into side road (left)		Into side road (right)	
	Left to right		Left to right		Left to right		Right to left		Right to left		Right to left	
Pedestrian movement	NPZC	NC	NPZC	NC	NPZC	NC	NPZC	NC	NPZC	NC	NPZC	NC
Normal process/ always done this	7	1	11	0	10	4	8	4	2	2	6	4
Driver might not see me	9	2	6	1	5	2	8	0	9	2	13	2
Marked crossing; pedestrians have right of way	5	0	8	0	10	0	8	0	9	0	12	0

NPZC: Non-prescribed zebra crossing
NC: No crossing

Wait for safe gap in traffic

With no crossing present, the most common option selected was “I would wait on the pavement for a safe gap in the traffic before starting to cross”. When asked to explain their reason for selecting this option, most of the participants said it was the safe thing to do or that they always check the road and wait to cross. Some also added that it would depend on the traffic and whether it seemed safe to cross. Others said that because there was no formal crossing point, they would expect cars to have priority and so, would normally wait for traffic before crossing safely (comments shown in Table 13). Below are examples of the responses:

“I would stay on the pavement so the driver can see I am not crossing straight away and so the driver can see better into the junction”

“The driver may not have seen me so I would give way to the car and cross after it has turned - providing there was no more traffic”

“I would always wait for a safe gap in traffic in all directions. I would stand on the kerb but be mindful not to block the view of those wishing to pull out of the junction”

Table 13: Reasons for selecting ‘I would wait on the pavement for a safe gap in the traffic before starting to cross’

Image scenario	Out of side road		Into side road (left)		Into side road (right)		Out of side road		Into side road (left)		Into side road (right)	
	Left to right		Left to right		Left to right		Right to left		Right to left		Right to left	
Pedestrian movement	NPZC	NC	NPZC	NC	NPZC	NC	NPZC	NC	NPZC	NC	NPZC	NC
safe thing to do/ for safety	5	13	5	18	2	16	5	12	5	19	1	12
car present	2	5	5	7	4	7	0	6	5	7	3	4
driver might not see me/stop	4	4	3	3	6	3	1	7	3	10	3	6
no marked crossing	0	5	0	8	0	5	0	10	0	7	0	11
Marked crossing; I have priority	3	0	0	0	1	0	2	0	1	0	3	0

NPZC: Non-prescribed zebra crossing
 NC: No crossing

3.2.2.3 Recognition of features in images

Participants were asked which of the following features they saw in each image: traffic lights, Belisha beacons, pedestrian crossing, STOP sign, GIVE WAY sign, "Men at Work" sign and SLOW writing. Each option was presented with an image of the feature along with the words. With the exception of the pedestrian crossing (see Figure 10), none of these features were present in the image and participants did not identify seeing them.

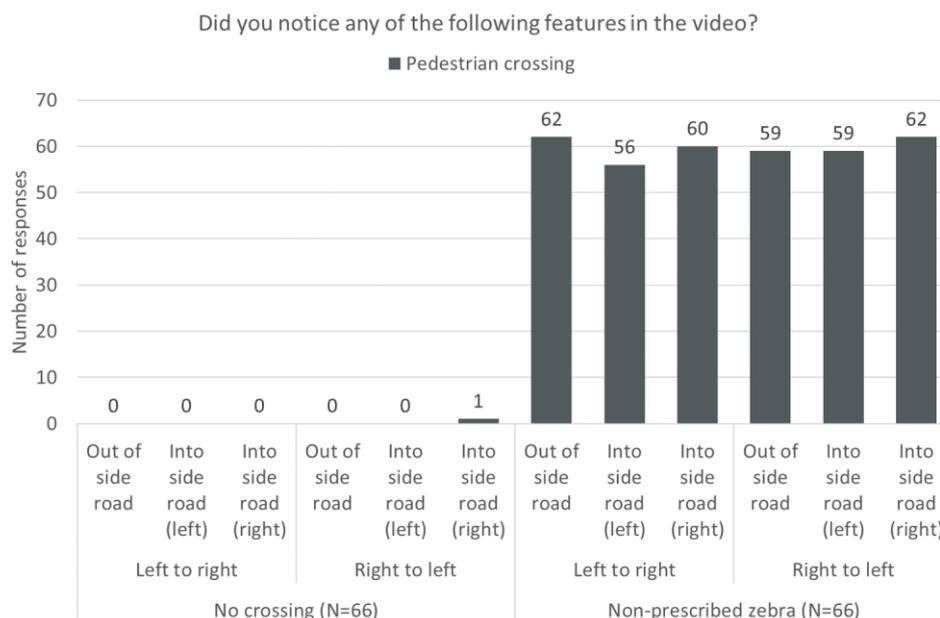


Figure 10: Pedestrian crossing identified in each scenario (pedestrians)

