The effect on Traffic Safety and Mobility for Children, Elderly and Disabled of implementing a Vision Zero 50/30-km/h-street
A case study in Malmö, Sweden

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BACKGROUND AND AIM

On behalf of the Swedish National Road Administration, SNRA, the department of traffic engineering at Luleå University of Technology assess the effects on traffic safety and mobility for children, elderly and disabled of the reconstruction of Regementsgatan to a Vision Zero 50/30-km/h-street. Countermeasures include traffic calming, to secure that the 90-percentile of the motor vehicle speed is below 30 km/h and that is not possible to overtake at zebra crossings and the implementation of a new Code aiming at “forcing” motorists to give way to pedestrians.

According to the UN Convention of Children’s Rights, what is best for children should be the target for all governmental decisions affecting children. Children are to be respected and for example should have influence and possibility to participate in the planning of the society.

The children’s view and perception of oncoming traffic may be affected not only by their state of cognitive development but also by their height, thereby restricting their range of view (Connely et al., 1998 and Sandels 1981). This together with parked cars, trees, or buildings makes it even more difficult to survey the traffic. For the elderly, these physical and cognitive resources decline with age.

According to the Swedish Vision Zero, the standard 50 km/h-street in built-up areas is changed to a 50/30 km/h-street, 30 km/h-street or walking-speed street where pedestrians, bicyclists and car traffic intermingle. The design aims to prevent motor vehicles from driving faster than 30 km/h at zebra crossings on 50/30-streets and along 30-streets. This criterion is motivated by the relationship between speed and fatality risk (Teichgräber 1983, Ashton 1982, and Waltz et al 1983, Leden et al 2000, Calm Street 1998).

The Swedish law concerning car drivers giving way to pedestrians was strengthened on May 1, 2000. Since then, drivers must give way to pedestrians who intend to cross the street at zebra crossings, whereas the previous law stated that drivers should, if possible, give way to pedestrians. When the new law concerning car drivers yielding to pedestrians was enacted, a number of zebra crossings were removed in Sweden. From year 2000 to year 2002 the number of zebra crossings at 50-streets were reduced with 4800 or 12 % (draft, Ifver 2002).

The field studies were made in the City of Malmö in Sweden. It is stated in Vision Zero (Belin, 1999) that the measures taken in urban areas to increase safety and mobility should benefit especially children, elderly and disabled. These age groups are found to be the road users facing the greatest risks when travelling as pedestrians and cyclists as discussed above. This is true also for many other countries (MacGregor et al., 1999, Connely et al., 1998).

1 Föredrag vid Transportforum i Linköping 2003: "Löser 50/30-gatan barns krav på säkerhet och tillgänglighet? Fallstudie Regementsgatan i Malmö"
METHOD

National pedestrian crash data from 1995-2001 were analysed. This was supplemented with detailed crash data from the City of Malmö, Sweden, for 1997-2002, (11) and data provided by Ramqvist, 2002 (unpublished data).

Places were video filmed simultaneously from various angles to capture the different road-users’ behaviour and their interactions with car drivers at four time periods:

1. before change of Code and reconstruction (March 1999),
2. after change of Code but before reconstruction (May, June 2000),
3. after both change of Code and reconstruction (September 2001),
4. one year after reconstruction (or in other words two years after change of Code) (May, 2002).

The traffic situations with pedestrians and cyclists recorded on videotapes were manually analysed and coded. Passages by children (0-12 years), youth or teenagers (13-19 years) and elderly (older than 64 years) as pedestrians and cyclists were coded and passages with conflicts or High Severity Situations were coded independent of the road users’ age. High Severity Situations are most often less severe than a serious conflict. Even if conflicting road users do not have a collision course, some encounters can be defined as High Severity Situations. Svensson (1998) discusses the possibility that there is a threshold in the severity hierarchy above which there is a high probability of an accident while encounters below this level rather are a sign of safe interactions. Occurrence of conflicts situated low in the severity hierarchy therefore can be a good sign. This threshold might be differently situated in the hierarchy if a child is involved. Children do not always understand the connection between speed, time and distance and can therefore often act unpredictable (Cross, 1988).

