The effects of traffic calming on child pedestrian skills development

Prepared for Road Safety Division, Department for Transport

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Executive Summary

Engineering measures, such as traffic calming, are particularly effective in bringing about a reduction in casualties for vulnerable road users such as child pedestrians and cyclists. However it is not known what effect such measures have on the development of pedestrian skills in children growing up in such environments, or the safety of children who are familiar with traffic calmed environments when they are exposed to traffic in un-treated areas. The aim of this project is to look for any measurable differences in the skills of these children which may indicate a need for additional training or publicity.

The first phase of the project reviewed the relevant literature and re-examined existing data on child pedestrian exposure in calmed and un-calmed areas, and gathered information for the design and implementation of an empirical study. The empirical study, which formed the second phase of the project, compared the pedestrian skills and exposure of children growing up in a traffic calmed area to those of children growing up in a nearby 'untreated' control area. Pupils in schools local to each area were tested, and their parents/guardians interviewed.

The literature review found no direct research on the development of child pedestrian skills in traffic calmed areas. Some indirect evidence suggested that the type of road traffic environment may influence factors affecting the development of pedestrian skills. In particular, research suggests that the interaction between the perceived safety of an environment, the type of safety advice given to children by adults (which itself may be dependent on the environment), and the level of independent exposure afforded to children may influence skills development. The literature also suggested that modified sites may not necessarily be perceived as safer than untreated sites, and that there was some limited evidence that independent exposure may increase in modified sites.

The re-analysis of child pedestrian exposure data found that children from calmed areas make more journeys on foot and less by car, are likely to make fewer trips but stay out for longer when they go out, and are less likely to be accompanied by somebody over 16 years of age, and that young males from calmed areas spend more time making trips than young males from un-calmed areas.

Following a review of the road safety skills tests which may be used to detect differences in skills between children from calmed and un-calmed areas, two tests were selected: a 'visual timing and gap selection' test and a 'safe place crossing location' test. The visual timing and gap selection test was thought to be most pertinent to this study, since children used to calmed areas where speeds are well regulated may be less skilled in coping with fast moving traffic on un-calmed roads. The second test compliments this as it tests a different set of skills.

A PC version of the visual timing and gap selection test has clear advantages over its roadside equivalent, but had not been validated against the roadside test prior to this study. An exercise to validate the PC test against roadside tests conducted in schools local to TRL with 7-9 year old pupils showed results from the two tests to compare favourably. On the basis of these validation tests it was decided to use the PC version of the test in the main study, but to complement this with a limited number of roadside tests. It is possible that three age groups might be of interest in examining possible differences in road safety skills of those children from calmed and un-calmed areas: 7-9, 10-11 and 11-12 years. The first category (Years 3 and 4, i.e. 7-9 year old pupils) was selected for the main study, as this is the age at which learning starts to increase rapidly, and where it is thought that any measurable skill differences will (if they exist) start to emerge. It is also likely that at this age experience of traffic will still largely be gained in the area close to home.

A large traffic-calmed area in Worcester Park, Surrey, was chosen for the study, using a nearby untreated area for a 'control'. Four primary/junior schools, 2 in the calmed area and 2 in the control area, agreed to co-operate in the study, and approximately 25 pupils aged 7-9 in each school took part in the road safety skills tests.

The PC visual timing and gap selection test detected no difference in skills between those pupils from the calmed area and those from the control area. There were some small improvements in skills from Year 3 to Year 4, and those of higher rated ability scored better than those of lower rated ability, suggesting that the test was able to identify skills differences where they exist. The roadside visual timing and gap selection test did detect some statistically significant differences in skills of children from the calmed and control area, with the children from the calmed area appearing to be the more skilful. However, these differences could equally be attributable to differences (mean age and academic ability – factors found to result in improvements in skills in the PC tests) in the two samples of children rather than exposure to calmed or un-calmed streets.

The safe crossing location test was scored against two factors – the safety of the crossing locations selected, and the reasons given for the choice of crossing location (the conceptual score). Pupils from the calmed area generally scored very slightly higher on the safety scale (i.e. their crossing locations were more safe) than those from the control area, although the difference rarely reached statistical significance. However, they tended to score lower on the conceptual scale (i.e. their reasons were less sound) than those from the control group. There were no differences between scores of pupils from different school years or of different assessed ability.

The interviews with parent/guardians suggested that the children from the calmed and control areas were reasonably well-matched on factors other than the traffic calming in their street. However, slightly more of the children in the calmed area were driven to school. There were no differences (calmed versus control) in the types of areas (gardens, streets etc) in which the children played or spent time, or in the time spent walking or playing near

home. When asked whether their child would be able to cross safely at various crossing facilities, slightly more of the parents from the calmed area said he or she would be able to cross safely, although the difference in numbers were not statistically significant. Similarly when asked if the child would be allowed to undertake certain activities (e.g. walk alone to the local shop) the parents from the calmed area were slightly more permissive, although differences between the calmed and control area were not statistically significant. Overall, the results of the interview survey suggest little difference in the exposure of children on local roads in the calmed and control areas.

The study has shown little difference in the road safety skills of those children living in a traffic calmed area compared to those living in an un-calmed area. It is likely that individual differences in pupils' road safety skills due to (for example) the attitudes of parents towards road safety, and differences between schools are greater than those resulting from living in a calmed or un-calmed environment. It is thought that further testing at different sites/with different age children/using different skills tests is unlikely to detect significant differences.

1 Introduction

1.1 Background

Road engineering measures such as traffic calming are well established in places such as the Netherlands, and are being used increasingly in the United Kingdom to reduce traffic speeds. Engineering measures are particularly effective in bringing about a reduction in casualties for vulnerable road users such as child pedestrians and cyclists (Webster and Mackie, 1996). However, it is not known what effect such measures have on the development of pedestrian skills in children growing up in such environments. It is possible that gaining experience as pedestrians in areas where vehicle speeds are well managed might limit children's ability to deal safely with traffic on un-calmed roads.

Environmental factors are major influences on the accident liability of child pedestrians. Residential roads with through traffic, high vehicle speeds and flows, and on street parking pose particular risks for children (Tight 1987, Ward *et al.* 1994, Christie 1995). In the UK, these road features are characteristic of many old urban areas, and have been identified as possible reasons for the particularly high child pedestrian accident rate in the UK compared to other northern European countries (Lynam and Harland 1992).

