TOWARDS A SAFE TRAFFIC ENVIRONMENT FOR CHILDREN - A STARTING POINT

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1. INTRODUCTION

Our traffic environment is designed to fit grown-up people rather than children. According to the UN Convention about Children's Rights, what is best for the children should be the target for all governmental decisions affecting children. The Swedish National Road Administration has therefore initiated research as a base for developing guidelines "towards a safe environment for children". It should be noted that a traffic environment that is safe for a child as a vulnerable road user typically is safe for people of all ages. When designing roadways, it should be remembered that children of different ages have different needs and abilities. The very youngest may in most environments be under adult supervision, whereas preteens typically are allowed to move around freely even outside their immediate neighbourhood. These children are often shorter; and sight, hearing, intellect and understanding are not fully developed. Older teenagers may have the same ability to judge situations as adults, but their attitude is often different—they not only take higher risks, they sometimes also want to seem 'cool' and therefore do not scan before crossing or wait for adequate gaps. And obviously, they have less experience with traffic.

One of the main principles of the Swedish Vision Zero states: The level of violence that the human body can tolerate without being killed or seriously injured shall be the basic parameter in the design of the road transport system.

The following hierarchical division of roads and streets is suggested to fulfil this:

1. Through traffic route (70-km/h-road or shorter 70-road) with only grade separated crossings
2. 50/30-km/h-street or shorter 50/30-street. 30 km/h at pedestrian and cycle crossings. 40 - 50 km/h elsewhere (Main street/Urban arterial road)

3. 30-km/h-street or shorter 30-street **(**Residential Street/Wohnstrasse/Rue Residentielle)
4. Walking speed street (Woonerf)
5. Car-free areas such as pavements, footpaths, squares, cycle-tracks, cycle-lanes etc.

Above other things this means that in built-up areas the standard 50-streets are changed to 50/30-streets or 30-streets depending on if pedestrians and cyclists need to cross at certain points with specific safety features or anywhere they like along the street. The carriageway on a 50/30-street normally has two lanes for ordinary car traffic, one lane in each direction. Four lanes or more should always be avoided where there is a chance that pedestrians may cross at grade. The 50/30-street also has wide cycle-tracks and wide pedestrian pavements, affording pedestrians and bicyclists good accessibility, safety and security. An intersection between two 50/30-streets always has marked pedestrian and bicyclist crossings. These crossings are designed so that a car will not be driven through them at speeds exceeding 30 km/h. The pedestrian and cycle crossings should be designed to meet the needs of children, elderly, and disabled persons (Wramborg, 1998). Children find intersections to be appreciably more troublesome than sections of road. Therefore it is favourable for them if pedestrian crossings are located midblock rather than at intersections. However, the speeds have to be kept low in order to make the midblock crossings truly safer than those at intersections. Excellent sight conditions at these locations are also important. (Leden, 1988). However, it should be kept in mind that crosswalks at intersections may have to be provided as well if there are substantial pedestrian flows along the street. This is typically the case in older neighbourhoods where separate walkways away from the street network do not exist.

One example of a future reconstruction of a 50-street to a 50/30 street is Regementsgatan, Malmö. This project is planned to be completed in May of 2000.

At Luleå Technical University a methodology is being developed based on before and after studies of children's behaviour and safety. Places that are to be rebuilt are filmed simultaneously from different angels to capture the different road-users' behaviour. Close-up pictures of vulnerable road users as well as of car drivers, and overviews of the traffic environment.

The results from three case studies are presented here. The first and the second from Regementsgatan, Malmö, and Hultagatan, Borås, Sweden. These studies examine differences between children's, grownups' and elderly people's interactions with motor traffic at a zebra crossing. The third one compares driver behaviour in Kaiserslautern, Germany and Borås, Sweden, when children, adults and elderly people are to cross at a zebra crossing.

Different methods to analyse data are presented and discussed. For example, pros and cons with image processing and the reliability of different methods are compared.

Test site Regementsgatan, Malmö

Regementsgatan is a trunk road just outside the Malmö city centre. It carries approximately 14000 vehicles per day. The volume of traffic after reconstruction is not expected to change substantially. Scheduled bus traffic and other heavy traffic is quite frequent The number of cyclists is about 580 per day along Regementsgatan. The speed limit is 50 km/h. The width of the road is between 16 and 20 meters and it is divided into one or two traffic lanes in each direction. Parking is allowed along the road except for at the bus stops. Both sides of the road have wide pavements.

Intersection Regementsgatan – Skvadronsgatan

Three intersections were studied. However this paper focuses on the results from the intersection between Regementsgatan and Skvadronsgatan. The traffic on Skvadronsgatan is about 600 vehicles per day. The intersection has one zebra crossing on the west side of Regementsgatan, Figure 1.1. A three-meter wide refuge island divides the zebra crossing into two parts (with one-way traffic on each side of the island). There are no zebra crossings across Skvadronsgatan. Bus stops on both sides of Regementsgatan are situated just west of the intersection with Skvadronsgatan. To the south is a school named Ribergsborgsskolan.

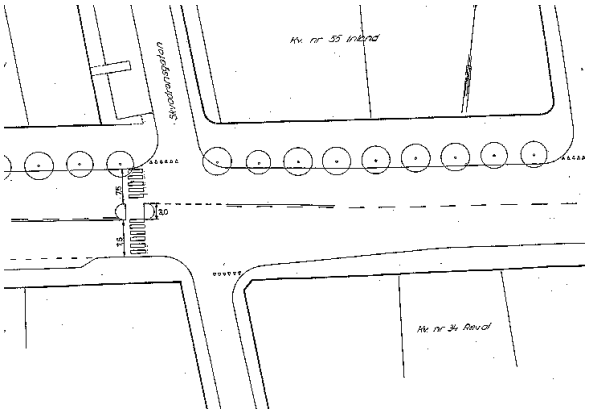


Figure 1.1. The intersection Regementsgatan – Skvadronsgatan before reconstruction.

Regementsgatan is 17.5 meters wide west of Skvadronsgatan, narrowing to 16 meters, east of Skvadronsgatan. There is only one lane in each direction, though the lane is so wide that it is possible for one motor vehicle to overtake another, especially when there are no parked vehicles. After countermeasures are implemented this will not be possible. Speed cushions will restrict the speed before the zebra crossing to approximately 30 km/h, see Figure 1.2. Skvadronsgatan is narrow, the south part is 6.5 meters wide and the north is 7.5 meters wide.

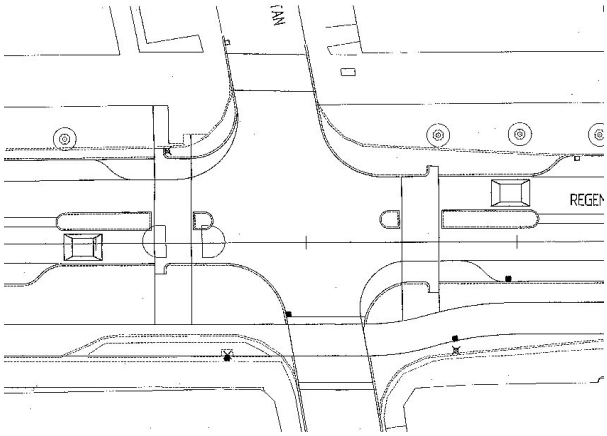


Figure 1.2. The intersection Regementsgatan – Skvadronsgatan after rebuilding

Test site Hultagatan, Borås

Hultagatan is a major street with approximately 5000 vehicles per day and about 3 km from the centre of Borås. The speed limit is 50 km/h. Both busses in scheduled traffic and traffic with other heavy vehicles exist. The width of the road is between 6 and 7 meters and it is divided into one traffic lane in each direction. See Figure 1.3. To the north of the road, above the zebra crossing, is an open park area with trees. Below the

zebra crossing is a wall next to the pavement. To the south is Hulta centre with a housing area, supermarket and a school named Ekerängskolan.

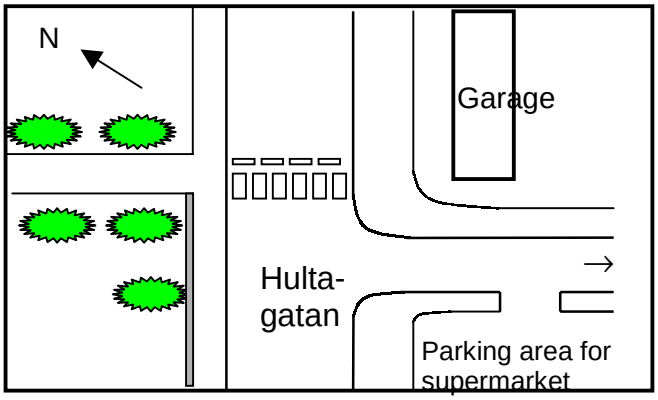


Figure 1.3.. Hultagatan, Borås.