In the six scenarios with a non-prescribed zebra crossing, the majority of participants (between 85% and 94% of 66) reported seeing a pedestrian crossing. It is not known why there are some participants who did not report seeing a pedestrian crossing. From responses to other open-ended questions by the same participant, it is possible that these participants did not identify the non-prescribed zebra crossing as a pedestrian crossing because it was unfamiliar to them. These participants said that the crossing shown caused confusion and made them feel unclear about priority.

3.2.2.4 Perceived level of safety

On a scale from 1 to 5, pedestrians were asked to select how safe they perceived the junctions shown in the images to be:

- 1 - Very unsafe
- 2 - Quite unsafe
- 3 - Neither safe nor unsafe
- 4 - Quite safe
- 5 - Very safe

Figure 11 shows how safe pedestrians report they would feel if crossing at each of the junctions.

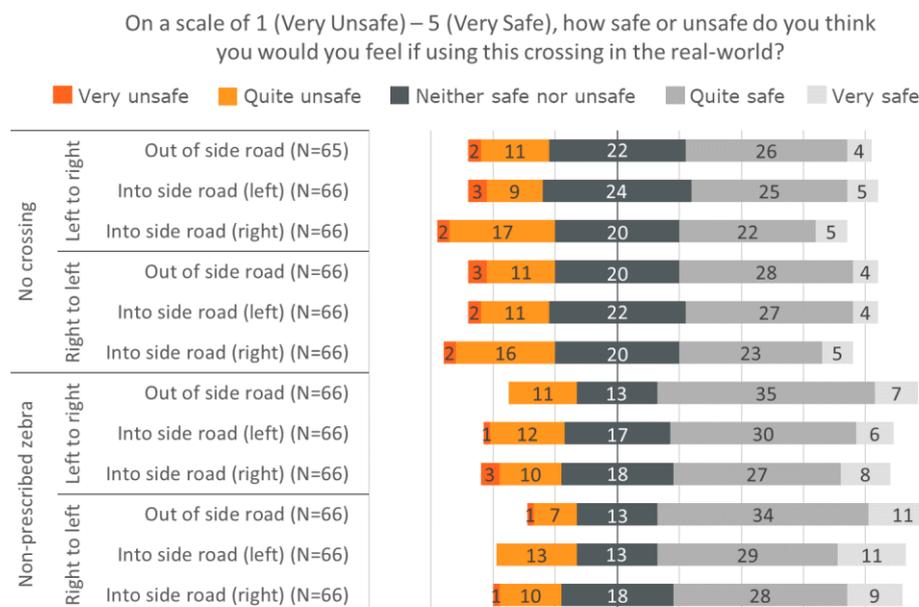


Figure 11: Reported level of safety of crossing at the junction (pedestrians)

More than half of participants (between 35 and 45 of 66) reported that they felt the non-prescribed zebra crossing was safe ('quite safe' or 'very safe'). This compares with between 27 and 32 who reported feeling safe using no crossing.

More than half of the participants reported that they felt the non-prescribed zebra crossing was safe.

Statistical tests show there was a significant difference between the responses for the 12 scenarios ($p < 0.001$). Pairwise comparisons between the 'no crossing' and 'non-prescribed zebra crossing' scenarios for each vehicle movement showed that the response was significantly different for some of the scenarios: $p = 0.032$ (significant) for 'no crossing, left to right, out of side road' compared with 'non-prescribed zebra, left to right, out of side road'; $p = 0.315$ (not significant) for the comparison between the two 'left to right, into side road (left)' scenarios; $p = 0.066$ (not significant) for the comparison between the two 'left to right, into side road (right)' scenarios; $p = 0.001$ (significant) for the comparison between the two 'right to left, out of side road' scenarios; $p = 0.019$ (significant) for the comparison between the two 'right to left, into side road (left)' scenarios and $p = 0.016$ (significant) for the comparison between the two 'right to left, into side road (right)' scenarios.

Pedestrians felt safer when shown a junction with a non-prescribed zebra crossing compared to a junction with no crossing.