Under the White Paper 'A new deal for Transport: Better for everyone', published in July 1998 (DETR, 1998), local authorities were required to draw up five year Local Transport Plans containing their proposals for delivering an intensive transport policy. Measures to reduce accidents include:

- Local safety schemes, including 20 mph zones and traffic calming schemes giving greater priority to safer walking by providing more pedestrian crossings and improving footpath maintenance.
- Making it easier and safer to cycle, through provision and maintenance of cycle lanes.
- Reducing the volume of traffic, establishing traffic-free zones and more pedestrianised areas.

As a result there is likely to be a growing number of area-wide road engineering schemes aimed at reducing the speed of traffic, and making it safer for children to walk or cycle. In particular, 'Home Zones' are now being introduced in the UK. 'Home Zone' is a term for residential areas in which pedestrians, cyclists and motorised traffic all have equal status and vulnerable road users are able to use all of the road space. Within the zone the aim is to keep speeds below 20mph (Jones and Childs 1999).

There are some concerns about the development of child pedestrian skills in such traffic calmed sites, as Preston (1995) commented: 'It has been suggested that if children got used to playing on the road in these areas they would also play on other roads and so accidents outside the protected Home Zones might increase. The boundaries of the Home Zones must be clearly marked and children must be taught the difference between protected Home Zones and other roads. The possibility of accident migration must be considered seriously but the evidence suggests that playing on the roads in residential safety zones does not lead to an overall increase in accidents.' There is not strong evidence that accidents migrate to untreated areas around modified zones. On the contrary, Mackie and Webster (1995) found an overall accident decrease of 16 percent on surrounding roads following the implementation of traffic calming schemes.

However, it is not known whether growing up in one particular type of road environment influences the development of pedestrian skills. Children may receive different types of safety advice or may be allowed different levels of mobility exposure according to how safe their parents or carers perceive the environment to be. These different influences may well equip children with different skills as pedestrians, but the mechanisms are not well understood.

1.2 Objectives

The overall project objectives were:

- To compare the road behaviour, activity levels, strategies (including risk appraisal), skills, attitudes and knowledge of children who have grown up in or been largely exposed to traffic calmed areas with those who have grown up in untreated areas.
- To assess the impact of environmental improvements on independent play, travel and accompaniment strategies.
- To assess whether the adaptations and cognitive rules developed in traffic calmed environments are sufficient to protect children in potentially more dangerous environments, or whether the lack of early experience of danger or potential danger places these children at greater risk.
- To relate any differences in child behaviour to the differences in road design and the differences in the behaviour of other road users in these areas.
- If differences are identified between children from calmed areas and those from other areas, to develop recommendations for enhancing pedestrian training.

1.3 Survey methods

The project was completed in two phases. The first phase included:

- Reviewing current international literature.
- Further analysis of existing databases on exposure of children in calmed and un-calmed areas.
- Considering which skills are most likely to vary between children growing up in different street environments and examining the tools that could be used for measuring these skills.
- Reviewing traffic calming schemes in Great Britain to try to ascertain the feasibility of locating suitable areas in which to conduct a study.

The second phase included:

- Testing skills identified as important in the first phase of the research in schools within a traffic calmed area and in a nearby untreated 'control' area. One of the selected tests (a gap acceptance test) was computer based, and it had not previously been determined whether or not it gave results similar to comparable tests conducted at the roadside. The computer test was validated in tests at schools local to TRL prior to the main tests in the calmed and control sites, as part of the second phase of the research. These validation tests are described within this report;

- Conducting an interview survey with the parents/ guardians of the children tested in the schools (calmed and control) to determine their child's exposure to road traffic, and their level of accompaniment.

2 Phase 1: Review of existing data and development of design methodology

2.1 Literature review

2.1.1 Method

The aim of the literature review was to assess the research evidence on whether the development of pedestrian skills is influenced by early experience in different types of road traffic environments.

The review was carried out using a number of psychological, health and road research library databases, including PSYCINFO, MEDLINE and IRRD. Additionally, contact was made by email to researchers at main European transport research establishments to find out if any relevant ongoing (or as yet unpublished) research existed.

These searches showed that no studies had directly investigated whether pedestrian skills develop differently according to the environment. However, there is indirect evidence to suggest that the interaction of a number of different factors may affect the way children develop pedestrian skills. The literature suggests that the perceived safety of an environment will affect both the type of safety advice provided by adults, and the amount of independent exposure afforded to the child by its parent or carer. This review focuses on the studies that have looked at the interaction of these factors.

2.1.2 Safety advice and training according to degree of traffic separation

The safety training and advice a child receives from adults may vary according to how safe the environment is perceived to be, and this advice may influence the development of pedestrian skills.

Bjorklid (1992) conceptualised child pedestrian behaviour from the perspective of the ecology of human behaviour. From this perspective children develop through a relationship of active interplay with the environment and the quantity and quality of that interplay is likely to be influenced by the parent or carer. Bjorklid argued that when adult carers experience worry and stress over their children’s traffic environment, they attempt to protect their children in a variety of ways by engaging in activities to improve the environment, pointing traffic dangers and limiting freedom of movement. She carried out a survey to investigate how adults (teachers and parents) interpret children’s traffic environment and how this influenced the traffic safety advice they gave children. Interviews were carried out with teachers and a questionnaire was completed by parents and 90 children aged between 8 and14, two thirds of whom lived in a traffic-intensive area and the rest in a traffic-separated area.

There were marked differences in the ways teachers perceived the safety of the traffic environment and the road safety education goals they promoted. Comparisons between the responses of teachers living in the two types of traffic environment suggested that teachers in the less safe, traffic-intensive environments were more likely to:

- Perceive the immediate environment as dangerous for pupils.
- Mention traffic safety.
- Be more worried about children’s safety.
- Express the need for environmental measures.
- Be more motivated to try and protect children by imposing the use of cycle helmets and by pointing specific dangers in traffic environment.

Teachers in the safer environment were more likely to:

- Mention the meaning of traffic signs and rules.
- Express concerns that children did not get sufficiently used to environments with traffic.