Pedestrians and people of all ages going by bike are crossing Hultagatan at the zebra crossing on their way to Hulta centre. Another housing area is situated some hundred metres to the north in the picture. The vehicles travelling on Hultagatan are either passing trough the area or going to the Hulta housing area or Hulta centre. Especially in the afternoon, there is substantial car traffic to the supermarket.

Test site Sjöbotorggatan, Borås

The intersection chosen in Borås is a T-junction with about 300 vehicles per hour and a speed limit of 50 km/h. But it has the character of a 30 km/h-street. The right-hand-priority-rule is in force here as well as in Kaiserslautern. The zebra crossing studied is marked with a circle in Figure 1.4. This one was chosen because of several identical characteristics compared to the one chosen in Kaiserslautern, such as the school's position immediately next to the zebra crossing and the fact that the minor street is on the same side of the zebra crossing. Vehicles entering from both directions of the major street as well as from the minor street are included in the analysis.

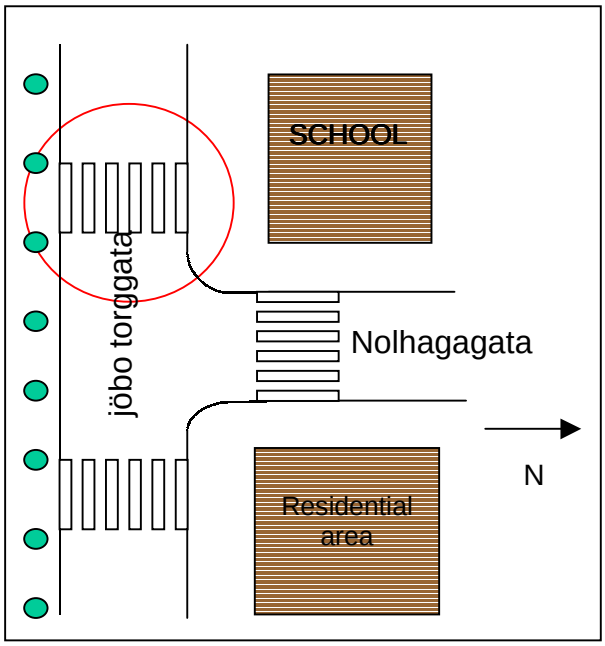


Figure 1.4. The Sjöbo torggata/Nolhagagatan-intersection in Borås used for a comparison of deceleration behaviour in Sweden and Germany.

Test site Kaiserslautern, Germany

The intersection chosen in Kaiserslautern is a four-way intersection with a speed limit of 30 km/h and with about 380 vehicles per hour. The right-hand-priority-rule is in force. The zebra crossing studied is marked with a circle in Figure 1.5. The vehicles included in this comparison drove in both directions. The vehicles coming from the minor approaches are also included, as well as all pedestrians wanting to cross the street at, or just beside the zebra crossing.

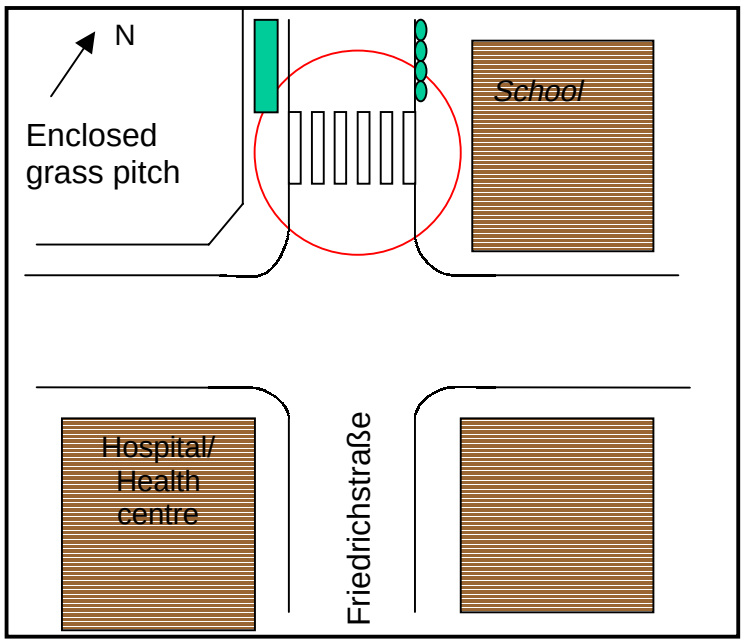


Figure 1.5. The Friedrichstraße/Augustastraße-intersection in Kaiserslautern used for a comparison of acceleration behaviour in Sweden and Germany.

2. METHOD

Video filming

The intersections are filmed with video cameras. Sony's Hi8 system is used. The advantages with these cameras are that they are light in weight and small in size. Most important is that the quality of the picture is better than conventional VHS system. When filming traffic situations it is most important that road users do not easily detect the cameras. If the road users detect the cameras it might influence their behaviour. Therefore the cameras are placed on posts and walls of the houses hopefully invisible to drivers as well as pedestrians and cyclists.

Up to five cameras are used to capture all road users' behaviour. Figure 2.1 shows the placing of the cameras at the intersection Regementsgatan- Skvadronsgatan. One camera is used for filming close ups of the pedestrians crossing and the road at the zebra crossing. Two cameras are used for overview pictures of the intersection.

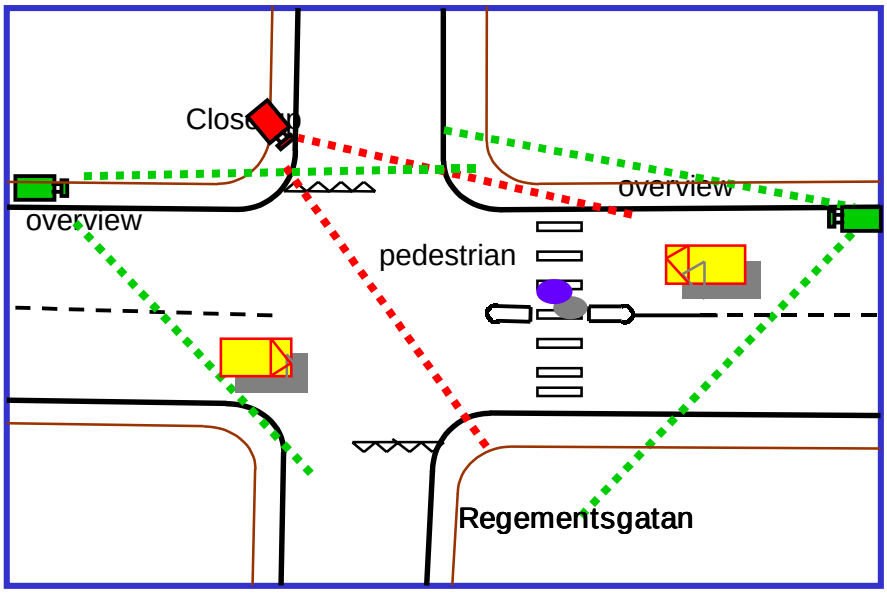


Figure 2.1. Placing of cameras.

The close-up camera captures first of all the approximate age and the gender of the pedestrians. It also captures the behaviour of the pedestrians. Examples are head movements and speed.

It is important to include vehicles coming in both directions to the intersection. That is why it is necessary to use two overview cameras. This enables us to measure the speed of the vehicles and to see whether the brake lights of the vehicles are activated. The overview cameras must be placed high, otherwise it is not possible to measure the speeds of the vehicles and get a good picture of the traffic situation.

The two cameras not yet mentioned are to capture the head movements of the car drivers that are driving into the intersection from the secondary street as well as on the main street. The pedestrian flow of children is directed to school in the morning and from school in the afternoon. Children walking in the opposite direction are not covered. The vehicles travelling on the main street in the direction having children on the right side are filmed. Also those drives on the secondary street who are turning right and having the zebra crossing to their right are included.

The filming periods are chosen to capture the hours of the day when children are travelling to and from school. This is also the time of day when other vulnerable road users are travelling. As mentioned, the flow of children on their way to school is strongly directed in the morning and in the afternoon. In the morning this coincides with the peak hour for the traffic. School often starts at 8.10 –8.30 a.m. The morning filming period is therefore chosen to be 7.30 to 9.00 a.m. In the afternoon the situation is a little bit different, dependent on the age the children their school day ends at different hours. Therefore the filming period in the afternoon is longer, between 2.00 and 5.00 p.m.