Coding was done using 37 parameters that can be divided into three groups; first description of pedestrian or cyclist, second description of car driver and vehicle and third description of encounter. When comparing 1.5 hour of captured video material containing 47 pedestrian and cyclist passages, two trained observers had 83 % agreement in coding the parameters describing the behaviours. If excluding the difficult parameter to assess, head movements, the two trained observers had 89 % agreement in coding the behaviours. A Baysian approach is used to explore the behavioural data.

The speeds of ‘free’ cars were measured with radar at the intersections, just before the zebra crossing, i.e. the hypothetical point of action to avoid a collision. School children’s opinions of the road reconstructions and change of Highway Code were gathered by questionnaires at three different occasions. Video recordings were also conducted with an instrumented cycle with two video cameras attached to a cycle that were sent to experts in the field of traffic safety as a questionnaire.

DESIGN OF SURVEY, SITES AND DATA COLLECTION

Studies at six different intersections in Malmö are presented in this paper. Not all studied intersections have been reconstructed. The intersection Munkhättegatan and Nydalastigen saw no physical changes but of course the change of Code. There are no zebra crossings, but it is common that pedestrians and cyclists cross the street here nevertheless. The intersection at Munkhättegatan is used as a comparison site without zebra crossing to test the hypothesis that after change of Code the pedestrians and cyclists are bolder when crossing the street, even though there is no zebra crossing. Two intersections at Bergsgatan in Malmö (Möllevångsgatan and Kristianstadsrgatan) are used as comparison crossings with zebra crossings. No physical changes were made there. Three intersections along Regementsgatan in Malmö (Skvadronsgatan, Sergels Väg and Dragonstigen) are the treatment intersections, the core in the study. The studied intersections are chosen due to the fact that it is common that children cross the street there. Regementsgatan were during the winter 2000/2001 reconstructed according to Vision Zero, to secure that the 90-percentile of the motor vehicle speed is below 30 km/h and that is not possible to overtake at zebra crossings (Safer Roads, 1998). The intersections at Skvadronsgatan and at Sergels Väg were similar to each other in design and traffic both before and after the reconstruction. The intersection at Dragonstigen is a midblock pedestrian- and cyclists crossing. It was before reconstruction.
signalised, after reconstruction unsignalized, see Figure 1. After the reconstruction, all zebras were kept and also one was added at Regementsgatan – Skvadronsgatan, see Figure 2. The street was also narrowed to totally eight meters with 2 meter-wide refuges in the middle and the intersections have speed cushions installed 4.7 – 5 m before the zebra crossing (9 m before at Skvadronsgatan at the cycle crossing). The 8 cm high speed cushions were designed to be less of a hindrance to bus traffic than other traffic, see Figure 3. Paving stones are used to mark the zebra crossings for people with impaired view. The signal was removed from Dragonstigen.

Data for the first period, before change of Code and reconstruction, was collected at three different time periods, one week in October 1998, one week in June 1999 and one day in December 1999. Data for the second period, after Code change but before reconstruction, was collected one week in May 2000. For the third period, after Code change and reconstruction, one week was studied in September 2001. The last and fourth data collection was done in May 2002. 3183 pedestrian and cyclist passages were analysed from the video recordings in totally 109.5 h of film.

Figure 1 The intersection Dragonstigen – Regementsgatan before (left) and after (right) reconstruction.

Figure 2 The intersection Skvadronsgatan – Regementsgatan before (left) and after (right) reconstruction.
Figure 3. Measures of speed cushion (Towliaiat, 2001).

Questionnaires were given to schools at three different occasions:
1. Before reconstruction (Wilhelmsson, 2000)
2. Shortly after reconstruction and change of Code
3. In May 2002 one year after reconstruction.

Questionnaires 1 and 3 were directed to 6-13 year old school children at Ribersborgsskolan close to Regementsgatan. Questionnaire 2 was directed to 11-13 year old school children at Ribersborgsskolan and at two schools close to the comparison site without a zebra crossing. At occasion 1, 2 and 3 questionnaires were given to 215, 261 and 277 school children respectively.

To improve the quality of the estimates the answers in questionnaire 2 were not included in the analysis if:
?? school children at Ribersborgsskolan seldom or never had crossed Regementsgatan and
?? school children at the two schools close to the comparison site had not described the change of Code correct or almost correct.

