Evaluation of the effects of rebuilt bicycle paths at intersections on arterial streets in Lund
– a case study.

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Abstract

The safety of cyclists at intersections is tried to be improved by new construction types of cycle crossings. These crossings are elevated and red-grey coloured. Cyclists' safety is evaluated by literature studies, accident analysis and observational studies such as speed measurements, behaviour studies, conflict studies and interviews. The field observations take place at two pairs of junctions –each pair consisting of one rebuilt and one control junction. The results are speed reductions of cars and a higher number of priority getting cyclists at rebuilt junctions. Moreover, an unconscious interpretation of the reconstructed crossings by cyclists' having priority and a lack of knowledge concerning the right of way regulations are assumed. The final conclusion is that the total safety seems to be unchanged at both construction types. However, the components of safety differ as there seem to exist more self-confident cyclists and more defensive drivers at the reconstructed junctions. A suggestion of improvement is to create indicators for cyclists like traffic signs. Herewith it might be simplified to recognize the right of way regulation for these road users especially at rebuilt junctions.

Keywords: cycle crossing, elevation / hump, red and grey coloured, intersection, traffic safety, Lund

1 Background

Safety is an important issue when dealing with the design of the traffic environment. Vision Zero in Sweden (Persson, 2004) aims to achieve no killed road users in a long-term and in a short-term period having 50% less killed road users in 2007 than in 1996. Moreover, the municipality of Lund tries to convince drivers to become cyclists. An increased number of cyclists and a decreased number of drivers shall lead to less carbon dioxide emission. In order to convince drivers to change from car to cycle the quality and comfort of cycle traffic must be improved. That is why Lunds Agenda 21 respectively Cykelkommunen Lund (Lunds Agenda 21, 1997 and Lunds program för ekologiskt hållbar utveckling, 2005) deals -relating to the design of cycle paths- with new and better cycle paths, more safety at junctions and better lightning conditions along the paths. However, new constructions should be evaluated in order to find advantages and disadvantages as well as possible recommendations. Therefore the traffic safety of cyclists is researched at rebuilt cycle crossings.

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Whereas the first reconstructed crossings were just grey and consisted of asphalt Lund's municipality designed red-grey crossings made of several surfaces in order to create more clearness in 1997. Today there are about 110 reconstructed red-grey coloured cycle crossings. Since not all are placed in junctions the municipality named 71 rebuilt junctions for this investigation. Further, the municipality gave a set of 15 junctions, which will be rebuilt.

The non-rebuilt junctions have combined crossings for cyclists and pedestrians. Here, the crossing of pedestrians is organized with a zebra. The bicycle crossing has borders of white squared markings on one side and zebra markings on other side. Itself it is not marked in any colour.

The reconstructed cycle crossings consist of three parts. These are two ramps and one even part for cyclists and pedestrians. The specific design variants depend on the characteristics of each location. Therefore the given measurements in Figure 1 are only orientation values. The even part of a rebuilt crossing is always made of clinker. Here, the part for cyclists is covered by red coloured stones. The part for pedestrians is grey. The ramps consist sometimes of the same grey clinker like the pedestrian part but sometimes they are made of natural stone cobbles. The orientation of the clinker in the grey parts is mostly vertical to the kerbstone while the red stones orientation varies between parallel and vertical to the kerbstone. According to the road width these cycle crossings are sometimes combined with refuges. Their placing is variable depending on the location. At some junctions the reconstructed cycle crossings are combined with a guiding system for blind people by designing the entry to these crossings with special surfaces.

Further, junctions –independent from their construction type– have to be distinguished by the position of the priority giving line for drivers coming from the side street. In one case it is before the cycle crossing (A) and in another case this line is after the cycle crossing (B) (see Figure 1).