Training of observers

When using people to do traffic conflict observations in the field, it is of great importance that the person observing the traffic has the ability and knowledge to correctly estimate and register the speed of a vehicle and the distance from the vehicle to any given point. A person who is about to become a trained observer in the Swedish technique(see e.g. Svensson, 1998) has to practice discerning a conflict situation, estimating the speed of moving vehicles and estimating the distance between the

observed vehicle at the moment of an evasive action being taken and the estimated collision point. Because of the great difference in ways of estimating it is preferable if this practice is done both in the field and by using video films. According to the manual from the Swedish National Road Administration (Mattson 1983) no more than 1/3 of the observers' estimates may deviate more than 30% from the measurements obtained by for example radar guns. Our observers met this criterion. These observers can typically estimate the speed of a vehicle within 5 km/h.

Behavioural studies

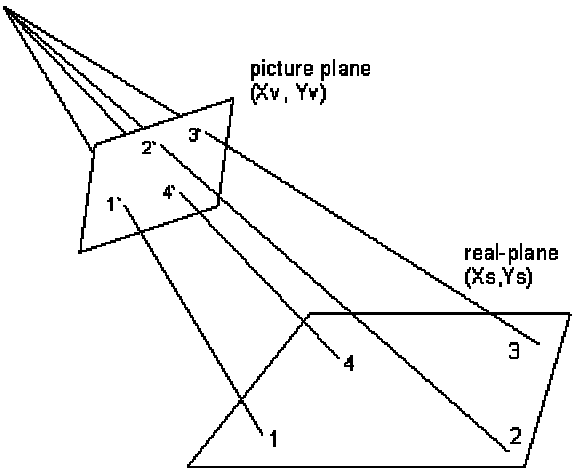
The traffic situations stored on videotapes are analysed and coded. The coding is based on Øvstedals and Ryengs (1999) work where they studied the behaviour of children and car drivers at intersections. Some adjustments are made to better describe the traffic situation in question. See Appendix 1.

Parameters of interest to describe the behaviour of the vulnerable road users are primarily their speed (and if they are slowing down or not) and how they move their heads and eyes. Head movements indicate if they look around to detect vehicles. Other parameters of interest are if they stop at the kerb and/or at the refuge or not. Speeds and acceleration behaviour of motor vehicles and to what extent they stop when vulnerable road users are present at zebra crossings are key issues when describing the behaviour of drivers.

ViVAtraffic – A system for analysis

A semiautomatic image processing computer program, ViVAtraffic, has been used to analyse traffic conflicts and interactions of higher severity. It was developed by a team of computer specialists and traffic engineers from the transportation department at the University of Kaiserslautern. It is supplied by the GVA (Gesellschaft für VerkehrsAnalyse) mbH. The program distinguishes two different methods of measurements, the interactive measurements and the automatic survey.

The real plane and the picture-plane are set in a mathematical relationship to make it possible for the program to do the measurements. Every point in the real plane corresponds to exactly one point in the picture-plane, Figure 2.2.



$$X_s = \frac{C_1X_v + C_2y_v + C_3}{C_4X_v + C_5y_v + 1}$$

$$y_s = \frac{C_6X_v + C_7y_v + C_8}{C_4X_v + C_5y_v + 1}$$

Figure 2.2. The relationship between the real plane and the picture-plane graphically and mathematically expressed. (http://transport.arubi.uni-kl.de, 1999)

The angle of view of the video shooting is very important for the quality of the results. The higher the position of the camera and the steeper the angle of the camera, the

better it is. A flat camera angle will result in a strong distortion in the perspective as shown in Figure 2.3

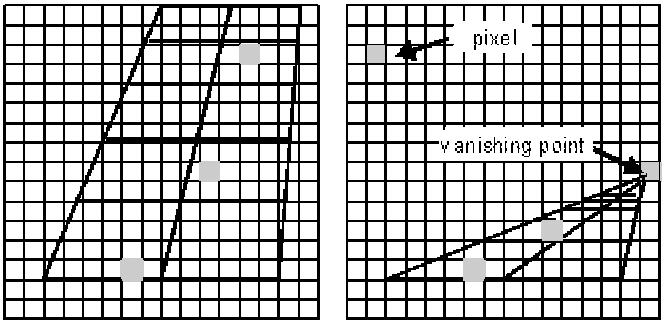


Figure 2.3. A visualisation of the fault caused by a too flat camera angle. (http://transport.arubi.uni-kl.de, 1999)

The interactive measurements that can be done are:

- Distance measurements
- Speed measurements
- Acceleration measurements
- Motion-line measurements

The motion-line measurement tool is used for the analyses in this project. This tool makes it possible to track all movements of the road users in an image sequence, and put them in relation to each other.

The program is also capable to make automatic observations by automatically trace road users in video sequences and collect relevant data such as number of vehicles, average speed and the projected 2-dimensional length of the vehicles. It is possible to analyse several lanes at the same time.

3. RESULTS

Reliability test of observers

Below we will discuss the two tests applied here. The first one, below named “results from practise”, had the main purpose of training and was based on comparing interactions, which all three observers had detected. The second one, below named “reliability test”, will be based on comparing all interactions which VIVA traffic had detected (above a severity level) However the interim results presented in this paper is based on an evaluation of interactions of higher severity where all three observers have given an estimated value for all three parameters.

The results from the practice, “Average 1” and “Std. deviation 1”, are based on one hour of video filming in Malmö on October 24th, 1998. There were a total of seven interactions of higher severity for this period that could be used for reliability testing.

The results from the test, “Average 2” and “Std. deviation 2”, are based on one hour of video filming in Malmö on October 26th and 19 interactions of higher severity are from this study. The results are shown in Table 3.1-3.4, where the “Average difference”-values are the average of the difference in estimates between the observer’s judgement as written in the title bar and the “average”-values. These Averages are the

average of the estimates of all three observers, which is the best estimate we have. The standard deviation, “Std.deviation”, tells us how the values in a certain set of data vary around this average. The smaller the standard deviation, the closer is the values, which is good. The parameters compared are:

1. Velocity of pedestrians
2. Velocity of cyclists
3. Velocity of motor vehicles
4. Time to Accident, TA

It is important to keep in mind that the estimates for parameter numbers 1 and 4 are small when measured in km/h and s respectively. It is easy to let oneself be fooled to think that an average difference of 0.5 is very good, but when the estimates are small, a standard deviation of 0.5 means that we have a large relative error.

The average of the estimated velocities of pedestrians is 2.99 km/h for the practice with a standard deviation of 0.88 km/h, and 2.56 km/h for the reliability test with a standard deviation of 1.00 km/h. For the estimated velocities for cyclists the average is 8.42 km/h with a standard deviation of 3.09 km/h for the reliability test. There were no cyclists to compare during the practice. The average of the estimated velocities of the motor vehicles is 45.48 km/h with a standard deviation of 6.49 km/h for the practice and 41.0 km/h with a standard deviation of 9.2 km/h for the reliability test. The average of the estimated TA is 1.68 seconds with a standard deviation of 0.40 seconds for the practice and 1.75 seconds with a standard deviation of 0.52 seconds for the reliability test.

Table 3.1. Difference between the observers' estimated velocity (km/h) of pedestrians. (1 = Practice, 2 = Reliability test)

	Observer 1-Observer 2	Observer 1-Observer 3	Observer2 – Observer 3	Observer 1-Average	Observer 2-Average	Observer 3-Average
Average difference 1	-0.54	-0.70	-0.16	-0.41	0.13	0.29
Std. deviation 1	0.95	1.54	0.76	0.81	0.25	0.74
Average difference 2	-1.02	-1.67	-0.65	-0.90	0.12	0.77
Std. deviation 2	0.91	1.06	0.62	0.63	0.38	0.50

Table 3.2. Difference between the observers' estimated velocity (km/h) of cyclists. (1 = Practice, 2 = Reliability test)

	Observer 1-Observer 2	Observer 1-Observer 3	Observer2 – Observer 3	Observer 1-Average	Observer 2-Average	Observer 3-Average
Average difference 2	1.25	-3.25	-4.50	-0.67	-1.92	2.58
Std. deviation 2	1.26	1.71	2.89	0.27	1.37	1.52

Table 3.3. Difference between the observers' estimated velocity (km/h) of motor vehicles. (1 = Practice, 2 = Reliability test)

	Observer 1-Observer 2	Observer 1-Observer 3	Observer2 – Observer 3	Observer 1-Average	Observer 2-Average	Observer 3-Average
Average difference 1	5.86	5.57	-0.29	3.81	-2.05	-1.76
Std. deviation 1	6.20	4.65	4.92	3.27	3.40	2.43
Average difference 2	-1.95	-5.05	-3.11	-2.33	-0.39	2.72
Std. deviation 2	6.05	5.01	4.89	3.32	3.26	2.61

Table 3.4. Difference between the observers' estimated TA (sec). (1 = Practice, 2 = Reliability test)

	Observer 1-Observer 2	Observer 1-Observer 3	Observer2 – Observer 3	Observer 1-Average	Observer 2-Average	Observer 3-Average
Average difference 1	-0.06	0.34	0.39	0.09	0.15	-0.24
Std. deviation 1	0.55	0.51	0.57	0.30	0.33	0.31
Average difference 2	-0.20	0.32	0.52	0.04	0.24	-0.28
Std. deviation 2	0.64	0.49	0.53	0.34	0.35	0.26

Sites and data collection

Data from Regementsgatan, Malmö and Hultagatan, Borås are used in an analysis of differences in traffic behaviour between sites, see Table 3.5. First one day's data from Malmö are analysed, then two different days in Malmö are being compared to see if there are any differences in behaviour. Data from Malmö are being compared with data from Borås to see what the differences between the two cities are. Interactions of higher severity levels in Malmö are compared with a larger set of data to detect differences.