211 valid answers remained.

Questionnaires including video recordings from an instrumented bike were sent to totally 16 experts and 9 of these answered.

RESULTS

Crash Data Validation

In the ten-year period before reconstruction there were 19 pedestrian accidents and 23 cyclist accidents with injuries along Regementsgatan. For the studied experimental sites there were a total of zero police reported pedestrian crashes and zero cycle crashes in the 3-year period preceding the change of the Highway Code.
During the time after reconstruction, there were also zero pedestrian crashes and zero bicycle crashes. Some readers may see this as an indication that no safety problems existed before or after the reconstruction. However, that is not the case. It is in this type of environment—arterial streets through towns and cities—that a majority of vulnerable road-users are injured. The fact that there aren’t crashes every three-year period on every section doesn’t mean that the long-term safety level is exactly zero crashes. But, what the lack of recorded crashes does mean is that we need less blunt instruments than crash data for evaluating the effectiveness of a reconstruction.

If we lengthen the analysis period for the studied experimental sites, there were one police reported pedestrian crash and one cycle crash in the 5-year period preceding the change of the Highway Code.

Obviously, the crash data material from these sites is so limited that it is impossible to draw conclusions on expected accident frequency. However, the change of Code has been evaluated through a macro study of all of Sweden based on a draft by Ifver, 2002 (unpublished data). It is likely that the months right after the change of Code, and the months preceding the change too, aren’t representative of before and after conditions. Therefore, a reasonable before period would be 1999 while 2001 would be the only full year available for after data. However, the year 1999 had compared with the years preceding it a lower number of accidents and fatal accidents. Therefore an average for the years 1995-1999 were used as comparison.

Overall, in 1995-1999, there were on average seven pedestrians per year killed in Sweden at unsignalised zebra crossings. In 2001, that number was eight. About 60 pedestrians per year were severely injured at unsignalised zebra crossings in 1995-1999. In 2001, that number was 70.

A comparison should consider that some crosswalks were eliminated in connection to the change of Code. Therefore, a reduction in the number of fatalities at crosswalks should be expected even if the Code change had no effect on risk. Also, like in Malmö, there was reconstruction of locations to make them safer. This should also be expected to marginally reduce the total number of pedestrian crashes in Sweden. So the conclusion is that the effect of the change of Code in Sweden so far has not been very successful in terms of safety. In Switzerland a similar change of Code was enacted in 1994. The first year after the change of Code the number of pedestrian accidents increased with 13 percent. The second year after change of Code the number of accidents were reduced to the level seen before change of Code. The same may happen in Sweden.

Pedestrians

A high share, 70-100%, of the pedestrians encounter a car when they intend to cross the street at Regementsgatan Less than 20% of the pedestrians were given way before changes made. After change of Code at least 50% of the pedestrians were given way. Shortly after reconstruction at least 60% of the pedestrians were given way, with exceptions for children and adults and youth at Sergels väg. A year after reconstruction the shares are lowered at Skvadronsgatan for all ages, but at Sergels väg and Dragonstigen children, youth and elderly were more often given way. Dragonstigen was the site of the three at Regementsgatan with the lowest share of children given way to in the third time period, but that is changed to the fourth time period when the highest shares are shown at Dragonstigen. At the comparison crossings at Bergsgatan, the share of pedestrians given way to increased after change of Code from less than 30% to at least 30%, and also a year and five months after change of Code when at least 40% were given way. Two years after change of code the shares are at least 60% for all ages except elderly. At Munkhättetegatan almost all pedestrians met a car when they crossed the street during all four time periods and almost none of them were given way to, as they legally didn’t have to be since there is no marked zebra crossings.