3.2.2.5 Reasons for perceived level of safety

When asked to explain the reason behind their choices, the most common explanation for perceiving the junction with no crossing to be safe ('quite safe' or 'very safe') was that participants felt it looked safe enough or not too busy. Table 14 shows comments from

participants who perceived the junction to be quite safe or very safe. Below are examples of participants responses.

“Not busy junction and clear lines of sight”

“I would need to keep my wits about me but I could cross when it was safe to do so”

“Doesn’t look like a busy road”

Table 14: Reasons for pedestrians perceiving the junction to be safe³

Image scenario	Out of side road		Into side road (left)		Into side road (right)		Out of side road		Into side road (left)		Into side road (right)	
	Left to right		Left to right		Left to right		Right to left		Right to left		Right to left	
Pedestrian movement	NPZC	NC	NPZC	NC	NPZC	NC	NPZC	NC	NPZC	NC	NPZC	NC
Not busy; looks safe	7	13	5	16	9	10	8	12	10	8	4	7
Depends on situation; looks safe here	12	4	7	7	4	6	3	4	5	12	6	7
Marked crossing; clear priority	7	0	5	0	5	0	11	0	6	0	14	0

NPZC: Non-prescribed zebra crossing
NC: No crossing

Some participants perceived the junction with no crossing to be unsafe (‘quite unsafe’ or ‘very unsafe’) and said they were unsure if a driver would be able to see a pedestrian. Others said the lack of crossing made it feel unsafe shown in Table 15. Below are examples of their responses:

“Car coming round of main road could hit pedestrian.”

“drivers may not see you”

“Car will concentrate on the road”

“No indication this is a safe crossing position”

Table 15: Reasons for pedestrians perceiving the junction to be unsafe⁴

Image scenario	Out of side road		Into side road (left)		Into side road (right)		Out of side road		Into side road (left)		Into side road (right)	
	Pedestrian movement		Left to right		Left to right		Left to right		Right to left		Right to left	
	NPZC	NC	NPZC	NC	NPZC	NC	NPZC	NC	NPZC	NC	NPZC	NC
No designated crossing	0	3	0	2	0	2	0	4	0	1	0	3
Concerns that driver may not see me/stop	0	3	0	1	0	6	0	2	0	1	0	5
Concerns that driver may not be aware of crossing	0	0	3	0	6	0	3	0	3	0	6	0
Too close to junction, having to look 3 ways for traffic	6	0	3	2	6	2	4	0	8	4	3	0

NPZC: Non-prescribed zebra crossing
NC: No crossing

Participants who perceived the non-prescribed zebra crossing to be safe ('quite safe' or 'very safe') frequently said it was due to the presence of a marked crossing that made priority clear. Other responses included clear visibility of the traffic as shown in Table 14 above. Below are examples of their responses:

"It has a pedestrian crossing."

"Generally would be fine with crossing like this, unless roads nearby are really busy"

"Theres a crossing which at least will indicate that pedestrians will be crossing here"

"The crossing roadmarkings should alert the driver to look out for pedestrians"

Participants who perceived the junction with no crossing to be unsafe ('quite unsafe' or 'very unsafe') commented that they would be concerned that they would not be seen by a driver or would have to scan in 3 directions to check for traffic. Some participants were also concerned that a driver would not be aware of the crossing at that location (Table 15). Below are examples of participant responses:

"It's on a junction and drivers will be distracted already. "

"I would not expect drivers to be aware of immediately turning into a pedestrian right of way"

"Multiple directions traffic could come from"

"Due to it being so close to the junction it would cause danger"

3.2.2.6 Design of Junction

Participants were asked if they would like to see any changes to the design of the crossing to improve safety. Figure 12 shows how pedestrians responded.