Results also showed substantial differences between parents living in different areas. All the parents in the traffic-segregated area regarded the route to school as safe compared to only 42 percent of parents in the unsegregated environment. In the traffic-intensive areas 68 percent of carers worried about their children’s safety on the route to school compared to only 6 percent of parents in the traffic-segregated area.

Children in the traffic intensive areas perceived their local environment as more dangerous than children in the traffic segregated and also reported more anxiety, higher risks, limited freedom of mobility and greater discomfort from car emissions.

These findings suggest that the perceived safety of the environment by the adult carers may lead them to generate different sorts of safety advice. This may lead to the development of different pedestrian skills. Children who experience dangerous traffic environments may be made more aware of risks and how to cope with them by their carers compared to children living in safer environments. Therefore it might be expected that they may have better risk appreciation and a wider repertoire of coping strategies than children whose carers feel that this safety advice is less necessary.

Johansson and Drott (1996) reported similar findings. They looked at the road safety goals of pre-school teachers and parents of pre-school children, aged 4 to 6, with respect to traffic education. Interviews were carried out with ten pre-school teachers and a questionnaire-based survey was successfully completed by 56 parents who were asked to estimate their child’s skill as a road user. The researchers identified two goals used by adults. One goal emphasised cautiousness, and the other independence or coping skills. They found that the cautiousness goal dominated the traffic-segregated areas and the independence goal was characteristic of the less safe traffic-intensive areas. The types of advice characterising the independence goal involved telling children to:

- Be afraid of traffic.
- Understand that there are rules that have to be strictly followed.
- Know how to behave in traffic.

They also found a positive correlation between traffic intensity and emphasis on skills and protective devices.

2.1.3 Exposure

If the parent or carer regards the environment as safe then the child may be allowed more independent mobility and as a result have more opportunities to learn pedestrian skills. In this way it may be expected that modified sites may be associated with greater independent exposure for children compared to areas without traffic calming measures. However, there is evidence that some modified sites are still not regarded as safe enough for children to be allowed independent mobility.

For example, Jones and Childs (1999) looked at the perception of residents in a Home Zone area in the UK. The study was based on 74 questionnaires and represented 48 percent of households in the zone. Speeds were not perceived as slow enough on the shared surfaces for it to be regarded as being safe. Most children reported that they enjoyed playing on the surface though a significant minority did not, because they felt unsafe.

Allott and Lomax (1999) carried out a survey in Seedley, Salford where a number of engineering measures had been introduced, including a 20mph scheme, mini roundabouts, kerb realignment, speed cushions, round top road humps, road narrowings, build-outs, entry signs and gateways into the zone.

The scheme was monitored with respect to the effect on the environment, traffic levels, noise, air quality, accident reduction and severance. Surveys methods included traffic counts, video data and a questionnaire-based survey among the residents which, among other things, looked at children's exposure and the reasons why journeys were made in particular ways. The same survey methods were used before and after the measures were implemented.

Results showed that there was no change in the volume of traffic but average speed had been reduced by 19 percent from 28mph to 23mph. Video surveys indicated that street activity did not appear to be affected by the zone and people were not inclined to spend more time undertaking activities in the street as a result of the zone. Residents perceived the area to be safer but, although actual speeds had been reduced, the residents had not perceived a significant reduction in vehicle speeds. Some parents reported that they were more likely to let children play out but there was no notable increase in activity. There was some evidence of a less cautious approach by pedestrians after the modifications with less care being taken in looking for approaching traffic. However, the 'before' surveys were conducted between June and July and the 'after' surveys in January and October. Therefore it is possible that seasonal factors affected these responses.

2.1.4 Conclusions

- No direct research on the development of child pedestrian skills in traffic calmed areas was identified through the literature searches.
- There is some indirect evidence that the factors which may influence the development of pedestrian skills may vary according to the type of road traffic environment. In particular, research suggests that the interaction between the perceived safety of an environment, the type of safety advice given to children by adults and the level of independent exposure afforded children may influence skill development.
- Safety advice itself may vary according to the type of environment especially with respect to risk awareness, and the need to follow rules and to use protective devices.
- It cannot be assumed that modified sites will be perceived to be safer. Some modified areas may not be perceived to be greatly safer by the residents even when objective measures show significant reductions in vehicle speed.
- There is some evidence that independent exposure may increase in modified sites but this is not conclusive.

2.2 Analysis of child pedestrian exposure data

2.2.1 Method

In 1999 MVA Limited published their European study of child pedestrian exposure and accidents (MVA Limited, 1999). The aim of the study was to try to explain the higher accident rates amongst child pedestrians in Great Britain compared with their European counterparts. A key finding of this study was that special measures to reduce speed were a highly significant contributory factor, and could explain about a third of the gap between the Netherland's and Britain's accident rates. An overview of the surveys undertaken and the available data is given in Appendix A1.

It was decided to perform further analysis of this very rich data-set to look for differences in exposure levels between British children (aged 5-15 years) living in traffic calmed areas and British children living in other areas. It was known that the data on engineering measures in the other two European countries were not consistently recorded, due to problems determining when the measures had been installed. Given this, the nature of the project, and the potential underlying cultural influences, it was decided not to include the non-British data.

2.2.2 Results

The calming status of the home area of the child was not recorded in the MVA database. It was therefore necessary to try to derive this information from the data based on reasonable assumptions about their travel patterns. This method is described in Appendix A2 and relies on detailed trip stage information. Once the respondent has been classified as living in a calmed or un-calmed area then the diary data for the trips on the pre-interview day can be analysed.

An example of a diary day for a 7 year old boy from an un-calmed area on a school day is shown below. Details of the roads crossed, traffic situation etc. are all contained within the stage records for the trip selected for detailed investigation.

Time	*Trip*	*Stage*	*Mode*	*Purpose*	*Accom-panied by adult*	*Stage time*
08:45	1	1	Foot	To school	Yes	2 mins
15:20	1	2	Foot	From school	Yes	2 mins
16:00	2	3	Bicycle	Playing/hanging about streets	n/a	30 secs.
16:05	2	4	Bicycle	Other activity	n/a	1 min.
16:15	2	5	Bicycle	To/from visiting friends	n/a	30 secs.
17:00	3	6	Foot	To/from visiting friends	No	1 min.
17:01	3	7	Foot	To/from visiting friends	No	3 mins.
17:30	3	8	Foot	To/from visiting friends	No	1 min.