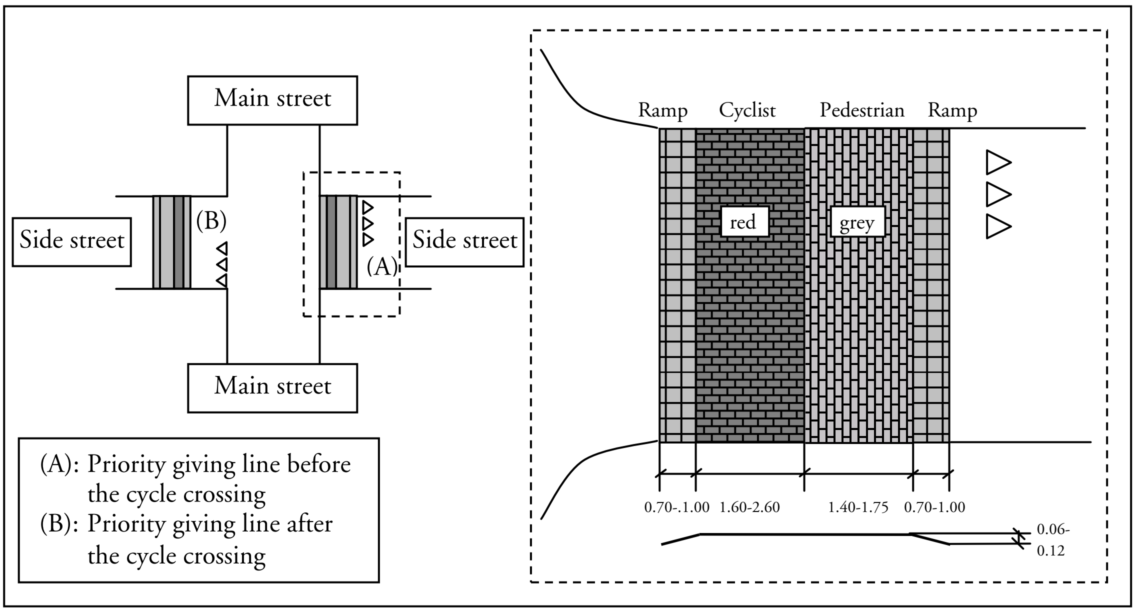


Figure 1: Characteristic elements of rebuilt crossings: elevation and red-grey colour

2 Purpose and hypotheses

The aim is to find an answer to the question: Is the traffic safety of cyclists increased by the reconstructed cycle paths? In order to answer this question six hypotheses are formulated, and tested by studying various variables observed in several studies. These hypotheses are:

1. There are less accidents and conflicts between car-drivers and cyclists at rebuilt intersections than at non-rebuilt intersections.
2. Cyclists feel safer at rebuilt intersections.
3. Priority is clearer at rebuilt than at non-rebuilt intersections.
4. Car-drivers give more often priority to cyclists at rebuilt than at non-rebuilt intersections.
5. The elevation as one characteristic aspect of the rebuilt crossing has a speed reducing effect on car-driver's behaviour.
6. Car-drivers slow more down before a rebuilt intersection than before a non-rebuilt intersection.

Afterwards the results are combined and discussed under two aspects: 1st interactions and undisturbed passages and 2nd objective and subjective safety.

3 Method

3.1 Literature study

The aim of the literature studies is to study the basic elements of cycle crossing constructions and edge conditions of influences on behaviour. It is assumed that the behaviour of a road user at an intersection is based on knowledge about traffic regulations, actual impression of a situation and former experiences. During the literature study there is a closer look at the subject of knowledge while describing the right of way regulations at bicycle crossings. Actual impressions of a situation are reflected while dealing with the characteristics of reconstructed cycle crossings which are their red colour and their elevation.

3.2 Accident Analysis

During an accident analysis it is dealt with former experiences. So, traffic safety numbers of accidents and reasons for cycle accidents during the last years are researched. The accident analysis concentrates on three levels: national via *Vägtrafikskador 2004* (2005), regional via *Olycksrapport Skåne 2004* (Ekman, 2005) and municipal via *Trafikräkningar och trafikolyckor i Lunds kommun 2004* (2004). Additionally, the research in the municipal level contains an examination of cycle accidents with STRADA (*S*wedish *TR*affic *A*ccident *D*ata *A*cquisition) at the 86 relevant intersections.

3.3 Field observations

Within the research crossings built at side streets are considered. These side streets are located at intersections with arterial streets in Lund / Sweden. Here, the field observations concentrate on four junctions in Lund. These four intersections create two pairs of junctions whereas each consists of one rebuilt and one non-rebuilt intersection. These four junctions were selected from the data pool of 86 junctions (see Background chapter). The positions of all four junctions and the locations of the two rebuilt junctions are presented in Figure 2.