Pedestrians that have stopped at the curb before crossing the street was less often given way to a year after reconstruction compared to shortly after reconstruction. At Regementsgatan 75% of those that had stopped at the curb were given way to in Time Period 3, in Time Period 4 61% were given way to. Pedestrians not stopping at curb before crossing the street are more often given way to a year after reconstruction compared to shortly after reconstruction. At Regementsgatan 72% of those that did not stop at the curb were given way to in Time Period 3, in Time Period 4 82% were given way to. The trend is the same at the control crossings at Bergsgatan, but the opposite at the comparison site without zebra crossing Munkhättetegatan, but the number of observations is low at Munkhättetegatan.
Of the pedestrians that were given way to all or very close to all were walking in the marked zebra crossing at the three intersections at Regementsgatan and the two intersections at Bergsgatan during all four time periods. The pedestrians that weren’t given way to were also most often walking on the marked zebra crossings at the three intersections at Regementsgatan and the two intersections at Bergsgatan at all four time periods.

Stopping at the curb decreased for children after change of Code and after reconstruction at Regementsgatan. Before changes made 58% of the children stopped at the curb, a year and five months after reconstruction 12% of the children stopped at the curb. Of the elderly 42% stopped at the curb before changes made. Shortly after reconstruction 15% of the elderly stopped at the curb, but a year and five moths after reconstruction the share was increased to 44%. The change of Code did not effect stopping at the curb very much. At the control crossings at Bergsgatan stopping at curb increased in Time period 4 for pedestrians as a group from 26% in Time Period 3 to 28% in Time Period 4. The increase was rather large for the age groups children, adults and elderly (from around 20% to around 40%), but the number of observations for these groups was low, but for youth the share decreased (from 32% to 22%) and the number of youth was high.

The percentage exhibiting a “safe” traffic behaviour of pedestrians defined in terms of looking sideways increased somewhat at the reconstructed intersections, but stopping at the curb before crossing the street decreased. Children and elderly as pedestrians and cyclists were not benefited more than other age groups. The selection of parameters is based on the expert survey described in Johansson, 2001.

At the reconstructed intersections at Regementsgatan, the share looking in both directions before the curb was unchanged low, no effect was shown by the change of Code or reconstruction. The share of pedestrians looking only to the left increased though, from 78% in Time Period 3 to 82% in Time Period 4.

At the comparison crossings at Bergsgatan, looking to the left before the curb increased from 8% in time Period 3 to 27% in Time Period 4. At the comparison site without zebra crossing Munkhättegatan, the trend is also that pedestrian head - turns before the curb but the number of observations is low at some Time Periods.

At Regementsgatan head movements to the left at the curb increased in Time Period 4 from 56% to 70%. Looking in both directions also increased from 14% to 19% At the comparison crossings looking in both directions at the curb did decreased and looking only to the left somewhat increased in Time Period 3 but in Time Period 4 31% looked in both direction and 67% only to the left. The observed changes are the opposite at the comparison site without zebra crossing. At each studied site the pedestrians do head turns to detect cars though.

**Vehicle Speeds**

At Skvadronsgatan the average speed (just before the speed cushion) was 46.3 km/h, at Sergels väg 47.8 km/h and at Dragonstigen 48.3 km/h in Time Period 1, see Table 1. After change of Code, the speed at Skvadronsgatan and Sergels Väg was more or less the same. Three months “shortly” after the reconstruction was completed, the 90-percentile speeds was significantly lowered at the three intersections at Regementsgatan to 42, 39 and 35km/h. The 90-percentiles were 40, 40 and 31 km/h a year after reconstruction. The mean speeds were significantly lower (2-5 km/h) compared to shortly after reconstruction, but the stated goal with traffic calming to reduce the 90-percentile speed on the zebra crossing to below 30 km/h was only fulfilled at one site. As mentioned above free motor vehicle speeds were measured just before the zebra crossing. It should be noted that the speed probably is lower at the zebra crossing compared to just before the speed cushion. According to Towliat (2002) the difference for the 85-percentile is typically 1-5 km/h. Therefore the 90-percentile at the zebra crossing at Regementsgatan – Dragonstigen was probably lower than 30 km/h. Also according to Towliat (2001) the criteria was quite often not fulfilled with this type of speed cushion located before a zebra crossing. At nine sites of 17 studied the 90-percentile was 30 km/h or higher at the zebra crossing. At the comparison sites with zebra crossing the mean speed had increased about 1 km/h a year after reconstruction (compared to shortly after).
Table 1. Vehicle speeds including estimates of mean $m$ and standard deviations of mean $s$