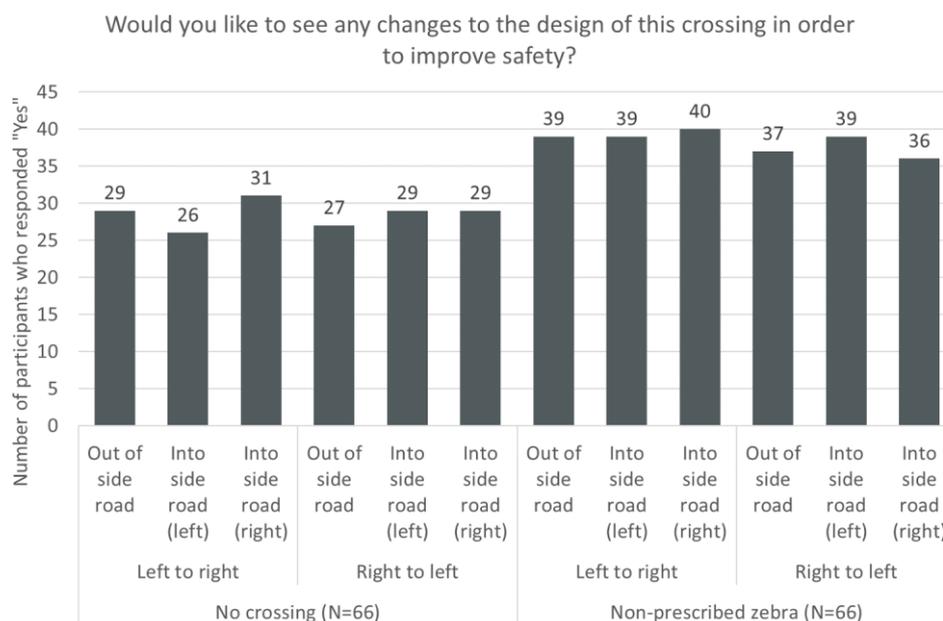


Figure 12: Number of participants reporting that they would like to see changes to the design of the crossing to improve safety (pedestrians)

Over half of the pedestrian sample (between 36 and 40 out of 66 participants) wanted to see changes to the non-prescribed zebra crossing scenarios, but this figure was significantly lower (between 27 and 31 participants) for the no crossing scenario ($p < 0.001$). Pairwise comparisons between the 'no crossing' and 'non-prescribed zebra crossing' scenarios for each of the six pedestrian and vehicle movement combinations show that the 'left to right, into the side road (left)' comparison was the only significant difference ($p = 0.015$).

Recommendations for improving layout

Pedestrians, who answered that they would like to see improvements to the design of the junction, were asked to provide detail on what improvements they would like to see implemented.

When presented with a junction with no crossing the most common suggestion for improving the junction was to implement changes that would result in a prescribed pedestrian crossing (although the differences between prescribed and non-prescribed were not specifically commented on). Some pedestrians said it should be a signal-controlled crossing if it was to be at the junction (Table 16). Other suggestions were about including light to improve visibility, adding warning signs, and adding yellow markings and/or refuge island.

For images with a non-prescribed zebra crossing, the most common suggestion was to move the crossing away from the junction and to add signage or road markings to warn drivers

about upcoming or potential crossing point (suggestions shown in Table 16). Suggestions included Give Way, pedestrian, or speed limit signage and SLOW markings on the road. Some also suggested adding more lights for better visibility in the dark and bad weather. The next most common suggestion was to add Belisha beacon lights on the zebra crossing to increase visibility of the crossing and to serve as a warning sign for drivers. Other suggestions were about including lights for better visibility.

Table 16: Suggestions for improving junction

Image scenario	Out of side road		Into side road (left)		Into side road (right)		Out of side road		Into side road (left)		Into side road (right)	
	Pedestrian movement		Left to right		Left to right		Left to right		Right to left		Right to left	
	NPZC	NC	NPZC	NC	NPZC	NC	NPZC	NC	NPZC	NC	NPZC	NC
Add pedestrian or zebra crossing	0	11	0	14	0	12	0	13	0	13	0	15
Add pedestrian crossing further away from junction	0	2	0	6	0	3	0	1	0	3	0	3
Move crossing further away from junction	14	0	11	0	15	0	13	0	15	0	11	0
Add warning signs or markings	10	4	9	3	8	5	10	6	9	6	10	4
Add Belisha beacons	10	0	11	0	7	0	11	0	7	0	10	0
Add lights	5	6	4	4	4	6	2	3	5	0	3	4
Pelican crossing or controlled lights	4	3	4	3	6	3	8	4	2	2	3	4

NPZC: Non-prescribed zebra crossing
 NC: No crossing

Over half of the pedestrian sample recommended making improvements to the layout of a non-prescribed zebra crossing, including adding Belisha beacons, traffic lights or signage.

4 Limitations

When looking at the results of this study it is also important to understand any possible limitations and their potential impact of the outcome of the report. All participants were presented with scenarios that had minimal traffic in full day light conditions. Participants were only required to attend to one vehicle in the environment. In a real-life scenario, it is likely that there may be more traffic during certain times of the day. Poor weather conditions could also greatly impact visibility. These situations add risk to both driver and pedestrian safety. In the scenarios presented, participants noted that trees, buildings, and other infrastructure were not obstructing their view. In both the images and the videos, the field of view was limited. Although the scene presented to participants gave them an understanding of the environments and road layout, it did not allow them to adjust their field of view. In the real road environment both drivers and pedestrians would be able to adjust their head and body position to gain a far greater field of view.