Table 3.5. Data collected for the analysis.

	Malmö Day 1	Malmö Day 2	Interactions of higher severity levels in Malmö	Borås
Date	March 25 1999	March 26 1999	March 24 1999 March 25 1999 March 26 1999	May 4 1999
Time	2.00 to 5.00 p m	1.30 to 4.30 p m	1.30 to 5.00 p m	2.00 to 5.00 p m

In the second type of analysis, Viva traffic was used to explore driver behaviour during the final 4 to 6 seconds of approaching the zebra crossing. Data from Sjöbotorggatan in Borås, Sweden are compared to data from Friedrichstrasse in Kaiserslautern, Germany. Car drivers' behaviour expressed in speed and acceleration are analysed when a vulnerable road user crosses the street at a zebra crossing.

Results from one site

The intersection between Regementsgatan and Skvadronsgatan in Malmö

The habit of pedestrians to stop at the kerb[1] or on the refuge island has a typical age structure. The percent share that stops and waits falls with age until the group 65-years and older, then it increases, Figure 3.1. The percentages shown in Figure 3.1 are

[1] At the kerb or close to it (on the sidewalk or in the carriageway)

related to all events including crossing behaviour when no motor traffic is present. If these events are excluded a slightly lower percentage of pedestrians stop at the curb or refuge. This pattern is also seen in accepted time gaps, waiting time and passage-time distributions.

The average accepted time gap by children is just over 10 seconds but falls towards 5 seconds for youths and adults. For the group of elderly the average accepted time gap is almost 15 seconds. One explanation is the elderly people's lower walking speed and therefore the need of more time to cross the street. The average waiting time is 6.1 seconds. Here as well,

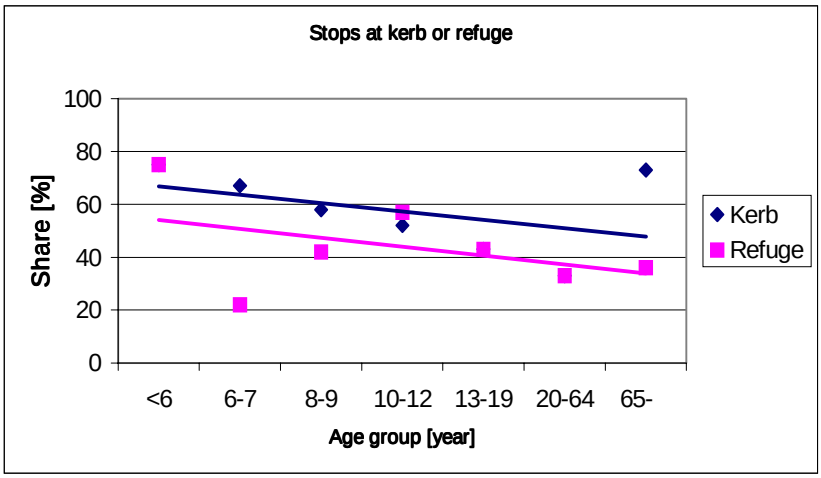


Figure 3.1 Frequency different age groups stops at kerb and refuge at Regementsgatan - Skvadronsgatan, Malmö Day 1

children and elderly have the longer waiting times. One group that stands out is adults travelling with children. Their waiting time is much longer than any other group, Table 3.6.

Table 3.6. Waiting times, all passages with interaction at Regementsgatan - Skvadronsgatan, Malmö Day 1.

	Children	Youth	Adults	Elderly	Adult + children
Average (s)	10.0	4.8	5.9	9.8	15.9
Standard derivation (s)	5.9	2.2	4.8	5.9	5.9
Maximum (s)	39	25	22	43	42
Number	33	11	70	36	16

Out of 449, only 20 vehicle drivers gave way to pedestrians waiting to cross at zebra crossings, *i.e.* a frequency of giving way of only 4%. 45 % of the drivers who stopped, stopped for elderly people. Elderly people made up 21 % of the passages. Lowest shares of giving way is to adults and adults travelling with children, only 5 % of the drivers stopped.

Observations of overtaking at the zebra crossing were also made. Both flying overtaking, when both cars were travelling forward, and overtaking of stopped vehicle were observed. In total, 22 overtaking or overtaking-like situations were observed when

analysing three hours of video recordings. Such situations are prohibited by the law and should not occur at all.

The average vehicle speed at the zebra crossings was 50 km/h (with standard deviation 5 km/h for the whole sample) for eastbound traffic and 48 h (with standard deviation 6 km/h for the whole sample) for westbound traffic. The 85-percentile was 56 km/h for eastbound traffic and 53 km/h for westbound traffic. These are very high speeds. The recommended speed level where vulnerable road users and motor traffic are mixed is 30 km/h or less, see Wramborg (1998).

Average driving speed is slightly lower (1.2 km/h lower), when a vulnerable road user is present compared to when no vulnerable road user is present.

A school inquiry was administered at Ribersborgsskolan for pupils in grades one to six. Approximately 83% of the 260 pupils who had the opportunity responded. The pupils in grades one to three answered the inquiry at home with the help of their parents.

Approximately 90% of the inquiries were fully answered. In some cases, there were comments indicating that parents had influenced their child's answers. The pupils in grades four to six answered the inquiry at school with the help of their teachers. 76% of these inquiries were completely filled out.

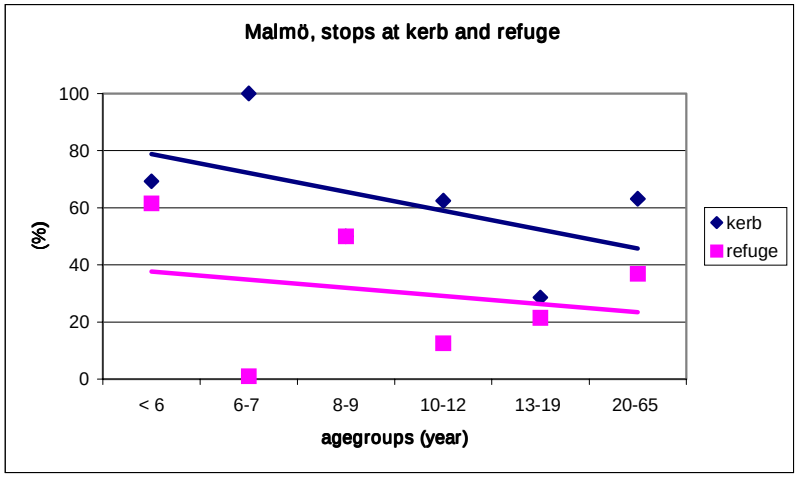
A major part of the pupils think that they have at least one dangerous location along their way to school and at least half of these pupils considered that this place was situated along Regementsgatan. Surprisingly, the place that most pupils thought dangerous is the intersection with the least police and hospital reported personal injuries of all the examined intersections. Maybe this is because people take extra care at the location which seems the most dangerous.

The primary reasons for considering a place dangerous were that vehicles drove at high speeds, high traffic volumes, that the cars didn't stop at the zebra crossings, and that traffic signals were missing. Pupils in grades one to three also thought that a limited sight contributed to unsafety. Among the pupils in grades four to six, 10% responded that they have had an accident in the traffic during the last 17 months. Even very slight accidents, like grazes, were then counted.

Comparison of results from two different days and different sites

It is of interest to examine if there are differences between two different days at one specific intersection or if the behaviour remains consistent. As seen, there are both differences and similarities. Data from Day 1 is presented in Figure 3.1 and Figure 3.2 below shows Day 2. Not a single pedestrian 65 years old or older was observed during Day 2 in the study based on close-ups. The remaining frequency shows a pattern of decreasing frequency of stopping with increasing age up to adults for the two days. Some ages show similarities in frequency between the two days; ages younger than 6 years and age 8-9 years. A stopping frequency of 60 – 80 % and 40 – 60 % respectively.