<table>
<thead>
<tr>
<th></th>
<th>Time period 1</th>
<th>Time period 2</th>
<th>Time period 3</th>
<th>Time period 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>all</td>
<td>heavy</td>
<td>all</td>
<td>Heavy</td>
</tr>
<tr>
<td>Regementsgatan - Skvadronsgatan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>304</td>
<td>48</td>
<td>334</td>
<td>43</td>
</tr>
<tr>
<td>$m$</td>
<td>46,3</td>
<td>44,3</td>
<td>47,9</td>
<td>44,7</td>
</tr>
<tr>
<td>$s$ of mean</td>
<td>0,33</td>
<td>0,78</td>
<td>0,34</td>
<td>1,05</td>
</tr>
<tr>
<td>90-perc</td>
<td>54</td>
<td>50</td>
<td>56</td>
<td>51</td>
</tr>
<tr>
<td>Regementsgatan - Beridaregatan, Sergels Väg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>162</td>
<td>-</td>
<td>192</td>
<td>23</td>
</tr>
<tr>
<td>$m$</td>
<td>47,8</td>
<td>-</td>
<td>48,3</td>
<td>45,3</td>
</tr>
<tr>
<td>$s$ of mean</td>
<td>0,52</td>
<td>-</td>
<td>0,46</td>
<td>1,33</td>
</tr>
<tr>
<td>90-perc</td>
<td>55</td>
<td>-</td>
<td>56</td>
<td>54</td>
</tr>
<tr>
<td>Regementsgatan - Dragonstigen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>198</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$m$</td>
<td>48,3</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$s$ of mean</td>
<td>0,40</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>90-perc</td>
<td>55</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Munhättegatan - Nydalastigen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>-</td>
<td>-</td>
<td>218</td>
<td>14</td>
</tr>
<tr>
<td>$m$</td>
<td>-</td>
<td>-</td>
<td>50,4</td>
<td>47,9</td>
</tr>
<tr>
<td>$s$ of mean</td>
<td>-</td>
<td>-</td>
<td>0,41</td>
<td>1,82</td>
</tr>
<tr>
<td>90-perc</td>
<td>-</td>
<td>-</td>
<td>59</td>
<td>57</td>
</tr>
<tr>
<td>Bergsgatan - Kristianstadvägen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>-</td>
<td>-</td>
<td>59</td>
<td>13</td>
</tr>
<tr>
<td>$m$</td>
<td>-</td>
<td>-</td>
<td>47,6</td>
<td>49,4</td>
</tr>
<tr>
<td>$s$ of mean</td>
<td>-</td>
<td>-</td>
<td>0,76</td>
<td>1,96</td>
</tr>
<tr>
<td>90-perc</td>
<td>-</td>
<td>-</td>
<td>54</td>
<td>56</td>
</tr>
</tbody>
</table>

The speed decrease at Regementsgatan implies less severe injuries to be expected and with high probability also a lowered injury risk.

At the comparison site without zebra crossing, at Munhättegatan, measurements were made for two time periods. After change of Code the average speed was 50.4 km/h, two years after the change of Code, the average speed was 51.4 km/h. A small significant increase in speed.

Heavy vehicles most often were driven slower than the total.

**Conflicts and Situations**

In total, 44 conflicts were observed in time periods 1 to 3; of them 17 were severe. The numbers of severe conflicts are too low at each intersection to draw any firm conclusions; the type of conflicts will be discussed here.

In the severe conflicts most often the driver of the involved motor vehicle took the evasive action independently of time period. In the not so severe conflicts more often the vulnerable road user took the evasive action. Of the totally 27 not severe conflicts it was in six cases the driver of the motor vehicle who took the evasive action, also this is independent of time period.
Of the totally observed 106 persons, 47 are adults, 32 are teenagers, 19 are children and 8 were elderly. More than half or ten of the children and half of the elderly were observed at Skvadronsgatan. 19 of the teenagers were observed at Munkhättegatan, the comparison site without zebra crossing. The adults were equally spread over the six sites. 18 persons were involved in severe conflicts and of these ten were adults, three were teenagers and five elderly. No changes were shown concerning the age of the involved pedestrians and cyclists in neither conflicts nor other Situations during the three time periods.