Another limitation of the results gathered is that large proportion of pedestrian respondents also had a driver's licence. This could have influenced their suggestions on how to improve the design with the knowledge of how a driver might approach the junction.

In summary, constraints imposed by this study include;

- Traffic – An increase in traffic levels in these scenarios could affect visibility of both pedestrians and drivers. Many driver respondents expressed concerns about holding up other road users when turning into a side road. In the survey no scenarios were shown when there was following traffic.
- Weather conditions – The videos and images represent a junction in day light conditions with good visibility. In adverse weather conditions or low lighting levels/night-time, the visibility at the junction would be greatly impacted. This was a concern that was raised by some participants.
- Field of view – the videos / images shown in the questionnaire have a limited field of view. Drivers and pedestrians would be able to gain a greater field of view by moving their head, body and eyes. A greater field of view would provide the driver or pedestrian with a greater understanding of the environment around them, giving them more situational awareness.
- Sample size – 111 participants responded to the driver questionnaire and 66 responded to the pedestrian questionnaire. Some participants who responded to the questionnaire from the perspective of a pedestrian, were also car drivers. There is a chance that they may have considered the junction from both perspectives rather than only from a pedestrian's perspective.
- Visibility – when developing the videos / images for the questionnaire, infrastructure was kept to a minimum to ensure maximum visibility of the junction. A real on-road scenario may have obscuration caused by road infrastructure / planting / buildings / parked vehicles etc.

5 Conclusion

The purpose of this study was to explore public understanding of the meaning and purpose of non-prescribed side road zebra crossing, in comparison with a side road with no formal crossing provision, with the aim of understanding perceptions of priority and safety. An online questionnaire was used with respondents answering questions around their perceptions of priority and anticipated behaviour in response to a series of either simulated videos from a driver's perspective or still images from a pedestrian's perspective. A sample of 111 responded to the driver questionnaire and 66 to the version for pedestrians. Responses were categorised by the turning movement of the vehicle- into or out of the side road; left or right. Respondents were asked to imagine they were faced with the junction presented and select what they would do next from a list of options that would be influenced by their perception of risk and who had priority.

5.1 Summary of driver responses

When presented with the videos of the non-prescribed zebra crossing, over 60% of the sample of drivers selected the option that they would 'look out for pedestrians waiting on the pavement or starting to cross and slow down or stop to let them cross'. However, with no crossing less than half would do so. Willingness to give way was strongly affected by turning movement- 47% for vehicles leaving the side-road but 27% when turning left and 29% when turning right. The difference was statistically significant and shows that the presence of the non-prescribed zebra crossing greatly improves willingness to let pedestrians cross.

Respondents were asked to comment on their reasons for their responses:

Of those drivers who said they would "look out for pedestrians waiting on the pavement" at a non-prescribed zebra crossing, between 12 and 17 (11% - 15%) participants referred to a pedestrian being visible and between 7 and 10 participants (6% - 9%) said that pedestrians had right of way. When there was no crossing present, comments were more likely to refer to the situation rather than priority per se- for example that they could see pedestrians and considered the risk if they started to cross.

For those that would 'slow down or stop for pedestrians that have started to cross', but not for pedestrians waiting on the pavement, when a non-prescribed crossing was present comments referred to pedestrians having priority on the crossing but only if they were already in the road. Some linked their decision to whether there were cars following them. With no crossing, comments were more likely to refer to drivers having priority and to the risk from following vehicles. Comments were also linked to the turning movement of the vehicle, with drivers turning into the side-road most likely to comment on following vehicles, especially with no crossing.

When presented with a list of features that might be expected to occur in the highway environment, a large majority of drivers identified the non-prescribed crossing as a 'pedestrian crossing'. Identification was affected by turning movement over 95% of the time for drivers turning out of the side-road, or turning left into it; however, when turning right into the junction identification fell to 72%. This is consistent with drivers' responses when asked about how easy it was to identify the crossing. When the vehicle was coming out of the side road, 81% of the sample of drivers reported that the pedestrian crossing was

easy or very easy to identify. When the vehicle was pulling into the side road this figure was lower: 59% for a left-hand turn and 33% for a right-hand turn.