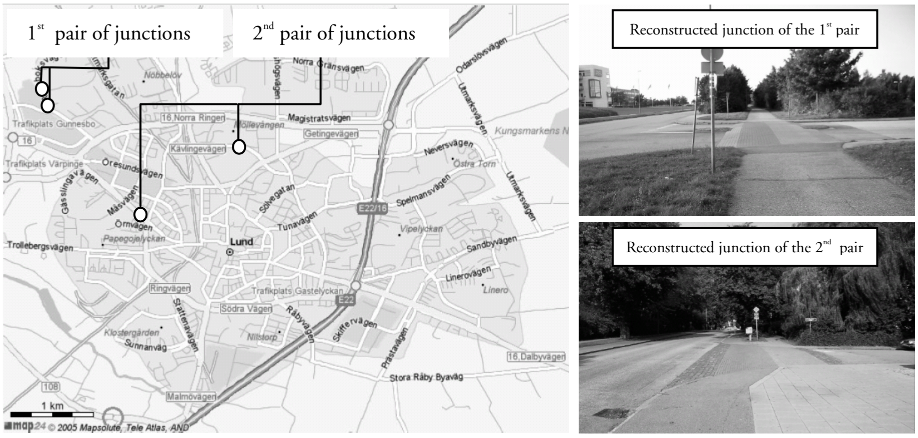


Figure 2: Location of the studied intersections

The junctions of pairs are investigated based on comparable traffic volumes, surroundings and traffic compositions as well as on similar geometries. For this purpose on-site observations and counts of traffic volumes are made. Both pairs differ from each other in the position of the priority giving line. These are signed after the cycle crossing at the junctions of the first pair and before the cycle crossing at the junctions of the second pair.

The field observations took place between 11th October 2005 and 9th November 2005 and they consist of more than 77 hours. The observations are done under daylight including dawn and dusk. The weather was always dry and sunny till overcast. The surfaces of roads and cycle paths were dry.

3.3.1 Speed measurements

The speed measurements of drivers and cyclists are carried out by the use of a mobile hand radar. These measurements are taken when road users have undisturbed passages. At each junction six motorised traffic flows are measured. The number of measured cycle traffic flows is either one or two. It depends on if there is a one-way or two-way cycle path. The measured traffic flows are categorized into four groups: 1st straight on going motorised flows on the arterial street, 2nd turning motorised flows coming from the arterial street, 3rd turning motorised flows coming from the side street and 4th cyclists on the cycle path. Vehicles are measured in each group two times except the 2nd group. First measurement is taken about 40m to 50m before the junction. The place of the second measurement depends on the flow. It is either at the beginning of the zebra or at the level of the junction for drivers or at the kerbstone for cyclists. By comparing the speed values of both distances a changing speed behaviour can be seen. The number of measured vehicles is between 30 and 148 per flow. If there are fewer than 30 vehicles measured the flows are not considered within this study.

3.3.2 Behaviour study

The behavioural study deals with situations when cyclists and drivers approach the intersection at the same time. In order to get a realistic impression of road user's behaviour no information concerning an observation is given to them before. During the observation all cyclists and car-drivers are considered independently from e.g. gender and age. Hereby, a general transferability to all cyclists and car-drivers at this junction is possible. There are 30 interactions per junction at one pair of junctions and 35 interactions per junction at the other pair observed.

The centre of interest is the handling of priority and road users' estimated speed behaviour before and while entering the junction. During the observation it is noted who gives priority including its traffic flow, a description of behaviour of both road users, the distance to the kerbstone or zebra marking when the reaction of the priority giving road user starts and finally, the estimated speed of the priority taking road user.

Threshold distances for priority giving cyclists are 4m and 10m for priority giving drivers. These values are about double as long as a standard vehicle. These distances symbolize up to which point avoiding actions take place without putting the other road user under pressure by reacting almost too late within an interaction. The estimated speeds for cyclists orientate on 15km/h and on 20km/h for drivers. The speed value for drivers refers to the characteristics of humps. By these drivers are forced to slow down to 20km/h - 25km/h. The speed value for cyclists bases on the lower level of usually cycled speeds which are between 15km/h and 20km/h (Schnabel, 1997). It is assumed to get a better speed differentiation taking 15km/h as the border line than taking 20km/h.

3.3.3 Conflict Study

In order to define the term *conflict* the Swedish Traffic Conflict Technique is taken (The Swedish Traffic Conflict Technique, 1992 and 2005). The observation of serious conflicts by the trained observer takes at least eight hours per junction. As the rate of conflicts increases with the number of road users at least five hours of observation are done during traffic peak times.

Conflicts between cyclists on the path or crossing and cars turning between the arterial street and the side street are in the focus of interest. However, all recognized conflicts concerning the observed junctions are noted –independent from kind of road user, gender, age etc..

3.3.4 Interviews

By means of standardized interviews 30 cyclists per junction of one pair are asked questions relating to the cycle crossing. In order to get a representative sample of cyclists at these junctions every cyclist is talked to. They are stopped after passing the crossing. There have not been any pre-information that these junctions are observed. Some standardized interviews were extended after the interview to an informal interview. On this occasion additional information were noted.

During this field interview five questions are asked – one open question and four questions with given answer alternatives. Additional information concerning age, gender and time are noted by the interviewer. An interview took between two and ten minutes. The interviews were made in Swedish.