Out of the sample of 1,002 UK respondents it was possible to identify whether the home area was calmed or un-calmed in 525 cases. i.e. just over half of the whole sample. However, there were only 62 (11.8 percent) who lived in a calmed area. All the statistics for calmed areas are based on just these 62 respondents. There was an even gender split in each of the two samples: 50 percent of the calmed sample were female, compared with 51 percent of the un-calmed sample.

Table 2.1 shows that there was no particular bias in the age of children identified as living in a calmed area compared the sample of children from un-calmed areas.

Table 2.1 Age group by living in calmed area or not

		Calmed		
Age group		*No*	*Yes*	*Total*
5-7	Count	125	18	143
	% within calmed	27.0%	29.0%	27.2%
8-9	Count	77	10	87
	% within calmed	16.6%	16.1%	16.6%
10-11	Count	88	12	100
	% within calmed	19.0%	19.4%	19.0%
12-13	Count	101	11	112
	% within calmed	21.8%	17.7%	21.3%
14-15	Count	72	11	83
	% within calmed	15.6%	17.7%	15.8%
Total	Count	463	62	525
	% within calmed	100.0%	100.0%	100.0%

The type of trips reported, as shown in Table 2.2a and Table 2.2b, were mainly on foot and there was a slightly higher percentage of journeys on foot for those living in a calmed area. Conversely, there were slightly fewer trips by car, but neither of these differences were statistically

Table 2.2a Mode of trip by living in calmed area or not (respondent based)

		Calmed		
Mode of trip		*No*	*Yes*	*Total*
Foot	Count	378	54	432
	% within calmed	81.6%	87.1%	82.3%
Roller Blade, Skate	Count	5	1	6
	% within calmed	1.1%	1.6%	1.1%
Bicycle	Count	12	0	12
	% within calmed	2.6%		2.3%
Car	Count	47	4	51
	% within calmed	10.2%	6.5%	9.7%
Bus	Count	19	1	20
	% within calmed	4.1%	1.6%	3.8%
Train	Count	1	0	1
	% within calmed	0.2%		0.2%
Other or missing	Count	1	2	3
	% within calmed	0.2%	3.2%	0.6%
Total	Count	463	62	525
	% within calmed	100.0%	100.0%	100.0%

Table 2.2b Mode of trip by living in calmed area or not (trip based)

		Calmed		
Mode of trip		*No*	*Yes*	*Total*
Foot	Count	1134	138	1272
	% within calmed	74.7%	80.2%	75.3%
Roller Blade, Skate	Count	18	3	21
	% within calmed	1.2%	1.7%	1.2%
Bicycle	Count	63	0	63*
	% within calmed	4.2%		3.7%
Car	Count	195	19	214
	% within calmed	12.9%	11.0%	12.7%
Bus	Count	97	7	104
	% within calmed	6.4%	4.1%	6.2%
Train	Count	4	1	5
	% within calmed	0.3%	0.6%	0.3%
Other or missing	Count	6	4	10
	% within calmed	0.4%	2.3%	0.6%
Total	Count	1517	172	1689
	% within calmed	100.0%	100.0%	100.0%

Calmed significantly different from un-calmed at P<0.05 (Chi-square test).

significant (Chi-square). There were, however, significantly more trips (Chi-square, $P<0.05$) by bicycle in the un-calmed area (Table 2.2b). The tables with sample sizes of 525 are based on respondents with their trip data being inversely weighted by the number of trips to give equal weight to each respondent. Tables with sample sizes of 1,689 are based on trips. The figures in these tables give greater weight to respondents recording higher numbers of trips.

The purpose of the trip (for those categories identified within the coding frame) as in Tables 2.3a and 2.3b, suggested that a higher percentage of trips were going to school for those in un-calmed areas when compared to those in calmed areas. This difference was statistically significant at P<0.05 (Chi-square test) when the number of trips are considered (Table 2.3b). There is no apparent reason for this, unless there was a problem recording and coding school trips.

Table 2.3a Purpose of trip by living in calmed area or not (respondent based)

Purpose of trip		*Calmed* No	*Calmed* Yes	*Total*
To school	Count	106	8	114
	% within calmed	22.9%	12.9%	21.7%
From school	Count	65	6	71
	% within calmed	14.0%	9.7%	13.5%
To/from visiting friends	Count	68	7	75
	% within calmed	14.7%	11.3%	14.3%
Playing/hanging about the streets	Count	41	7	48
	% within calmed	8.9%	11.3%	9.1%
Other or missing	Count	183	34	217
	% within calmed	39.5%	54.8%	41.3%
Total	Count	463	62	525
	% within calmed	100.0%	100.0%	100.0%

Table 2.3b Purpose of trip by living in calmed area or not (trip based)

Purpose of trip		*Calmed* No	*Calmed* Yes	*Total*
To school	Count	335	23	358*
	% within calmed	22.1%	13.4%	21.2%
From school	Count	221	20	241
	% within calmed	14.6%	11.6%	14.3%
To/from visiting friends	Count	229	20	249
	% within calmed	15.1%	11.6%	14.7%
Playing/hanging about the streets	Count	128	19	147
	% within calmed	8.4%	11.0%	8.7%
Other or missing	Count	604	90	694
	% within calmed	39.8%	52.3%	41.1%
Total	Count	1517	172	1689
	% within calmed	100.0%	100.0%	100.0%

Calmed significantly different from un-calmed at P<0.05 (Chi-square test).

Those living in un-calmed areas made fewer trips from school than they did going to school. This suggests that they had other activities after school and returned from these, as opposed to directly from school (and so the trip was not coded as a school journey).

Looking at just those trips undertaken on foot, as in Table 2.4, shows a similar picture to that in Tables 2.3a and 2.3b and does not explain the difference in going to and returning from school for those children in un-calmed areas.

Tables 2.5 and 2.6 show the mode of trip when either going to or returning from school. The mode of trip is very similar for both types of journey, except that no children from calmed areas travelled to or from school by car, although this difference is not statistically significant.