In Situations and conflicts at the comparison crossings at Bergsgatan and the comparison site without zebra crossing Munkhättegatan, portion of people stopping at the curb increased after change of code. At Regementsgatan it decreased. After reconstruction at Regementsgatan the stopping frequency increased, but at the comparison sites it decreased.

In all the Situations and conflicts at intersections with marked zebra crossings the pedestrians cross at the marked zebra crossings. The cyclists that are involved in Situations and conflicts at cycle crossings, if these are provided, at Regementsgatan most of the cyclists in Situations and conflicts cross the street at the intersections, not in the marked zebra crossings.

Looking sideways before reaching the curb when involved in Situations or conflicts to detect cars is not as common as for those not involved in Situations or conflicts. 58% of those involved in Situations or conflicts looked at least to the left before the curb and that is 10 percentage points lower than for the total observations. At the curb they did look sideways as much as those not involved in Situations or conflicts.

**School Surveys**

*Questionnaire 1 and 3*

As can be seen in Table 2 the percentage of school children that marked a dangerous spot at Regementsgatan was lower after reconstruction than before. However, especially at grade 1 and 2 the percentage was high even after 73% and 67% respectively, see also Figure 4 showing all dangerous locations on school itineraries according to pupils after the reconstruction.

<table>
<thead>
<tr>
<th>School grade</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4-6</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before (%)</td>
<td>78</td>
<td>68</td>
<td>79</td>
<td>66</td>
<td>73</td>
</tr>
<tr>
<td>After (%)</td>
<td>73</td>
<td>67</td>
<td>58</td>
<td>61</td>
<td>64</td>
</tr>
<tr>
<td>Total no. of answers</td>
<td>53</td>
<td>52</td>
<td>55</td>
<td>41</td>
<td>226</td>
</tr>
</tbody>
</table>

The percentage of school children walking alone or with a friend to school increased from 46% before to 64% after the reconstruction, see Table 3. Also cycling to school increased from 4% to 8%, see Table 4.

<table>
<thead>
<tr>
<th>School grade</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walked alone or with a friend BEFORE</td>
<td>7</td>
<td>43</td>
<td>56</td>
<td>53</td>
<td>53</td>
<td>68</td>
</tr>
<tr>
<td>Walked alone or with a friend AFTER</td>
<td>19</td>
<td>43</td>
<td>59</td>
<td>75</td>
<td>78</td>
<td>88</td>
</tr>
<tr>
<td>Walked with adult BEFORE</td>
<td>59</td>
<td>28</td>
<td>22</td>
<td>2</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Walked with adult AFTER</td>
<td>63</td>
<td>35</td>
<td>13</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total number of school children BEFORE</td>
<td>34</td>
<td>41</td>
<td>40</td>
<td>43</td>
<td>33</td>
<td>23</td>
</tr>
<tr>
<td>Total number of school children AFTER</td>
<td>34</td>
<td>42</td>
<td>49</td>
<td>59</td>
<td>45</td>
<td>48</td>
</tr>
</tbody>
</table>
Figure 4. Dangerous spots at children’s school itineraries in grade 1-3 and 4-6 respectively after the reconstruction. The number indicates the amount of school children marking the spot.

Table 4. Percentage of school children using other modes to school before and after reconstruction of Regementsgatan.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Before (%)</th>
<th>After (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycled alone or with friend</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Cycled with adult</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Buss</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Car</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Else</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>Total no. of answers</td>
<td>213</td>
<td>276</td>
</tr>
</tbody>
</table>
As can be seen from Figure 5 and 6 more school children are cycling along Regementsgatan after the rebuilding.

Figure 5. School childrens’ cycle itineraries on free time in grade 1-3. The number indicates the amount of school children cycling on the marked itinerary.
Questionnaire 2

At the comparison site without zebra crossing, Munkhättetgatan, where there was no reconstruction but change of Code, only 27% of the school children stated that the safety had improved. However, 87% expressed the view that the safety had increased at the sites, which were reconstructed.

49% of the school children at Regementsgatan expressed the view that the assessed change in risk was caused by just the reconstruction or mostly by the reconstruction.