The absolute majority of the interviewees are cyclists aged between 18 and 60 years (83,3%) who ride on the path in question everyday (65,0%). The distribution between male and female cyclists is about fifty-fifty.

4 Results

4.1 Findings from the literature study

It is to point out that red is a colour with a fast recognizable meaning. But the colour itself has to be used under bright lightning conditions in order to be well perceived by human eyes (Darum ist die Ampel rot, gelb, grün, 2005). Psychological effects of red are to be activating and aggressive and having a general warning effect on people (Seilnacht, 2005).

Humps are usual elements in order to force drivers to slow down –especially before crossings for non-motorized road users. These constructions are used to reduce the speed of motorised vehicles to 20-25km/h (Linderholm, 1996 and Lundberg, 2002). In this context the number of accidents decreases between 35% and 70% and consequently the traffic safety is increased by humps. However, especially if humps are combined with such crossings misunderstandings between road users might be generated (Linderholm, 1996).

The right of way regulations at cycle crossings turns out to be quite confusing. There are two aspects which have to be considered. On the one hand there is the position of the priority giving traffic signs. According to the Vägmärkesförordning (VMF) triangles on the surface are equal to the corresponding vertical triangular traffic sign at the roadside. Therefore these triangles demand drivers to give priority to all crossing vehicles (VMF, §52). So, if these signs are before the bicycle crossings drivers have to give priority to cyclists. Another aspect is that if cyclists who use a zebra crossing get off their bikes and wait at the kerbstone, they should get priority from drivers. However, a cycle crossing is not included in a zebra crossing. That is why if cyclists get off their bikes and wait at the cycle crossing they have no priority (Ahlström, 2004). Further, paragraph 3:61 in Trafikförordningen seems to be especially tricky. Here, it is written that drivers who after they turned into an intersection and are about to pass a cycle crossing have to give way to cyclists who are on the bicycle crossing or just before entering the bicycle crossing (TrF

3:61). To turn the argument on its head, drivers have priority when they are about to pass a cycle crossing located before they turn. In order to know who has to give way, cyclists have to study the intersection carefully. Here, they must check about the presence of squares and triangles on the road surface and the wherefrom cars come.

The following applies at rebuilt junctions. In the "Vägmärkesförordning" it is defined that a cycle crossing has to be marked with squares on the surface (VMF, §52). It means that if there are not such marks then there is no official cycle crossing. Here, the situation is regulated so that cyclists have to give way (TrF 2:21 and Vägverket, 2004). There are no special regulations for drivers (Vägverket, 2004).

4.2 Accidents

From the accident analysis no clear conclusions can be drawn. As a matter of fact it might be supposed that the rebuilt cycle crossings lead neither to an increased nor to a decreased number of accidents between cars and cyclists. This analysis shows that the general development of accidents in Lund follows the trends in Sweden and Skåne (Ekman, 2005 and Trafikräkningar och trafikolyckor i Lunds kommun 2004, 2004). Besides, the most common kind of cyclist accidents are single accidents and only the second most frequent reason consists of accidents between motorized vehicles and cyclists (Trafikräkningar och trafikolyckor i Lunds kommun 2004, 2004).

In STRADA numbers of accidents have been available for Skåne including Lund since 1999. In order to get a meaningful result the intersections should be checked four years before and four years after the reconstruction. By this the earliest junctions that could be checked were reconstructed in 2003. However, in this case are no four years after reconstruction available. Moreover, the year 2005 is not included in the evaluation as it is the actual year. That is why a research based on the results of the program should be done in several years again.

Table 1 presents the numbers of accidents per location where accidents between cyclists riding on the crossing and cars occurred- described in STRADA. There are relevant accidents at six of these 86 junctions. Three accidents happened before and four accidents happened after a reconstruction.

Table 1: Relevant and recorded accidents at 86 intersections in Lund

	Time before reconstruction	**Year of reconstruction**	**Time after reconstruction**
Intersection	2000-01-01 2003-12-31	2004	-
Sölvegatan / Helgonavägen	1	1	-
Thulemsvägen / Katedervägen	1	0	-
Intersection	1999-01-01 1999-12-31	2000	2001-01-01 2004-12-31
Tornavägen / Nikolovinsväg	1	0	0
Fjelievägen / Starvägen	0	0	1
Trollebergsvägen / Lärkvägen	0	0	2
Hjälmar Gullbergs väg / Fritjofsväg	0	0	1

However, it is possible to compare the descriptions of accidents' circumstances. Two accidents, which happened after the reconstruction, are described this way that the driver slowed down but then continued driving. In both cases the cyclists thought they would get priority. Two more descriptions explain that the drivers did not wait until the cyclists left the crossing. One driver touched the back wheel of a cycle.