Figure 3.2. Frequency different age groups stop at kerb and refuge.



Malmö Day 2, study based on close-ups.

Children is the group with the longest waiting time both days, see Table 3.5 and Table 3.7. The intervals for all age groups overlap, even for youths with the biggest difference in average. A difference in the analysis of Day 1 compared to Day 2 is that adults with children are not analysed separately.

Table 3.7. Waiting time for passages divided into age groups, all passages with interaction.

Malmö Day 2.

	Children	Youth	Adults	Elderly
Average (s)	12.2	10.8	10.4	9.0
Standard deviation (s)	6.4	4.7	7.3	5.0
Maximum (s)	27	16	41	21
Number	25	7	120	27

Below, data from two afternoons at Regementsgatan are compared to each other and with one afternoon at Hultagatan in Borås. Two different types of analysis is conducted, an overview study and a study based on close-ups. The result of the overview study contains more general information of the whole traffic situation and the result from the study based on close-ups contains more detailed information about the road-user behaviour. Table 3.8 shows the distribution by age.

Table 3.8. Age groups, study based on close-ups.

	Malmö, 1		Malmö, 2		Borås		Interactions of higher severity in Malmö	
Age		*%*		*%*		*%*		*%*
6 years or younger	4	*3*	14	*21*	11	*21*	1	*3*
6-7 yrs	9	*8*	4	*6*	5	*10*	0	*0*
8-9 yrs	36	*31*	6	*9*	6	*12*	2	*5*
10-12 yrs	42	*36*	8	*12*	10	*19*	1	*2*
13-19 yrs	7	*6*	14	*20*	10	*19*	4	*10*
20-64 yrs	6	*5*	19	*28*	10	*19*	22	*55*
65- yrs	11	*10*	0	*0*	0	*0*	10	*25*
Unknown	1	*1*	2	*3*	0	*0*	0	*0*
Sum	116	*100*	67	*100*	52	*100*	40	*100*

If the age groups are divided into gender we see that it was difficult to determine gender in Malmö Day 2 , see Table 3.9. This is due to the quality of the video films captured the different days. In Malmö the cameras were placed in the same spot the two days but depending of weather and light the pictures have different quality. I Borås the weather was fine, with lots of light, and this gives good quality of the pictures.

Table 3.9. Gender and age groups based on close-ups. Number of people.

	Malmö 1			Malmö 2			Borås			Interactions		
Age	Women	Men	Un-Known	Women	Men	Un-known	Women	Men	Un-known	Women	Men	Un-known
6 years or younger	1	3	0	3	0	10	1	0	7		1	
6-7 yrs	5	4	0	2	1	1	3	5	0	1		
8-9 yrs	11	25	0	2	4	0	1	5	0			1
10-12 yrs	11	31	0	1	4	3	2	8	0		1	
13-19 yrs	3	3	1	7	4	3	6	4	0	1	2	1
20-64 yrs	2	3	1	11	8	0	5	5	0	11	8	3
65- yrs	10	1	0	0	1	0	0	0	0	7	3	
Unknown	1	0	0	0	1	1	0	0	0			
sum	44	70	2	26	23	18	18	27	7	20	15	5
Total sum			116			67			52			40

In the overview study the ages are divided into the groups children, up to 13 years, youth 13-19 years, adults 20 - 64 years and elderly 65 years or older, Table 3.10.

Table 3.10. Age groups, overview study.

	Malmö, 1		Malmö, 2		Borås		Interactions of higher severity in Malmö	
Age		%		%		%		%
Children (-12 yers)	69	*23*	42	*12*	39	*16*	4	*10*
Youth (13-19 yers)	16	*5*	14	*4*	54	*22*	4	*10*
Adults (20-64 yers)	136	*44*	236	*69*	137	*57*	24	*60*
Elderly (65- yers)	56	*18*	40	*12*	10	*4*	8	*20*
Unknown	29	*10*	12	*3*	1	*0.4*	0	*0*
Sum	306		344	*100*	241	*100*	40	*100*

There is a difference in distribution in the age groups especially between Day 1 and Day 2 from Malmö in the close up study. Events chosen for the study based on close ups are those where a child is to cross the street, alone or with another person. The differences in age groups in the overview study might be explained by the fact that it differs one half hour in the filming period for the two days. In the interactions of higher severity levels, 60 % involve adults. That is almost exactly their share of exposure too. Roughly 10 % of the interactions of higher severity levels involve children. Elderly pedestrians seem to be over-represented with respect to interactions of higher severity.

Roughly 46 % of the persons in the overview study in Malmö Day 2 are female, 30 % are men and for 24 % it has not been possible to determine gender. Of the women 77 % or 122 persons are adults, 17 % are elderly. 79 % of the men are adults and 12 % are elderly whereas 5 % are youths. 39 % are adults. Of the 24 % that it has been difficult to determine gender close to half of them or 40 persons are children. It is difficult to determine gender of a child. They often wear a backpack and a quilted cap.

In the overview study in Borås 47 % were men/boys and 50 % were women/girls. For 3 % or 6 persons it was not possible to see their gender, all of these were children or youths. 53 % of the males were adults, 27 % youths and 18 % children. Amongst the women 64 % were adults, 18 % youths and 11 % children. For the women 7 % were elderly and for the men only 1 %.

There are differences in means of transport between Malmö and Borås; people walk to the same extent but it is more common to walk with the bike over the zebra crossing in Malmö, see Table 3.11. There are small differences in means of transport between the two days in

Malmö but walking is the most common way for both days. For interactions of higher severity levels, 80 % are pedestrians and 17 % are going by bike.

Table 3.11. Means of transport, close-ups.

	Malmö, 1		Malmö, 2		Borås		Interactions of higher severity	
		%		*%*		*%*		*%*
Walking	100	*87*	42	*63*	21	*40*	32	*80*
Bike	9	*8*	5	*8*	19	*37*	1	*3*
Walking with bike	4	*3*	6	*9*	1	*2*	7	*17*
Walking with pram	1	*1*	5	*7*	6	*11*	0	*0*
Walking with wheelchair	0	*0*	0	*0*	0	*0*	0	*0*
in wheelchair	0	*0*	0	*0*	0	*0*	0	*0*
sitting on bike	1	*1*	5	*7*	3	*6*	0	*0*
Rullator (walker)	0	*0*	0	*0*	0	*0*	0	*0*
Other, ex rollerblades	0	*0*	4	*6*	2	*4*	0	*0*
Sum	115	*100*	67	*100*	52	*100*	40	*100*

The second day in Malmö the average vehicle speed for the eastbound traffic was 51 km/h (with standard deviation 5 km/h for the whole sample) and the 85 percentile was 56 km/h. The average speed for the westbound traffic was 44 (with standard deviation 5 km/h for the whole sample) and the 85 percentile was 50 km/h. When comparing the speeds of the two different days there is no significant difference. One important explanation of the differences between the two directions can be that eastbound traffic was measured in the morning and westbound in the afternoon. The traffic intensity can be higher in the afternoon. The differences are not significant.

The speeds at Hultagatan in Borås do not differ from those in Malmö, the average vehicle speed was 49 km/h (with standard deviation 7 km/h for the whole sample) and the 85 percentile was 55 km/h.

Below is an overview of whether vehicles stop when a vulnerable road user is present at kerb or refuge. There is a difference between the two days in Malmö; 7 % more occasions on the second day, when one or more vulnerable road users are standing at the kerb or at the refuge, and a car stops for them. Borås shows the lowest figure, only one out of ten vulnerable road users is given the right-of-way by a car driver. The interactions with higher severity show the same pattern as other encounters in Malmö.

Table 3.12. Driver behaviour when a pedestrian or cyclistis present at kerb or refuge. Overview study.

Driver stops	Malmö, 1		Malmö, 2		Borås		Interactions of higher severity in Malmö	
		%		*%*		*%*		*%*
Yes	20	*13*	48	*20*	20	*11*	8	*20*
No	138	*87*	195	*80*	160	*89*	31	*80*
Sum	158	*100*	243	*100*	180	*100*	39	*100*
Crossing and no car present	73	*32*	44	*15*	61	*25*	0	
Total sum	231		287		241		39	

In Figures 3.1 and 3.2 we can see the pedestrian behaviour of stopping at the kerb and refuge when crossing Regementsgatan in Malmö. Below is the stopping frequency shown for one afternoon at Hultagatan in Borås. Hultagatan has no refuge and no persons older than 65 years were observed in the study based on close-ups at Hultagatan.