When asked how safe they considered the presented situation to be, perceived safety was lower for the non-prescribed crossing than for no crossing. Compared with no crossing, fewer participants reported that they felt the non-prescribed zebra crossing was safe ('quite safe' or 'very safe') and more reported this crossing was unsafe ('very unsafe' or 'quite unsafe'). Consistent with the reported ease of identifying the crossing, the difference was most extreme for the right-hand turn into the side road with 60% of the sample reporting that the non-prescribed zebra crossing was unsafe, compared to just 30% for no crossing.

For no crossing, the comments of participants that considered it to be safe suggest that they approached it as a regular junction that they would typically encounter on a daily basis. Some stated that pedestrians do not have the right of way and there were some that did not expect pedestrians to be crossing at that junction. Participants who had selected the unsafe options referred to a lack of warning signs. Some noted that if it was a busy junction, then a formal crossing point should be installed.

For the non-prescribed crossing, responses considering the situation to be safe were more likely to apply to turning out of the side road than turning in, and comments referred to clear visibility, and that this was like any other zebra crossing. Those who selected the unsafe options commented about the proximity of the crossing to the junction and the risk from following drivers and/or holding up traffic behind them. Participants also reported poor visibility of the zebra crossing when turning into the side road from the main road.

Respondents were asked if they would like to see changes to the junction. With no-crossing scenarios over one-third (37%) of the drivers wanted to see changes but this figure was significantly higher (between 58% and 68%) for the non-prescribed zebra crossing.

For the 'no crossing' junction, the majority of the participants suggested improving the layout by adding a pedestrian crossing, with references to zebra crossings and Belisha beacons. The second most common suggestion was to add signs or road markings to warn drivers about pedestrians crossing, "Give Way" or speed limit signs and SLOW markings on the road.

In scenarios with the non-prescribed zebra crossing, the two most common responses for improving the junction layout were adding warning signs or road markings and moving the crossing away from the junction. Other suggestions included adding Belisha beacons, adding in a refuge island in the middle of the road, changing it to controlled lights, or to remove the designated crossing entirely.

5.2 Summary of pedestrian responses

When presented with the images of the non-prescribed zebra crossing, over half of the sample of pedestrians (ranging from 33 to 43 participants out of 66) selected the response that they would 'stand just before the kerb so that drivers will see them waiting and give way to let them cross'. With no crossing only between 6 and 10 participants did so. The highest proportion giving this response was for situations with the vehicle turning out of the side road. This is a very large, statistically significant, increase in the proportion of pedestrians expecting drivers to give way. For the no crossing scenarios, it was

more common for pedestrians to select the option that ‘they would wait on the pavement for a safe gap in the traffic before starting to cross’. Only a small proportion of participants chose the option to look for somewhere else to cross – between 3 and 6 participants (4% - 9%) selected that they would look to cross somewhere else when presented with a junction with no crossing. The proportion was lower with the non-prescribed crossing – with only 1 or 2 participants selecting this option. With a non-prescribed zebra crossing most participants referred to a marked crossing and that they would expect to have priority. Some also commented that they would be concerned that drivers may not see them or stop in time, hence, they wanted to ensure the driver has seen and/or acknowledged them before stepping onto the crossing.

With no crossing, most of the comments referred to safety or that they always check road and wait to cross. Some commented that it would depend on the traffic. Some stated that they would expect cars to have priority and so, would normally wait for traffic before crossing safely.

When asked to identify features in the presented scenes, with a non-prescribed zebra crossing, nearly all the participants (between 85% and 94% of 66) reported seeing a pedestrian crossing. From responses to other questions by the participants that did not identify it as a pedestrian crossing, it is possible that this was because it was unfamiliar to them: these participants said that the crossing shown caused confusion and made them feel unclear about priority.

When asked about how safe they found the junction, there was a statistically significant difference in the proportion reporting that they felt safe; with more than half of pedestrians feeling safe with the non-prescribed crossing compared with less.

With no crossing, participants responding that it was safe referred it looking safe enough or not being busy; while comments by those who considered it to be unsafe referred to a lack of a designated crossing and the risk that drivers wouldn’t see or notice them.

With the non-prescribed crossing, participants considering it be safe commented on the presence of a crossing that gave them priority and alerted drivers to look out for pedestrians. Those that considered it to be unsafe were concerned that they would not be seen by a driver or would have to scan in 3 directions to check for traffic. Some participants were also concerned that a driver would not be aware of the crossing at that location.