Two accidents -which happened before the reconstructions- are described by priority taking drivers. In one case the car crashed on the bike and in the other case the cyclist crashed on the car.

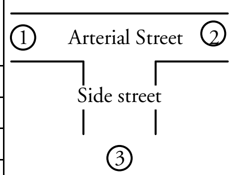
The descriptions of the two accidents left – one before the reconstruction and one in the year of reconstruction – are very unclear. Thus they are not reflected here.

4.3 Speeds

Table 2 shows the results of the speed measurements. Boxes without values reflect that there are less than 30 measurements taken. Herewith there are too few values in these flows for a scientific analysis.

Table 2: Means of speeds

	Flow	1^{st} pair of junctions		2^{nd} pair of junctions	
		Rebuilt junction	Non-rebuilt junction	Rebuilt junction	Non-rebuilt junction
		1^{st} measurement at a distance of 40m-50m / 2^{nd} measurement just before the crossing			
Group 1 (cars)	1=>2	48/48	49/47	47/49	49/49
	2=>1	52/51	52/48	49/48	50/45
Group 2 (cars)	1=>3	-/8	-/11	-	-/18
	2=>3	-	-	-/12	-/20
Group 3 (cars)	3=>1	16/8	33/19	24/7	30/15
	3=>2	-	-	26/7	29/16
Group 4 (bicycles)	1=>2	17/15	15/10	18/17	22/19
	2=>1	19/18	17/13	-	-



Group 1: Speed of straight on going motorised flows on the arterial street

The ranges of speeds and means do not differ significantly, independent if the junction is rebuilt or non-rebuilt. In detail a tendency to a bit wider ranges at reconstructed junctions than at non-reconstructed in both flows might be assumed. Moreover, the data underline a comparability of the junctions in pair.

For flow 1=>2 no clear conclusions can be drawn from the data of speed measurements. The data reflect an almost unchanged speed level at the reconstructed junction of the 1^{st} pair and at the non-reconstructed junction of the 2^{nd} pair. Furthermore, there is a tendency of retardation at the non-reconstructed junction of the 1^{st} pair and a tendency of acceleration at the rebuilt junction of the 2^{nd} pair. However, this acceleration might be caused by a nearby traffic light.

According to flow 2=>1 clear conclusions are drawn from the speed measurements. Comparing the means it becomes clear that a tendency for retardation exists at the non-rebuilt junctions. This tendency means a change of speed of 4km/h and 5km/h.

However, it has to be evaluated further how far the speed trends on the arterial streets depend on the reconstruction of the crossings or if it is a general trend in speed behaviour of drivers.

Gr*oup 2: Speed of turning motorised flows coming from the arterial street*

The available data for these flows show a clear speed reducing effect at the reconstructed junctions. There is a mean difference of 3km/h in flow 1=>3 in the 1st pair. In flow 2=>3 of the 2nd pair the means differ 8km/h. The measured driven speeds lead to the assumption that the pairs differ a lot in the general driven speeds. Therefore only the tendencies but not the total amounts of speeds and speed differences are comparable. Based on the different values of v_{85} it seems that the speeds in these flows are about 1/3 lower at rebuilt junctions than at non-rebuilt intersections. Moreover, the ranges of measured speeds at the reconstructed junctions are smaller than at the non-reconstructed intersections within each pair.

Group 3: Speed of turning motorised flows coming from the side street

From the available pool of data a retardation of speeds in both distances can be read. The means and v_{85} of the values measured just before the crossings / humps reflect that one drives at reconstructed junctions about half as fast as at non-reconstructed intersections. Mean speeds –just before the crossing– are less than 10km/h at rebuilt junctions whereas it is between 15km/h to 19km/h at non-rebuilt intersections. Moreover, the ranges are bigger at non-reconstructed junctions than at reconstructed ones – independently from the measurement points. These ranges start only at reconstructed intersections with 0km/h. So, there are some drivers who retard in order to stop at these intersections.

The dimension of retardation has a relationship with the position of the priority giving traffic signs. If these signs are after the reconstructed crossing –like at the 1st pair of junctions– the drivers slow down less compared to the non-reconstructed junction. If these signs are before the reconstructed crossing –like at the 2nd pair of junctions– drivers slow down equally to more than at the non-reconstructed junction.

Group 4: Speed of cyclists on the cycle path

At the 1st pair of junctions there are cyclists riding into two directions whereas cyclists at the 2nd pair are riding only into one direction. Therefore the cycle flow of the 2nd pair is compared to both flows at the 1st pair.