At the site Munkhättetgatan, where there was no reconstruction but change of Code only 18% of the school children stated that they had crossed Munkhättetgatan less frequently before the change. However 39% of the
school children assessed that they crossed Regementsgatan less frequently before the reconstruction and change of Code.

Results of the expert analysis and questionnaire to disabled people

The effect is estimated to be 5% for adults cycling along and 19% for children, and 46% for both children and adults cycling across Regementsgatan. The perceived effect is estimated to be 40% for cycling children and 30% for cycling adults. The experts have assessed that the mobility is twice as good for cycling children after the reconstruction compared to before. There is no consensus at all about the mobility effect for cycling adults. Eight of the nine experts assessed that Regementsgatan were more beautiful after rebuilding.

All experts assessed that the safety and mobility for disabled people have improved in general. However in relation to bicycle traffic safety has not improved for disabled people according to the experts.

According to the experts the design could have been further improved, for example by using one-directional paths on each side of the street.

SUMMARY, DISCUSSION AND CONCLUSION

The mean speeds were significantly lower after reconstruction and still lower (2-5 km/h) a year after reconstruction compared to shortly after reconstruction, but the stated goal with traffic calming to reduce the 90-percentile speed to below 30 km/h was not fulfilled. At Dragonstigen, the goal is almost met. The speed decrease at Regementsgatan implies less severe injuries to be expected and with high probability also a lowered injury risk.

The experts assessed that the rebuilding is more effective when cycling across Regementsgatan compared to when cycling along. The cycle track is estimated to be more effective for kids than adults. The experts have assessed that the mobility is twice as good for cycling children after the reconstruction compared to before. However according to the experts the design could have been further improved.

All experts assessed that the safety and mobility for disabled people have improved in general. However in relation to bicycle traffic safety has not improved for disabled people according to the experts.

The share of pedestrians given way to increased both after change of code and shortly after reconstruction at Regementsgatan, but children and elderly did not benefit more than other age groups. In Time Period 4 the share increased further for those not stopping at curb compared to Time Period 3. At the two comparison crossings at Bergsgatan, the share of pedestrians given way to also increased after change of Code and a further increase was seen a year and five months after the change of Code. Also an increase but smaller was shown at the comparison crossings at Bergsgatan two years and five months after change of Code. Children and elderly did not benefit especially here either. In other words the mobility has increased for the pedestrians as a group but children and elderly, the weakest age groups, did not benefit more than other age groups.

The children’s view after the reconstruction was that the mobility had increased, while the children at the comparison crossing meant that the mobility there was more or less unchanged under this time period. The actual behaviour confirmed this. More school children were walking and cycling to school and more school children were cycling along Regementsgatan on free time after the reconstruction compared to before.

In terms of car drivers giving way and pedestrians not having to stop at the curb, the effect of the change of Code was increased mobility at the marked zebra crossings both for pedestrians and cyclists. The reconstruction at Regementsgatan increased the mobility even more, and also safety as vehicle speeds was reduced. The percentage exhibiting a “safe” traffic behaviour of pedestrians defined in terms of looking sideways increased somewhat at the reconstructed intersections, but stopping at the curb before crossing the street decreased. Children and elderly as pedestrians and cyclists were not benefited more than other age groups.

At the sites with marked zebra crossings the effect of the time factor was that the mobility increased in May 2002 compared to September 2001 for pedestrians, both at sites earlier reconstructed and at the sites not reconstructed. At the reconstructed sites the effect was larger. Children and elderly were not benefited more than
others were though. At the comparison site without a zebra crossing the effect was the opposite, pedestrians stopped more often at the curb (at Time Period 4 compared to Time Period 3).

It has been estimated that traffic maturity is reached at around 12 years of age (MacGregor et al., 1999). The concepts of time, speed, and distance also undergo a lengthy developmental sequence. Children under the age of 12 have been found to have particular problems perceiving the direction of moving traffic, estimating the speed of oncoming vehicles, and performing adequate auditory estimates of approaching vehicles. Results suggest that the speeds are still too high at Regementsgatan, especially for the younger school children. Especially the school children 6 to 10 years old at grade 1 to 3 still considered Regementsgatan to be dangerous. However their mobility have increased.

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