Over half of the pedestrian sample (between 36 and 40 out of 66 participants) wanted to see changes to the non-prescribed zebra crossing scenarios, but this figure was significantly lower (between 27 and 31 participants) for the no crossing scenario. Of those who responded “yes”, with no crossing, the most common suggestions were to move the crossing further from the junction, adding Belisha beacons, or that it should be a signal-controlled crossing. Other suggestions were about including light to improve visibility, adding warning signs, and adding yellow markings and/or refuge island.

5.3 Implications

The presence of non-prescribed zebra crossing was recognised by both drivers and pedestrians as a crossing and both groups acknowledged that pedestrians have priority on the road in those instances. Drivers were more likely to give way to pedestrians seen waiting

on the pavement and pedestrians were more likely to assert their priority by positioning themselves where they can be seen by drivers. However, the two groups of participants differ in many respects. While the pedestrians found the non-prescribed crossing to be safer, the drivers considered it to be less safe.

For drivers, perceived safety and willingness to give way varied considerably with the turning movement of the vehicle: both being lowest for right turns into the side road. Drivers feeling unsafe commonly expressed concerns about obstructing traffic on the main road and their visibility of the crossing.

For pedestrians, participants that considered the non-prescribed crossing to be safe commented on the crossing alerting drivers to their presence, while those that considered it to be unsafe were concerned that drivers might not be expecting a crossing at that location.

When considering the implications of these responses it is important to note that the images shown to both groups of participants are drawn from the perspective of a fixed point of view. This means that concerns about sightlines are likely to be over-emphasised, because in practice people can move their head positions to improve their view into a side-road. The higher level of perceived risk by drivers could result in them giving more attention to the presence of pedestrians, or driving more slowly, so could result in overall safer behaviour. Nonetheless, the numerous comments suggesting concerns about obstructing following traffic, and the risk of collision it would present to them, could lead to drivers feeling pressured not to give priority to waiting pedestrians.

When asked for suggestions to improve the non-prescribed zebra crossing, the two most common suggestions by both drivers and pedestrians were adding signs or road markings to warn drivers and moving the crossing away from the junction. Some suggested adding Belisha beacons, which would effectively create a prescribed Zebra crossing in the middle of the link, which is already permitted. Such comments may reflect the participants' unfamiliarity with zebra crossings at side road junctions, leading to suggestions that are consistent with what people are more familiar with. It should also be noted that only a small minority of pedestrians said that they would look for somewhere else to cross.

The analysis presented in this report forms an important part of the research into side road zebra crossings but should not be considered in isolation. It is one step in a programme of research that will culminate in on-street trials. Each research project informs the design of the following ones which helps to ensure that risks are understood and managed.

The risks can only be fully assessed from trials; however a precautionary conclusion from this study would be to conduct trials initially in locations where traffic speeds and flows on the main carriageway are already relatively low, to minimise the risks, perceived or otherwise, of following traffic. It should be noted that the sites currently under consideration for the on-street trials have quite low traffic flows and would meet this requirement. This study also highlights the importance of turning movement as a factor in drivers' perception of risk and willingness to give way. The proposed on-street trials will analyse video observations of crossing events classified by turning movement, so will enable this to be investigated further using real-world data.

Appendix A Online questionnaire

A.1 Driver's perspective

You will now be shown a short video. Please view it once and answer the following questions below it.⁵

<video presentation>

1. Imagine you were faced with the situation presented to you in the video. As a driver, what would you do as you approach the junction

- I would proceed to turn into the main road if the way is clear.
- I would look out for pedestrians waiting on the pavement or starting to cross and slow down or stop to let them cross
- I would slow down or stop for pedestrians that have started to cross, but not if they are waiting on the pavement
- Not sure

Please explain the reasons for your answer:

2. Did you notice any of the following features in the video?



Pedestrian crossing

⁵ Participants were shown six different videos in randomised order. Questions 1 to 4 were repeated for all six videos. Question 5 was only asked when the video presented had a non-prescribed crossing in it.