Table 2.4 Purpose of trip by living in calmed area or not for journeys on foot

Purpose of trip		*Calmed* No	*Calmed* Yes	*Total*
To school	Count	260	19	279*
	% within calmed	22.9%	13.8%	21.9%
From school	Count	174	17	191
	% within calmed	15.3%	12.3%	15.0%
To/from visiting friends	Count	191	18	209
	% within calmed	16.8%	13.0%	16.4%
Playing/hanging about the streets	Count	88	17	105
	% within calmed	7.8%	12.3%	8.3%
Other or missing	Count	421	67	488
	% within calmed	37.1%	48.6%	38.4%
Total	Count	1134	138	1272
	% within calmed	100.0%	100.0%	100.0%

Calmed significantly different from un-calmed at P<0.05 (Chi-square test).

Table 2.7 shows the percentage of trips made where the child is accompanied by a person over 16 years of age. There is a 5 percent difference between those living in calmed as opposed to un-calmed areas, with those from calmed areas making more trips without an adult and fewer with an adult, although this difference is not statistically significant.

Table 2.8 shows that for nearly 84 percent of those living in a calmed area there is a play area within 10 minutes, whereas for those not in a calmed area this is over 11 percent less. This is not surprising because it is likely that there are play areas integrated with traffic calming schemes in some instances. However, the difference is not statistically significant.

Table 2.5 Mode of trip by living in calmed area or not – going to school

Mode of trip		*Calmed* No	*Calmed* Yes	*Total*
Foot	Count	260	19	279
	% within calmed	77.6%	82.6%	77.9%
Roller Blade, Skate	Count	2	0	2
	% within calmed	.6%		.6%
Bicycle	Count	2	0	2
	% within calmed	.6%		.6%
Car	Count	34	0	34
	% within calmed	10.1%		9.5%
Bus	Count	35	3	38
	% within calmed	10.4%	13.0%	10.6%
Train	Count	1	0	1
	% within calmed	.3%		.3%
Other or missing	Count	1	1	2
	% within calmed	.3%	4.3%	.6%
Total	Count	335	23	358
	% within calmed	100.0%	100.0%	100.0%

Table 2.6 Mode of trip by living in calmed area or not – returning from school

Mode of trip		*Calmed* *No*	*Yes*	*Total*
Foot	Count	174	17	191
	% within calmed	78.8%	85.0%	79.3%
Roller Blade, Skate	Count	2	0	2
	% within calmed	0.9%		0.8%
Bicycle	Count	0	0	0
	% within calmed			
Car	Count	22	0	22
	% within calmed	10.0%		9.1%
Bus	Count	21	2	23
	% within calmed	9.5%	10.0%	9.5%
Train	Count	1	0	1
	% within calmed	0.5%		0.4%
Other or missing	Count	1	1	2
	% within calmed	0.5%	5.0%	0.8%
Total	Count	221	20	241
	% within calmed	100.0%	100.0%	100.0%

Table 2.7 Percentage of trips made with person over 16 years old

Percentage		*Calmed* *No*	*Yes*	*Total*
None	Count	679	90	769
	% within calmed	61.0%	66.2%	61.9%
1% - 89%	Count	24	2	26
	% within calmed	2.2%	1.5%	2.1%
91% - 99%	Count	10	2	12
	% within calmed	0.9%	1.5%	1.0%
100%	Count	400	42	442
	% within calmed	35.9%	30.9%	35.4%
Total	Count	1113	136	1249
	% within calmed	100.0%	100.0%	100.0%
(excludes missing values)				

Table 2.8 Play area 10 minutes away by living in calmed area or not

Play area 10 mins away		*Calmed* *No*	*Yes*	*Total*
Yes	Count	334	52	386
	% within calmed	72.1%	83.9%	73.5%
No	Count	126	10	136
	% within calmed	27.2%	16.1%	25.9%
Missing	Count	3	0	3
	% within calmed	0.6%		0.6%
Total	Count	463	62	525
	% within calmed	100.0%	100.0%	100.0%

The most interesting variable is the average trip times taken. This has been looked at in two ways: firstly the average trip time weighted by respondent and then weighted by the number of trips. Table 2.9 shows the average trip time by respondent by gender and whether they live in a calmed or un-calmed area. Males living in calmed areas have a slightly higher average trip time, but it is not statistically significant. The standard deviation shows that the distributions must be very skewed and this is investigated later.

Table 2.9 Time taken to make trip (mins) – weighted by respondent

Sex of respondent	*Calmed*	*Mean*	*N*	*Standard deviation*
Male	No	12.84	223	35.10
	Yes	14.43	30	32.01
	Total	13.03	253	34.69
Female	No	11.55	234	17.47
	Yes	10.85	30	26.80
	Total	11.47	264	18.70
Total	No	12.18	457	27.51
	Yes	12.64	60	29.33
	Total	12.23	517	27.70

Table 2.10 shows that the males trip times average is higher in calmed areas. It is not statistically significant due to the very large standard deviations from the skewed distributions. i.e. there is a very long tail on the distribution of trip times.

Table 2.10 Time taken to make trip (mins) – weighted by trips made

Sex of respondent	*Calmed*	*Mean*	*N*	*Standard deviation*
Male	No	11.75	749	33.68
	Yes	17.83	85	38.23
	Total	12.37	834	34.19
Female	No	11.06	750	16.02
	Yes	11.35	84	27.43
	Total	11.08	834	17.48
Total	No	11.40	1499	26.36
	Yes	14.61	169	33.36
	Total	11.73	1668	27.16

Table 2.11 looks at the total time spent on trips during the diary day. Again the distribution must be very skewed because of the large standard deviation. However, males in calmed areas spend 12 minutes (30 percent) more trip time during the day. This is not statistically significant, but certainly indicative. Females have very similar total daily trip times whether from calmed or un-calmed areas.