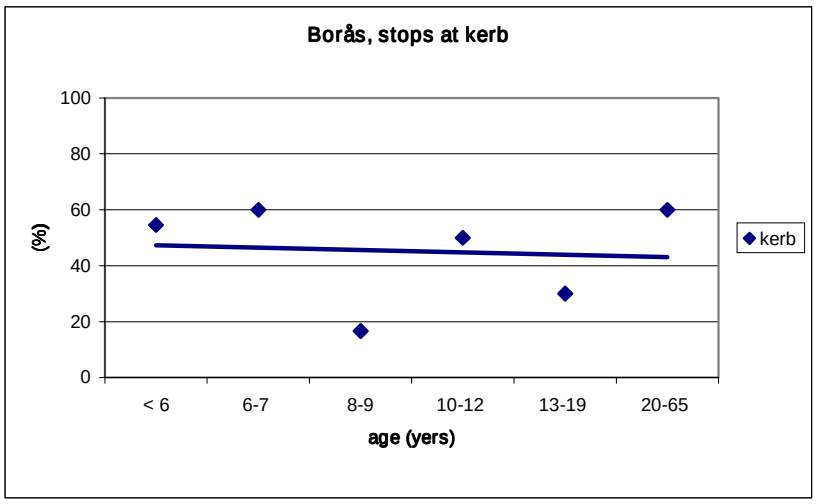


Figure 3.3. Frequency different age groups stops at kerb, Borås, study based on close-ups

Children and teenagers show similar behaviour in both of the days from Malmö and the day in Borås. The other ages show no clear similarities. The vulnerable road users in Borås do not show the same pattern as those in Malmö, the frequency of stopping does not decrease with increasing age.

The drivers' tendency to give way to vulnerable road users at the kerb or on the refuge island is presented below, see Table 3.13. In Borås the drivers gave way to children to a higher extent than in Malmö. But they did not give way to adults with a higher probability.

Table 3.13. Driver behaviour when pedestrian or cyclist present at kerb or refuge in Malmö Day 2and in Borås divided into age groups. Overview study.

	Malmö 2					Borås				
	Driver stops		Driver continue			Driver stops		Driver continue		
		%		*%*	Sum		*%*		*%*	Sum
Children	3	*8*	35	*92*	38	5	*19*	22	*81*	27
Youth	2	*17*	10	*83*	12	4	*10*	35	*90*	39
Adults	45	*23*	153	*77*	198	9	*9*	94	*91*	103
Elderly	9	*23*	31	*78*	40	2	*20*	8	*80*	10
Sum	59	*20*	229	*80*	288	20	*11*	159	*89*	179

In Malmö Day 2, l0% of all children, 14% of the youths and 16% of the adults crossed the street when no vehicle was present. When elderly people crossed there was by chance always a vehicle present. In Borås 31% of all children, 28% of the youths and 25% of the adults crossed the street when no vehicle was present. As in Malmö, when elderly people crossed there always was a vehicle present. The higher amount of free passages in Borås is a reflection of lower traffic intensity.

From the drivers' point of view only 4 % (49 out of totally 1146 car drivers) of those that had a vulnerable road user waiting at the intersection gave way to them in Malmö Day 2. In Borås 17 out of 331 car drivers, 5 %, gave way to a vulnerable road user in the intersection. In the table below we see that the drivers seem to show more respect to children and youths in Borås than in Malmö. Still, the majority of drivers do not give way to even children.

Table 3.14. From the driver point of view giving way to vulnerable road users. Overview study.

	Malmö 2		Borås	
		%		*%*
One or more children	1	*2*	4	*24*
Child with adult	1	*2*	0	*0*
One or more youths	1	*2*	3	*18*
One or more adults	34	*69*	8	*47*
Adult with pram	2	*4*	0	*0*
Elderly	8	*16*	2	*12*
Unknown	2	*4*	0	*0*
	49	*100*	17	*100*

When comparing behaviour at the 40 interactions with higher severity in Malmö (collected from video recordings at three different afternoons) with results from analysing all encounters of Day 2 in Malmö, the frequency with which vulnerable road users stop is higher in interactions of higher severity levels, Table 3.15. It should be noted that in seven of the 40 interactions of higher severity the vulnerable road user has an interaction of higher severity level with cars in both directions.

Table 3.15. Behaviour of pedestrian and cyclists. Vulnerable road user stops at curb or refuge.

Study based on close-ups.

	Malmö, 2				Interactions with higher severity level			
	Kerb		Refuge		Kerb		Refuge	
Vulnerable road user stops		*%*		*%*		*%*		*%*
Yes	37	*55*	22	*33*	11	*65*	17	*57*
No	29	*43*	40	*60*	6	*35*	13	*43*
Unknown	1	*2*	5	*7*	0	*0*	0	*0*
	67	*100*	67	*100*	17	*100*	30	*100*

It is also of interest to note that whether the car drivers are more likely to stop or slow down at interactions with higher severity than at other encounters. As the results show, the car drivers stop to a lower extent in interactions of higher severity. They slow down a little bit more than generally at encounters. This may be caused by the fact that a serious situation becomes even more serious when drivers do not stop.

Table 3.16. Behaviour of driver. Vulnerable road user at kerb or refuge

	Malmö, 2				Interactions of higher severity			
	Kerb		Refuge		Kerb		Refuge	
		%		*%*		*%*		*%*
No car	10	*15*	17	*25*	0	*0*	0	*0*
No car stops	47	*70*	40	*60*	14	*82*	25	*84*
First car stops	1	*2*	0	*0*	0	*0*	1	*3*
Second or later stops	2	*3*	2	*3*	1	*6*	0	*0*
First car slows down	0	*0*	0	*0*	1	*6*	1	*3*
Second later slows down	0	*0*	0	*0*	1	*6*	3	*10*
Unknown	7	*10*	8	*12*	0	*0*	0	*0*
Sum	67	*100*	67	*100*	17	*100*	30	*100*

Comparison of results from two sites

(The intersection between Sjöbotorggatan and Nolhagagatan in Borås, Sweden and the intersection between Friedrichstrasse and Augustastrasse in Kaiserslautern, Germany)

Both in Germany and Sweden, 80-90% of all accidents involving pedestrians happens when the pedestrian is trying to cross the roadway. An interesting comparison is the vehicle drivers' traffic behaviour in the two countries when approaching a zebra crossing where a pedestrian wants to cross the street. Do drivers have a difference in defensiveness or offensiveness when driving? Is there a difference in acceleration and deceleration behaviour between the countries? Do the vehicle drivers behave in a different way when the pedestrian waiting is a child than when the pedestrian is an adult? Do pedestrians behave differently?

A comparison was made concerning the acceleration/deceleration behaviour of the vehicle drivers when approaching a zebra crossing in Borås at the intersection between Sjöbotorggatan and Nolhagagatan, see Figure 1.4, and in Kaiserslautern at the intersection between Friedrichstrasse and Augustastrasse, see Figure 1.5.

The analyses continue up to the point where the vehicle stops, when the pedestrian has passed the vehicle, or when the vehicle reaches the zebra crossing. The data was divided with respect to age--children or adults--and city--Borås or Kaiserslautern. The traits of character were illuminated for every category. The number of studied interactions of higher severity differed from category to category, Table 3.17.

Table 3.17. Number of studied interactions of higher severity for each category.

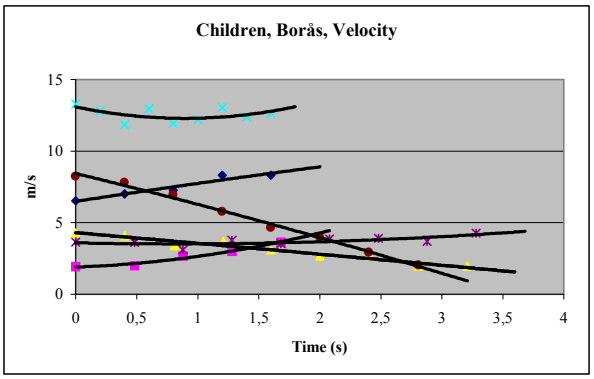
Category	Number of studied interactions of higher severity
1	6
2	6
3	11
4	21

Traits of character

In the diagrams below the velocity and acceleration/deceleration measurements are shown. The lines are trend lines of the type 2nd grade polygon. The beginning of the analysis of the approach is equivalent to the time 0 seconds in the figures below. The zebra crossing is situated at a point equivalent to the end of the time measurement (at 4, 5 or 6 seconds in the figures below)

Category 1 and 2: Children present at zebra crossing

In Borås, the trend lines for the velocity, shown in Figure 3.4, are quite different from each other. The velocity at the beginning of the analysis varies between 2 m/s and 13 m/s (7 to 45 km/h). A majority of the vehicles seems to *increase* their speed the closer they get to the zebra crossing. In Kaiserslautern there are more clear traits that can be seen. The velocity of all vehicles is in the interval 5-10 m/s at the beginning of the analyses, except for one vehicle, with a velocity of about 3.5 m/s. The velocity is decreasing during the approach for all vehicles. A majority has a velocity between 0 and 5 m/s at the end. When it comes to the acceleration, Figure 3.5, the outlook of the trend lines for the vehicles in Borås varies rather much from the trend lines for the German vehicles, which in general are U-shaped with a minimum. In Borås the patterns are also mostly U-shaped, but with a maximum *or* minimum. There is a horizontal or slightly upward trend at the end.