The means show a smaller retardation between both measured distances at reconstructed junctions than at non-reconstructed ones. Here, the speed differences are 1km/h and 2km/h at rebuilt and 3km/h to 5km/h at non-reconstructed junctions. Furthermore, no statement about generally higher or lower speeds at reconstructed and non-reconstructed intersections is possible. The reason is that the compared data for the 1st pair show a slower speed at the non-rebuilt intersection and for the 2nd pair a faster speed at the non-rebuilt junction compared to the belonging rebuilt intersections.

The ranges of cycle speeds at non-rebuilt junctions are –except in one case– usually not wider than at rebuilt junctions. Moreover, the comparison of the speed changes shows less retardation and more acceleration at reconstructed junctions than at non-reconstructed intersections.

4.4 Behaviour studies

The behaviour studies reflect that cyclists get more often priority at the reconstructed (about 2/3) than at non-reconstructed junctions (about 1/2) (see Table 3). Within these studies relationships between behaviour and both the position of the priority giving traffic signs and the types of construction are found. One result is that road users' behaviour during an interaction is generally determined by staying in motion as long as possible. However, this behaviour is stronger developed at rebuilt junctions. Further results are: first, priority taking cyclists cross faster during an interaction at rebuilt junctions and second, if cyclists stop before a junction they do it at non-reconstructed intersections. The third aspect is that cars stand rather on the crossing blocking the way for cyclists when the traffic sign is before the crossing.

Table 3: Priority giving and taking between cars and bicyclists

Priority taking road user	1st pair of junctions				2nd pair of junctions			
	Non-rebuilt junction		Rebuilt junction		Non-rebuilt junction		Rebuilt junction	
	[Number]	[%]	[Number]	[%]	[Number]	[%]	[Number]	[%]
Driver	14	47	10	33	17	49	9	26
Cyclist	16	53	20	67	18	51	26	74
Sum	30	100	30	100	35	100	35	100

4.5 Conflict study

Relating to the aspect of serious conflicts between cyclists and drivers no conclusion can be drawn since only two corresponding conflicts are observed. However, there are in general more serious conflicts at non-rebuilt junctions than at rebuilt ones.

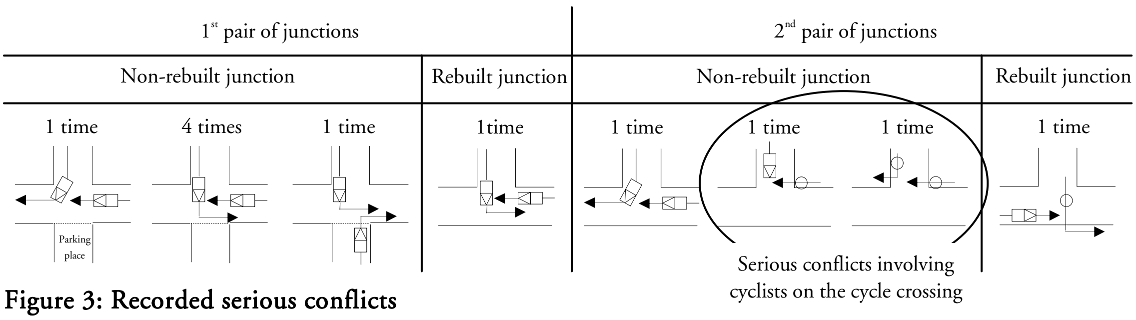


Figure 3: Recorded serious conflicts

The centre of interest are serious conflicts involving cyclists on the evaluated cycle path or on the crossing. There are eleven serious conflicts recorded (Figure 3) however, only two of these match with the centre of interest. Reasonable for such a small number of serious conflicts with cyclists might be a general rare traffic volume in side streets, a speed of cyclists less than 20km/h and crossings with a width of more than 10m. From the last two aspects follows that the Time-to-Accident-values reflect more often non-serious conflicts.

Besides both serious conflicts with cyclists took place at the non-rebuilt junction of the 2nd pair of junctions. In one case a cyclist turned right from the side street to continue on the cycle path and another cyclist –already on the cycle path– crossed the side street. Both cyclists braked and swerved around each other. The second case consists of a private car coming from the side street. While the driver braked on the zebra a cyclist swerved around the car's front.

4.6 Interviews

First interviewees were asked which colour the crossing has they passed. Correct answers relating to the colour were red at the rebuilt junction and white / grey at the non-rebuilt junction. The results show that both colours were answered at both types of junctions. However, more interviewees answered red at the rebuilt than at the non-rebuilt junction. Moreover, a higher number gave white / grey as response at the non-rebuilt junction than at the rebuilt junction. Further, half of the cyclists at the non-rebuilt and 2/3 of the cyclists at the rebuilt junction gave wrong answers or said that they had no idea (see Figure 4). So, there were more uncertainties relating to the colour at the reconstructed intersection. Moreover, it is remarkable that –independent from the type of construction– white was the most often answered colour cyclists gave after passing the crossings. Therefore it is assumed that this colour is more often unconsciously connected with a cycle crossing than other colours.