Table 2.11 Total trip time (mins) in the diary day

Sex of respondent	*Calmed*	*Mean*	*N*	*Standard deviation*
Male	No	38.76	227	64.12
	Yes	50.52	30	96.15
	Total	40.13	257	68.49
Female	No	35.28	235	40.35
	Yes	31.77	30	48.22
	Total	34.89	265	41.23
Total	No	36.99	462	53.34
	Yes	41.14	60	76.00
	Total	37.47	522	56.33

Table 2.12 Number of trips by living in calmed area or not

		Calmed		
Number of trip		*No*	*Yes*	*Total*
1	Count	41	10	51
	% within calmed	8.9%	16.1%	9.7%
2	Count	210	32	242
	% within calmed	45.4%	51.6%	46.1%
3	Count	38	2	40
	% within calmed	8.2%	3.2%	7.6%
4	Count	88	10	98
	% within calmed	19.0%	16.1%	18.7%
5	Count	25	3	28
	% within calmed	5.4%	4.8%	5.3%
6 or more	Count	61	5	66
	% within calmed	13.2%	8.1%	12.6%
Total	Count	463	62	525
	% within calmed	100.0%	100.0%	100.0%

Table 2.12 looks at the number of trips during the diary day. A greater percentage of those living in calmed areas have only 1 or 2 trips during their day. The difference is not statistically significant, but suggests that when they do go out then they tend to go out for longer periods, because it is known that overall their total time out during the day is longer.

The trip time data have a skewed distribution with a long tail. Figures 2.1 and 2.2 for males and females respectively show the individual trip time distributions in five-minute intervals. Males from calmed areas tend to have more 5-10 minute trips, although differences are not statistically significant. The reverse is apparent for females, with females making more trips of 5-10 minutes in the un-calmed areas, and the difference is statistically significant. Females also make significantly fewer trips of 5 minutes or less in the un-calmed areas than in the calmed areas. However, if all trips of up to 10 minutes are considered there is little difference between the number of trips in calmed or un-calmed areas for either males or females. There were more trips of between 10 and 30 minutes in the un-calmed areas, and more of 30 minutes or longer in the calmed areas.

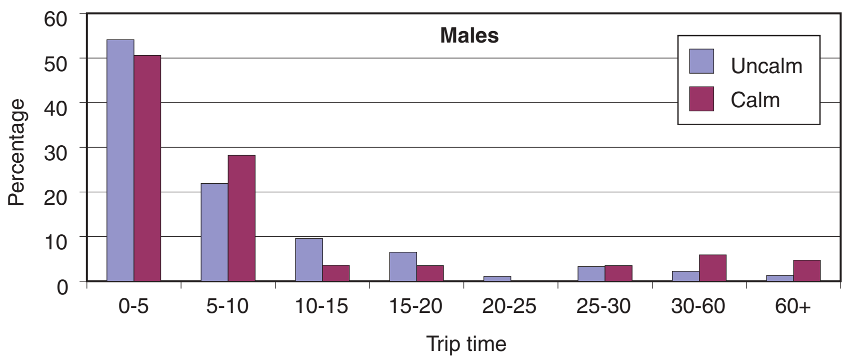

Figure 2.1 Distribution of trip times of males from calmed and un-calmed areas

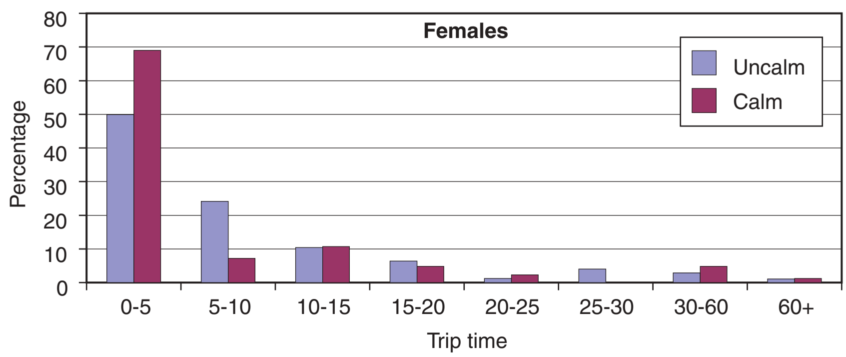

Figure 2.2 Distribution of trip times of females from calmed and un-calmed areas

2.2.3 Conclusions

This analysis has provided an indication (although not statistically significant) that, compared to children from un-calmed areas, those living in calmed areas:

- Make more journeys on foot and less by car.
- Are less likely to be accompanied by somebody aged over 16 years.
- Males in calmed areas spend more time making trips per day than males from un-calmed areas. This effect was not detected amongst females.

2.3 Review of pedestrian skills tests

2.3.1 Pedestrian skills and tests available to measure them

This first phase of this study considered which skills or other aspects of pedestrian competence are most likely to vary as a function of the differing experience between those children from traffic calmed areas compared to those from 'untreated' areas. The primary aim of traffic calming schemes in the UK, both historically and at present, is to reduce traffic speed rather than traffic volume. This suggests that any differences between children from calmed and non-calmed areas are likely to be subtle. Since children living in calmed areas may even enjoy more access to the road environment than children living in more dangerous areas, the former may well possess quite competent pedestrian skills within the environment that is familiar to them. It seems likely that their performance would suffer primarily when they leave their familiar environment and are confronted with the more complex problems presented by non-calmed roads. There may also be variation between children from different calmed areas as a function of the methods of calming that have been employed, given that these may induce rather different patterns of vehicle movement.

Bearing in mind these considerations, the first phase of the study considered all aspects of pedestrian skills and the possible tests to measure them. It was concluded that the following skills were the most relevant, and they are described below with tentative hypotheses about the likely effects of growing up in calmed areas on these skills:

1 Visual timing and gap selection:

It is accepted that these skills develop once children are confronted with busier roads, where it is not possible to wait for the road to clear before crossing. Instead, the pedestrian must learn how to select gaps in the traffic flow that can safely be negotiated and avoid those that cannot. Children who have not yet acquired timing skills typically focus on individual cars rather than on gaps, and on distance at the expense of speed or time.

In traffic-calmed areas where traffic must move more slowly, it may be substantially easier to retain the developmentally less advanced focus on vehicles as discrete entities placed at certain distances, and to fail to shift to a focus on traffic gaps and available time for crossing. Thus it seems reasonable to anticipate differences in the performance of children from calmed and un-calmed areas in these aspects of skill.