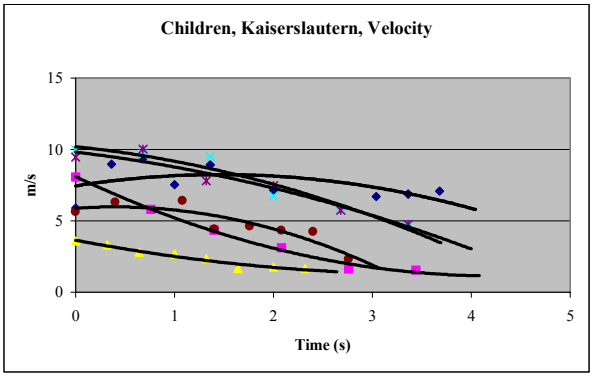
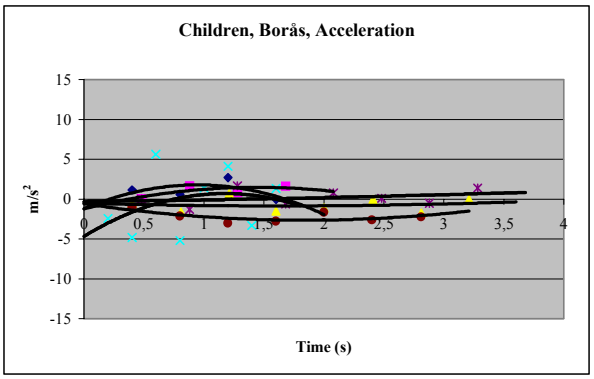


Figure 3.4. The velocity of the vehicles in Borås respectively Kaiserslautern when a child wants to cross the street.



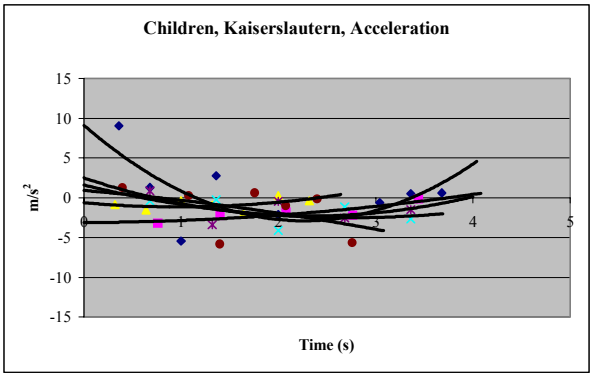


Figure 3.5. The acceleration of the vehicles in Borås respectively Kaiserslautern when a child wants to cross the street.

Category 3 and 4: Adults present at zebra crossing

For these two categories, the velocity, in general, is more varied than for the categories discussed above. The trend lines have a more horizontal outlook in both countries and it is hard to see any clear trends, but it seems like the vehicles in Kaiserslautern are decreasing their velocities more than the vehicles in Borås, see Figure 3.6. Looking at the trend lines for the deceleration/acceleration, Figure 3.7, both cities have a rather horizontal shape of the lines at the end of the approach, but in Kaiserslautern a majority of the trend lines is gathered around 0 m/s^2. Some vehicles are accelerating at the end of the analysis. This is most probably due to a better interaction between the pedestrian and the vehicle driver, which leads to a better traffic flow with fewer stops.

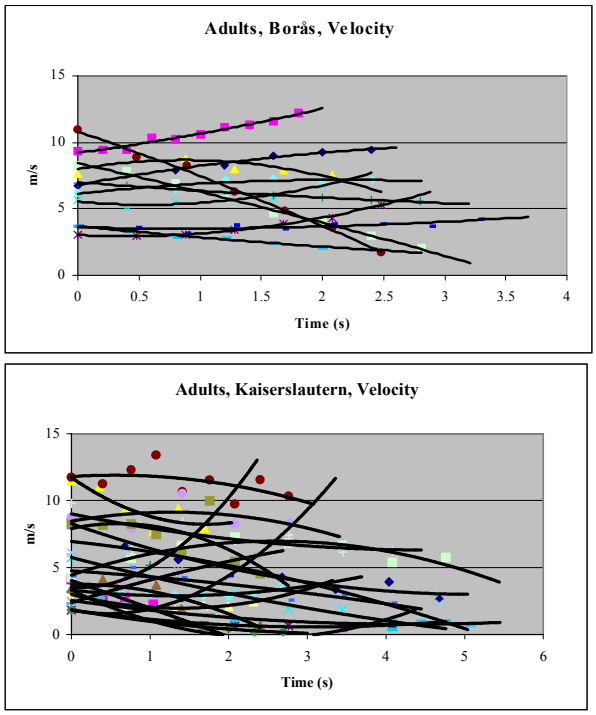


Figure 3.6. The velocities of the vehicles in Borås respectively Kaiserslautern when an adult wants to cross the street.

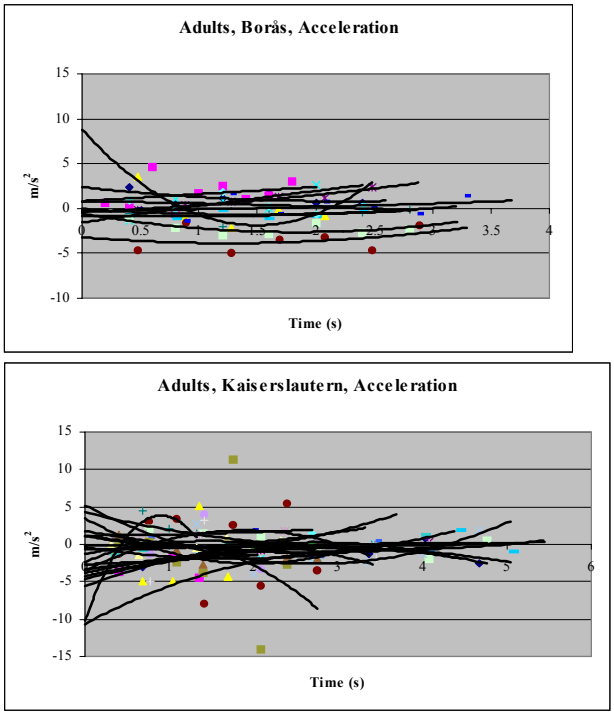


Figure 3.7. The acceleration of the vehicles in Borås and Kaiserslautern respectively when an adult wants to cross the street.

Stopping and give way frequency

A quite important factor for this comparison is the law. Is there a difference between the German and the Swedish law, or is it just a matter of obedience? It is stated in the Straßenverkehrs-Ordnung, 26§ 1st section, that "At zebra crossings, the vehicles (except for rail vehicles) must enable pedestrians (as well as persons admitted to a wheelchair), noticeably wanting to cross the street, to cross. The vehicles shall then approach with moderate velocity, if necessary, they have to stop." Compared to the Swedish Vägtrafikkungörelsen, 83§, which translated to English reads as follows "A driver of a vehicle approaching a zebra crossing shall adjust the velocity, so that he does not cause danger to pedestrians on the zebra crossing, or just about to step out onto it. If necessary, to enable the pedestrians to cross, the driver has to stop." The difference in wording does not seem that big. The German law might be a bit stricter when saying "...noticeably wanting to cross..." but otherwise the meaning of the two paragraphs can easily be interpreted as the same. Breaking the law in the two countries leads to similar punishments – fines, though the amount may vary.

A big difference between the countries is noticed when looking at the frequency of vehicles stopping or giving way to the pedestrians wanting to cross the street at a zebra crossing (figure 3.8). For all age categories Germany has a much higher frequency. The difference is between 45 and 80 points. Why do the drivers in Germany stop at the zebra crossings much more often than the Swedish drivers? Unfortunately the correct and true answer to this question has not been found, but most probably the difference depends on differences in “traffic cultures” which in turn may depend on several factors, some of general type and others related to vehicle – pedestrian interactions. A general obedience of traffic laws belong among the former ones, and factors such as plainer display of signs belong to the second category.