Furthermore, cyclists were asked if they thought that either cyclists or drivers had priority at the crossing. The percentage of cyclists who said they had priority is higher at the rebuilt junction than at the non-rebuilt junction. Further, about half of them thought cars had priority at non-rebuilt junctions whereas it was about a third who thought so at rebuilt junctions (compare Figure 4). Additionally, cyclists were asked why someone had priority. Here, the combination of the results of both questions concerning priority shows that cyclists have a lack of knowledge relating to the right of way regulations. In the sum the results lead to the assumption that the uncertainties relating to the handling of give way situations are bigger at the rebuilt junctions.

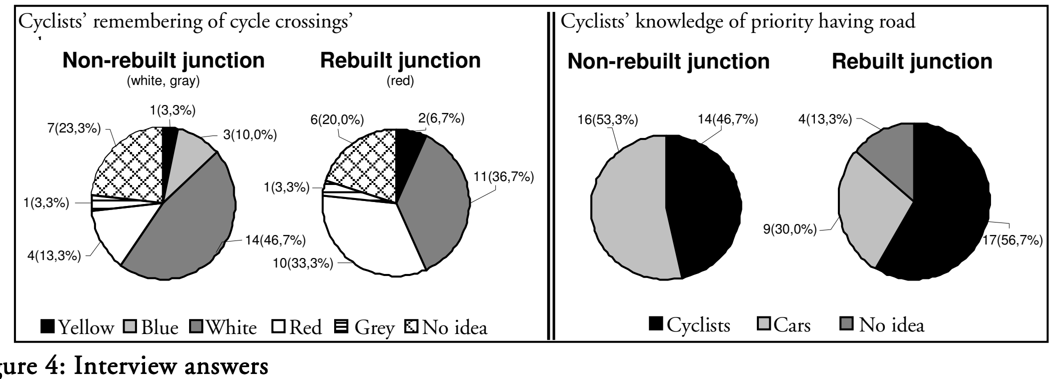


Figure 4: Interview answers

Furthermore, cyclists marked on a line how safe they felt at the junction. It is discovered that the safety feeling of cyclists does not differ at rebuilt junctions compared to non-rebuilt junctions. In general they feel rather safe than unsafe (see Figure 5).

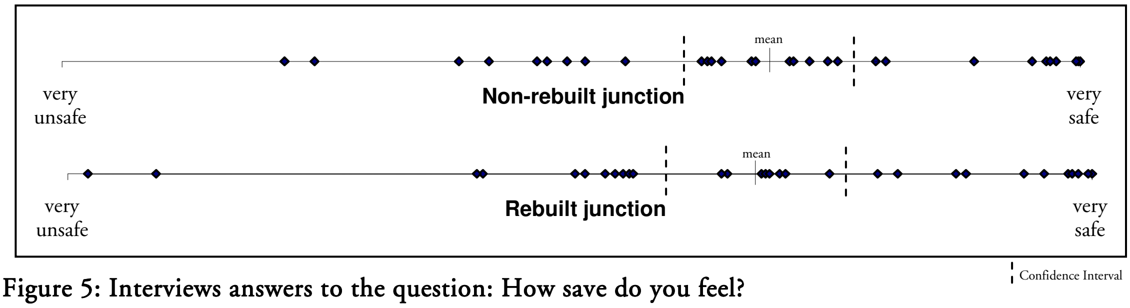


Figure 5: Interviews answers to the question: How save do you feel?

5 Discussion and conclusions

Drivers' speed behaviour while having undisturbed passages seem to depend on both the construction type of the intersection and the position of the priority giving traffic signs. Whereas the behaviour of drivers passing a cycle crossing during an interaction seems rather to depend on the position of the priority giving signs than on the construction type. Relating to cyclists' speed behaviour there is a correlation with the type of construction since they cross faster during an interaction at rebuilt junctions than at non-rebuilt junctions. Further, there are indirect relationships between the priority giving signs and cyclists' speeds since cyclists react on drivers' speed behaviour, which again depend on these signs. The assumption that cyclists' behaviour are connected to drivers' speed behaviour is also mentioned by Towliat (2003). Räsänen (2000) finds that rather cyclists see approaching cars than drivers see approaching cyclists before an accident. The problem following from this aspect is, when cyclists see drivers first and adapt their behaviour they have to interpret drivers' behaviour correctly in order to prevent serious conflicts or accidents. However, the results of the interviews and some reports from the accident analysis explain that cyclists have problems to assess from approaching drivers' behaviour whether they will give or will take priority. This happens independently from the type of construction. Räsänen (2000) found a comparable context. It contains that cyclists who had an accident with a car at a junction often gave as reason that they thought the driver would give priority.