2 Safe place crossing location:

Differences in children's performance here could be expected if there were differences in the types of road structure to be found locally. For example, children might have more difficulty coping with the problem of crossing near parked cars if they grew up in an area where there was little on-road parking. However, most of the features that produce dangerous roadside locations (e.g., junctions, blind corners, hills, obscuring bushes, trees, etc) are unlikely to vary systematically between calmed and un-calmed areas. Recognising the intrinsic danger posed by certain structures and situations probably depends on observing traffic passing there. For example, the effect of most of these structures is to obscure the child's view of approaching traffic (as well as drivers' view of the child). If there were significantly less traffic in a calmed area, there would be correspondingly fewer opportunities for children to observe the effect that the structures have on visibility, producing a possible lag in skill development. The same argument might even apply to slow-moving traffic, because the reduced speeds make it less imperative to spot traffic well in advance. It is therefore not quite clear whether differences with regard to safe place finding skills should be hypothesised or not. Their importance in the development of pedestrian competence is undoubted and, if differences do exist, they should not be missed.

3 Visual and auditory attention:

Once again, it seems unlikely that the total range of traffic relevant features would be greatly reduced in traffic calmed areas, except to the extent that traffic volumes are affected. However, the lower traffic speeds obtaining in calmed areas may mean that children are under less environmental pressure to become attuned to traffic relevant information, so they may show a deficit in this aspect of pedestrian skill.

4 Perception of the intentions of other road users:

As with the skills described previously, children's ability to identify the intentions of other road users will probably reflect the types of cues that are available within their local traffic environment. It seems likely that some differences may emerge between calmed and un-calmed areas. For example, those relating to traffic lights or pelican crossings would probably be more familiar to children from un-calmed areas. Others (e.g., cues specifying that a parked vehicle is about to reverse) would probably show no difference as a function of area. Some might conceivably show an advantage for children from calmed areas (e.g. understanding road humps or speed tables). Overall, it seems possible that children from un-calmed areas might show an advantage in understanding and anticipating the intentions of other road users because of the somewhat wider range of traffic scenarios that they are likely to encounter, and the greater pressure to attend to traffic relevant information in areas that have not been calmed.

While it might be desirable to test all these skills, for practical reasons it was decided to concentrate on just two skills in the second phase of the project. 'Visual timing and gap selection' is identified above as the most likely to vary between those growing up in calmed or un-calmed areas. 'Visual and auditory attention' while a skill in itself, is a necessary forerunner to the 'visual timing and gap selection' task, and so is not a complementary test to the gap selection test. 'Perception of intention' also taps similar skills. Of the tests suggested above, the test of 'safe place crossing location' was selected as the best choice for the second test, since it tests a distinct set of skills from the 'visual timing and gap selection' test.

Visual timing and gap selection has been assessed at the roadside using a number of related, but slightly different methods. One version of the task involves placing children at the roadside, where they indicate when they would cross by raising an arm. Children are tested individually at a single location, either making a fixed number of crossing decisions (e.g. 10), or making as many as they can within a given time period (e.g. 10 minutes). Traffic movements as well as children's decisions about when they would cross need to be recorded, and this can be achieved by video recording the tests.

A variety of measures are typically derived from the test. These include: the mean size of accepted gaps; the mean size of rejected gaps; the number of 'missed opportunities' (i.e., gaps which were acceptably large but were nevertheless rejected); the number of 'tight fits' (gaps that were accepted even though they were rather small); and 'starting delays' (how much time was wasted before deciding to step into a gap). The derivation of these measures from the raw data is fairly complex and time-consuming. A roadside test depends on the identification of a location close to participating schools where there is a relatively straight road and a reasonably constant traffic flow. Using more than one school also raises issues concerning the comparability of locations.

There is a computer-based version of the basic performance task (developed at Stratclyde University), which is set up in much the same way as the 'arm raise' version at the roadside, except that it involves clicking the mouse button to indicate when a crossing would be made. This has the advantage that a number of locations can be presented (instead of the single one used at the roadside) and it is easier to administer, and is scored automatically by the computer programming. However, at the time of the first phase of this study, it had not been validated against roadside judgements, and there were some reasons to question its comparability. Principal amongst these is that the simulation necessarily relies on scaled speeds, both of the vehicles and pedestrians. The children's decisions are also made in relation to pedestrians seen on the screen, so the whole process is at a remove from real traffic.

There is also a related video-based task, devised by Whitebread and Neilson (1998) at Homerton College, Cambridge. This involves children being placed in the middle of an array of three video monitors that show views across and along a road in either direction. Synchronised video sequences of traffic movements are played on the monitors, and children make responses as in the roadside task. The test is complex to score. At the time of the first phase of this study it had not been validated against roadside performance, although it has very high face validity. The test would have needed some further development for this project, had it been chosen as a research tool.

Because of the very real advantages of a computer based test, it was decided to test the validity of the computer based gap acceptance as part of the second phase of this study. If the results proved encouraging, this test would be used for the main comparison of 'visual timing and gap selection' skills between children from calmed and control sites. This validation exercise is described in Section 3.

The 'safe place crossing location' uses a table-top model. This consists of a large hardboard base or laminated card on which a road layout is printed. A range of buildings and trees are used, together with toy cars and doll pedestrians to create traffic scenarios not dissimilar to those encountered at the roadside. As a pure test instrument, the model produces comparable results to those obtained at the roadside (Ampofo-Boateng and Thomson, 1991) and training using the model has produced improved performance and awareness that are indistinguishable from roadside training (Thomson *et al.*, 1992; Ampofo-Boateng *et al.*, 1993). Because of the lack of journey time to a test site, test administration using the table-top model is shorter than for a roadside test, and has the advantage of strict comparability across different children.

2.3.2 Age and children's performance

In this first stage of the study three age groups were considered which may be of particular interest for the comparison of pedestrian skills development. The first is the age range 7-9, where learning really starts to increase significantly. Thus the age range 7-9 would seem to be the age where measurable differences between children from calmed and un-calmed areas (if they exist) would start to emerge. The performance of older children is somewhat less easy to predict. It may be that any differences detected in 7-9 year olds could be expected to grow larger, as the greater range of experience available to children in the un-calmed areas increases the divergence between the two groups. Alternatively, the differences might reduce as the children from calmed areas gradually extend their experience into un-calmed environments. Children around the age of 10-11 years might therefore also be of interest. Finally, the transition from primary to secondary school marks a substantial shift in both the scale and types of exposure that children face. For children from calmed areas, this transition is likely to be even more demanding. The effect this has on children's skill levels during their first year of secondary schooling (age 11-12) might also be worthy of assessment.