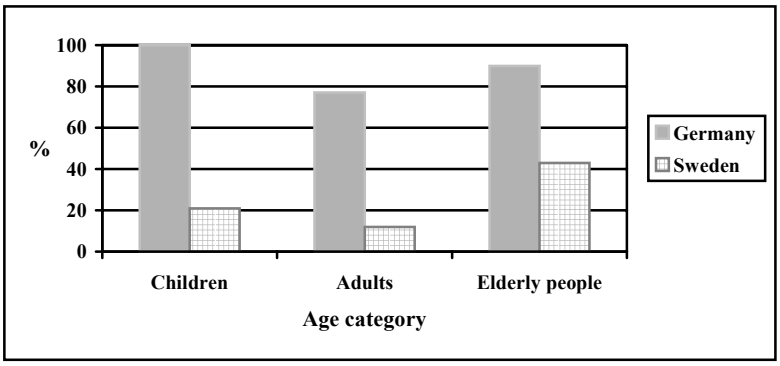


Figure 3.8. The frequency of vehicles stopping or giving way to pedestrians at a zebra crossing in Germany respectively Sweden.

Another interesting observation is the distribution between the different age categories. The behaviour shown in Germany, i.e. that the vehicle drivers are more cautious when there are elderly people waiting at the zebra crossings than when there is an adult person below age 65, and even more cautious if the pedestrian waiting is a child, can be seen as the most natural traffic behaviour at zebra crossings.

4. SUMMARY AND DISCUSSION

This study is based on traffic situations captured with video technique and later analysed in the laboratory. It was often difficult to find places where cameras could be placed invisible to the road users and at the same time capture pictures of high quality that clearly document the actual behaviours. When we used two cameras for capturing overview pictures, at least one camera usually provided us with pictures of sufficiently high quality of the overview. Sometimes the picture of one camera was unusable because of a passing bus or filming against the light. It was frequently difficult to capture the head movements of the car drivers, most often because of the fact that the sky was reflected in the windscreen of the car.

It was proven important that the coding was adjusted to the intersection in question so that all possible behaviours were adequately described. It was often difficult to see if the vulnerable road user moves his/her head to look around to detect cars. Future developments may contain comments from the observers recorded on the video, for example to sharpen estimates of children's age and head movements of drivers. This will be quite easily arranged if one of the cameras is hidden in a car.

An advantage working with an image processing method is that one can always go back and check things like prerequisites and important details, which otherwise is easy to miss or forget. An image processing method is needed to provide an estimation of the conflicting speed and the time to collision as a base for the calculation of the severity level of the interaction as suggested by Svensson (1998). This is a crucial feature when comparing behaviour for interactions of different severity levels and when evaluating key factors for a safe traffic environment. Another important factor for the kind of analysis made in a study of a traffic conflict is the duration in time in relationship to how valuable the obtained results are. Working with this specific program, important information such as speed, acceleration, and distance can easily be gathered. Compared to, for example, radar measurements, which typically only measure speed at one specific point, an advantage is that one can see the change in speed and acceleration over time when using the video/computer technique. Conclusions about the road users' traffic behaviour can be drawn based on these measurements. This can lead to biased results and findings. It can also be more difficult to identify a hazard or unpleasant situation by just looking at a screen, without any live experience. Some

other less pleasant problems experienced by working with a computer program are software problems and the problems that low-resolution video films may cause. For example, it is not just problems with the calibration and difficulties clicking the exact positions of the road users when the video film is of poor quality, the time needed is also much longer than when the quality is good. There might also be some difficulties with finding a good position for the video camera. The optimal position is at about 10 - 25 meters' height over the area of interest.

Two different days in Malmö show the same pattern in stopping frequency of pedestrians and cyclists at kerb or refuge. Children stop more often than youths and adults.

There were some minor differences in driver behaviour between different days in Malmö when analysing the interaction with vulnerable road users standing at the kerb or refuge.

There were, of course, differences between the sites in Malmö, Borås and Kaiserslautern.

Drivers seem to show more respect to children and youths in Borås than in Malmö. Still, the majority of drivers do not give way to even children.

Behaviour for drivers and vulnerable road users at interactions with higher severity levels and have been compared with behaviour at other encounters. This type of analysis seems to be a promising tool of analysis. However to draw any firm conclusions a larger sample size is needed.

In Kaiserslautern, in most cases, the velocity is decreasing the nearer the zebra crossing the car gets and the acceleration trends are U-shaped with a minimum, which indicates a defensive way of driving. In Borås it is more common with a velocity that is constant or increasing with time. The acceleration trend is generally such that velocity keeps going constantly upwards or even strongly increases in the beginning and then takes a more horizontal shape. These are characteristics for an offensive way of driving. When looking at the different age categories, no matter which country, one can see that when the pedestrian in question is a child the acceleration pattern is less aggressive than when there is an adult pedestrian present. In the case of an adult, the car drivers behave in a rather insecure and cautious, but more aggressive, way than when children are present.

The results suggest that driver behaviour in Borås, Sweden were more aggressive than in Kaiserslautern, Germany. The Swedish law will be changed in May 2000 with the aim that drivers will stop more often for pedestrians at zebra crossings. The effect of this law as well as the effect of physical countermeasures at the different sites will be studied by using a Baysian framework and the structure of measurements as described in this paper.

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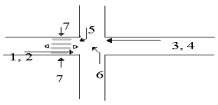
APPENDIX 1. CODING LIST

Reg. Number		Code
Gender		1 – woman 2 – man 9 – unknown
Age		Write ages for children between 6 and 12 years 1 – children (younger than 6 years) 2 – youth (13-19) 3 – adult (20-65) 4 – 65-75 5 – 75-85 13 – older than 85 99 – unknown
Means of transport		1 – walking 2 – by bike 3 – walking with bike 4 – walking with pram 5 – walking with wheelchair 6 – sitting in wheelchair 7 – sitting on bike behind 8 – other handicap aid 9 – other
Group	Group number	Every group get a number, start with 1000
	Numbers in the group	Numbers of persons in the group (one or more)
	Gender of oldest in group	Same code as gender
	Age of oldest in group	Same code as age
Crossing behaviour	Stops at kerb	1 – no 2 – yes 9 – unknown

	Stops at refuge	1 – no 2 – yes 9 – unknown
	Crossing behaviour	1 – on zebra crossing 2 – close to zebra crossing 3 – outside zebra crossing-closer to the intersection 4 – outside zebra crossing-away from the intersection 9 – unknown
	straight angle across	1 – straight 2 – angle or diagonal across 9 – unknown
Tempo	Before intersection biking: put 1 before	1 – slow 2 – normal 3 – walking fast 4 – running 5 – vary 9 – unknown
	First lane Going by bike: put 1 before	As above
	Second lane Going by bike: put 1 before	As above
	After intersection Going by bike: put 1 before	As above
Look around	Before kerb	1 – no, no head movement 2 – both sides 3 – only left 4 – only right 9 – unknown
	At kerb	As above
	When passing first lane	As above
	At refuge	As above
	When passing second lane	As above

Traffic situation	First vehicle / interaction 	1 – To the intersect, left 2 – To the intersect, right 3 – From the intersect, left 4 – From the intersect, left right? 5 – Secondary street, right turn 6 – Secondary street, left turn 7 – Straight ahead 9 – unknown
	Type of vehicle	1 – car 2 – lorry 3 – small lorry 4 – buss 5 – bike 9 – unknown
	Speed	Speed in km/h (no speed below 20 km/h) 0 – vehicle standing still 1 – no vehicle 9 – unknown
	Overtaking at intersection at zebra crossing	1 – no 2 – yes 9 – unknown
	Overtaking of vehicle standing still	1 – no 2 – overtaking 3 – stops beside 9 – unknown
	Vehicle from the left	1 – no 2 – yes, but no conflict 3 – yes, but far away (as far as it is possible to cross before) 4 – yes, close 9 – unknown
	Vehicle from the left stops	0 – no car, no conflict 1 – no

		2 – first car stops 3 – second car or later stops 4 – first car slow down 5 – second car or later slow down 9 – unknown
	Vehicle from the right	1 – no 2 – yes, but no conflict 3 – yes, but far away (as far as it is possible to cross before) 4 – yes, close 9 – unknown
	Vehicle from the right stops	0 – no car, no conflict 1 – no 2 – first car stops 3 – second car or later stops 4 – first car slows down 5 – second car or later slows down 9 – unknown
	Car drivers head movement	1 – no, no head movement 2 – both sides 3 – only right 4 – only left 9 – unknown
	Time gap accepted1	In seconds
	Time gap accepted 2	In seconds
	Waiting to cross, time	In seconds
	Time for crossing	In seconds
Comments	More than one is possible	1 – playing with ball 2 – talking 3 – playing and singing 4 – pushing 5 – playing 6 – jumping/walking backwards etc 7 – one leads other

		8 – reach out hand 9 – rollerblades, skateboard etc
Free comments		Text

Time gap accepted 1; time gap between vehicles which is accepted by vulnerable road user

Time gap accepted 2; time gap measured from when the vulnerable road user starts to cross until vehicle reaches point of conflict.