Várhelyi (1990) did not include an influence of the position of the priority giving traffic signs to the frequency of giving way in his analysis. Towliat (2001 and 2003) shows a relationship between speed reduction of motorized traffic and frequency of giving priority to non-motorized road users. He concludes the higher the retardation of motorized vehicles the more often non-motorized road users get priority. Further, he determines that drivers give priority rather to cyclists than to pedestrians. Following this train of thoughts, Heerekop and Jacobs (2000) concluded that faster speeds of cars refer to less priority taking pedestrians. The fact that the frequency of getting priority is strongly influenced by drivers' speeds matches to the results of this study. Cyclists get priority more often at rebuilt junctions with slower car speeds than at non-rebuilt junctions.

Relating to their subjective safety cyclists answered that they would have no different feeling of rather safe than unsafe at both types of junctions. However, the analysis of cyclists behaviour refers to a contrary assumption. Basically for this is at first, that priority taking cyclists' measured speeds are higher and second, that cyclists' activities to take priority are more self-confident at rebuilt junctions. But also priority giving cyclists seem to be more self-confident since they cross more often rebuilt junctions by rolling whereas they sometimes even stop at non-rebuilt junctions.

Another aspect is that cyclists take more often priority at rebuilt junctions. The interviewees underline this examined behaviour since the number of cyclists thinking they have priority is higher at rebuilt junctions than at non-rebuilt ones. However, –independent from the construction type– the interviewees could not give any reasons why someone would have priority. Besides a lot of cyclists seem to know how to behave as a cyclist on a zebra. But nobody seems to know about the correct combination of right of way regulations on a cycle crossing. So, cyclists' behaviour and their handling of priority seem to be more self-confident at rebuilt junctions. Therefore it is supposed that they feel safer at these junctions in an unconscious way. However, this is just an assumption since the answers from the interviewees reflect an unchanged safety feeling and the uncertainties about the priority regulation are stronger developed at rebuilt junctions. Therefore more research dealing with this aspect might be helpful to prove this assumption.

Having these conclusions in one's mind it is interesting to compare them with the numbers of accidents and serious conflicts representing the level of objective safety. However, no tendencies of in- or decreasing numbers of such incidents between cyclists and drivers can be evaluated. This development might be caused by the humps forcing drivers to slow down. So, drivers might spend earlier or more attention to cyclists at reconstructed junctions. Accordingly, Towliat (2001) found that lower speeds lead to lower numbers of serious conflicts. Further, he mentions that drivers give more often priority the slower they drive. So, it seems that the stronger subjective safety of more self-confident cyclists is compensated by more defensive behaviour of drivers at rebuilt junctions. Therefore the objective safety might be on the same level at both construction types.

However, the results of Räsänen (2000) let assume that the potential of a finally decreased objective safety exists. He found that the more cyclists know that they have priority the more accidents happen. The relationship between these facts might be that these cyclists insist on their priority. The results from this study –or rather the interviews– do not reflect that cyclists know who has priority but they think more often they would have it at rebuilt junctions. So, the potential of accidents is increased at the reconstructed junctions.

Concerning the influence of red colour Räsänen (1998) found a relationship between drivers' attention to cyclists and cycle crossings in this colour. Hereby, the attention of drivers is increased by red marked cycle crossings. However, these crossings in Helsinki / Finland are not elevated. Therefore there might be other impressions of this colour to drivers –due to another view angle– at the junctions in Lund / Sweden. Though Räsänen found a relationship between drivers' behaviour and this colour while an unconscious relationship between this colour and cyclists' behaviour is discovered within the present study. But the influence of the red colour on elevated crossings on drivers' behaviour is still unsure. Besides red is a colour, which needs bright lightning conditions to be well recognized. So, if one likes to point out this colour the cycle crossings should be lighted up.

The final conclusion from this study is that the total safety of cyclists is unchanged. However, the participation in interactions change according to the kind of road user. Whereas cyclists cross more self-confident reconstructed junctions drivers behave rather defensive at these junctions compared to non-rebuilt intersections. At last the uncertainties relating to the right of way regulations by cyclists, which are combined with their thinking of having priority seem to be causal for this development.

Finally, it is concluded that these kinds of construction have potential to improve cyclists' total traffic safety. For this it might be helpful to visualize the right of way regulation –e.g. by traffic signs at the cycle paths– for approaching cyclists.

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