STOP sign



Belisha beacons



SLOW writing



Traffic lights



"Men at Work" sign



GIVE WAY sign

None of the above

Other (please specify):

3. On a scale of 1 (Very Unsafe) – 5 (Very Safe), how safe or unsafe do you think this junction is?

1 – Very unsafe

2 – Quite unsafe

3 – Neither safe nor unsafe

4 – Quite safe

5 – Very safe

Not sure

Please give reason for your answer:

4. Would you like to see any changes to the design of this junction in order to improve safety?

Yes

No

If yes, please describe the changes you would like to see in order to improve safety:

5. How would you rate the visibility of the pedestrian crossing shown in the video you have just viewed?

- Very difficult to identify when approaching in a vehicle
- Difficult to identify when approaching in a vehicle
- Not sure
- Easy to identify when approaching in a vehicle
- Very easy to identify when approaching in a vehicle

A.2 Pedestrian's perspective



1. Imagine you are faced with the situation presented in the image above. In order to cross to the other side of the side road, which of the following would you do?⁶

- I would wait on the pavement for a safe gap in the traffic before starting to cross
- I would stand just before the kerb so that drivers will see me waiting and give way to let me cross
- I would step onto the edge of the road so that drivers will see me starting to cross so that they and give way to let me cross
- I would go somewhere else to cross the road
- Not sure

Please explain the reasons for your answer:

2. Did you notice any of the following features in the image?



Pedestrian crossing



GIVE WAY sign

⁶ Participants were shown 12 different images in randomised order. Questions 1 to 4 were repeated for all 12 images.



SLOW writing



Traffic lights



Belisha beacons



STOP sign



"Men at Work" sign

None of the above

Other (please state):

3. On a scale of 1 (Very Unsafe) – 5 (Very Safe), how safe or unsafe do you think you would you feel if crossing at this junction in the real-world?

1 – Very unsafe

2 – Quite unsafe

3 – Neither safe nor unsafe

4 – Quite safe

5 – Very safe

Not sure

Please explain the reasons for your answer:

4. Would you like to see any changes to the design of this junction in order to improve safety?

Yes

No

If yes, please describe the changes you would like to see in order to improve safety:

Non-prescribed zebra crossings at side roads

Technical Annex 4: Road user understanding and perceptions

Transport for Greater Manchester (TfGM) is seeking to understand how non-prescribed zebra crossing markings, positioned flush against the mouths of side roads in urban areas, can be used to provide direct but safe crossing options for pedestrians. TfGM commissioned TRL to conduct research into the proposed crossing which involves desk-based research and behavioural studies followed by on-street trials. This technical annex sets out the methodology and findings from attitudinal research into the perceptions of drivers and pedestrians, using simulated images and video representing different scenarios and turning movements.

Drivers were more willing to give way to pedestrians with the non-prescribed crossing than with no crossing; however this was affected by the direction of turning, with highest intention to give way reported when viewing images from the perspective of a driver turning out of the side road. Non-prescribed zebra crossings were significantly easier to identify when shown from the perspective of drivers turning out of the side-road than turning into it. Drivers had more safety concerns about junctions with a non-prescribed zebra crossing than those without a crossing. Safety concerns were highest when viewed from the perspective of drivers making right-hand turns into the side road. Pedestrians felt safer when shown a junction with a non-prescribed zebra crossing compared to a junction with no crossing.

Titles in this subject area

PPR1003	Non-prescribed zebra crossings at side roads. Final Report. Jones M., Matyas M. and Jenkins D. 2021
PPR1004	Non-prescribed zebra crossings at side roads. Technical Annex 1: Analysis of collision records at existing sites. Hammond J. and Simms G. 2019
PPR1005	Non-prescribed zebra crossing at side roads. Technical Annex 2: User surveys at existing sites. Verwey L., Novis K., Wallbank C. and Stuttard N. 2020
PPR1006	Non-prescribed zebra crossing at side roads. Technical Annex 3: Effectiveness of alternative markings. Novis K., Hyatt T., Stuttard N. and Wallbank C. and Verwey L. 2020
PPR1007	Non-prescribed zebra crossing at side roads. Technical Annex 4: Road user perceptions and understanding. Blunden A., Gupta B., Matyas M., Mazzeo F., Wallbank C. and Wardle A. 2021
PPR1008	Non-prescribed zebra crossing at side roads. Technical Annex 5: Implications for people with disability. Blunden A., Gupta B., Verwey L., Butler, R. and Wallbank C. 2021
PPR1009	Non-prescribed zebra crossing at side roads. Technical Annex 6: Driver simulator trials. Jenkins D., Ramnath R., Stuttard N. and Chowdhury S. 2021
PPR1010	Non-prescribed zebra crossing at side roads. Technical Annex 7: Observations of conflict and giving-way during on street trials. Greenshields S., Ognissanto F., Lee R. and Macgregor E. 2021

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