For the main part of the study just one age group (7-9) was chosen, where learning starts to increase significantly and any differences might start to emerge. If differences in skills were to be found within this age group between children from calmed and un-calmed areas, then further tests with the other age groups could be considered.

2.4 Review of calming schemes

2.4.1 Background

Safety engineering is seen as an important way of reducing accidents. In the past, much of the safety engineering work to help pedestrians, including children, concentrated on the more major roads. It had often consisted of the installation of pedestrian crossings where a site-specific history of accidents had occurred. Different types of pedestrian crossing have been developed - zebra, pelican (traffic light controlled) now with infra-red detection of pedestrians and called 'Puffin' crossings, and pedestrian phases at signalised junctions.

Where pedestrian crossings were not justified, central refuges were often used in an attempt to make the pedestrians' task of crossing a road easier.

More general engineering measures have also helped vulnerable road users as well as the occupants of vehicles. These measures include better lighting, use of road markings to channel vehicles, control of parking, and the use of speed limits - normally 30mph in urban areas, but more recently 20mph in special zones, enforced by engineering measures. In some areas, "speed cameras" have been introduced and have already had a beneficial effect on speed and safety.

In recent years, mainly since about 1990, the focus, on existing roads, has largely been on more comprehensive traffic calming as the means to help the vulnerable road users, especially children, and hundreds of traffic calming schemes have now been installed.

2.4.2 Selection of a scheme for study

It was decided that the 'traffic calmed' areas to be considered for this study should be limited to 20 mph zones with self-enforcing speed humps. This is for a number of reasons:

- Their location and installation are well documented.
- A significant speed reduction of around 10 mph is achieved, through self-enforcing measures.
- Vertical deflections (i.e. usually humps) are now favoured to horizontal measures, such as chicanes. Therefore humps hold more relevance for informing future policy.

In order that the children should have 'grown up' in a traffic calmed area, it is necessary that the measures had been in place for a number of years. (i.e. since at least 1995). In order that the 'calmed' children should have been exposed as little as possible to un-calmed environments, it was desirable that primary schools were contained within the calmed area, which should itself be large.

TRL had information on all 20mph zones installed since their inauguration in 1990 until 1999, when the need to apply for the Secretary of State's authorisation was relaxed. Examination of more than 300 records resulted in a short list of sites suitable for the project. In trying to identify suitable sites the following criteria were used:

- Established pre-1996.
- Large.
- Primary school within the zone.
- A variety of housing types.
- A suitable control area nearby

From the short list a very large 20 mph zone in the Worcester Park area of Sutton, Surrey was selected for the study. The housing is predominantly 1930s, and mostly semi-detached or in short terraces. There are some Victorian terraces. The roads are mainly long and straight and have been calmed using humps and some speed cushions. The boundary roads all contain parades of shops. There are four primary schools in or on the edge of the calmed area.

A suitable large control area exists adjoining the calmed area, containing a similar style of housing, and with primary schools located within the area. Further examination of the proposed control area revealed three streets to have been traffic calmed, but this left a considerable number of streets eligible for the control site. Traffic and accident data for the two areas is given in Appendix B. Traffic counts showed speeds to be generally slightly higher in the control site, although speeds on one of the calmed area roads (Green Lane) were particularly high. This road, however, was not typical of the roads in the calmed area, having flat top humps, while the remainder of the scheme is calmed with round-top humps. Accident data showed the number of accidents to have reduced since the introduction of traffic calming.

When traffic calmed areas were first introduced there were significant differences in the traffic environment in calmed 20mph zones compared to other areas. But now many of the streets that had the highest risk have had some type of traffic calming, so the difference may not be so large. Thus while the traffic speeds did not differ greatly between the proposed calmed and control sites, the two areas were thought to be broadly representative of conditions today, and thus provide a suitable basis for the study. There is also likely to be a greater proportion of speeds significantly higher than the average speed in the un-calmed areas, even if the averages do not differ substantially.

Typical roads within the area calmed area are shown in Figures 2.3 and 2.4. The control area was very similar in character.

3 Phase 2: Validation of the PC visual timing and gap selection test

3.1 Method

A number of schools (local to TRL) with a road nearby suitable for on-road 'visual timing and gap selection' tests were contacted, and five were chosen to take part in the tests. None of these were in or near to traffic calmed roads. At each school 6 children took part in the tests. Eight year olds (predominantly Year 4) were chosen for the validation to match the age group planned for the main study, and staff at the school were asked to volunteer children with a range of abilities. In addition, only those children whose

Figure 2.3 A typical road within the traffic calmed area (speed humps)

Figure 2.4 A typical road within the traffic calmed area (speed cushions)

parents had agreed for their child to take part in the roadside test by signing a consent form were selected for the tests. Of the 6 children in each school, 3 completed the roadside test first, and 3 completed the PC test first.

3.1.1 The PC visual timing and gap selection test

The PC test, as developed at the University of Strathclyde, showed a scene in which all vehicles travelled at constant speed. This was felt to be inappropriate for the intended purpose of the test – i.e. to distinguish between the skills of those growing up in traffic calmed areas compared to those in un-calmed areas, since those from calmed areas might have particular problems with judging differences in vehicle speeds. The PC test was therefore modified by Strathclyde University to include vehicles at different speeds. This necessitated raising the viewpoint slightly so that a greater length of road was in view. The test was also modified to show the pedestrian walking along the road at the start of the test to give the child an indication of walking speed. The test was extended to show three test scenarios: (1) a straight road in a residential area (30mph), (2) a road in a park, with 40mph speed limit and a slightly wider carriageway, (3) as (1) but with a crossroad close to the crossing point. The scenes are shown in Figure 3.1.

The child was asked to click the mouse button when he/she thought it was safe for the pedestrian to cross the road. For each of the three scenes the test terminated after the mouse was clicked 6 times, or after about 3.5 minutes, whichever was the sooner. For each child there was therefore a maximum of 18 crossing attempts. The first scene was also used as a practice for the child to familiarise him/herself with the task, but was not scored. It was then repeated for the main test.

The PC software computed the following variables for each child:

- Mean size of accepted gap (and standard deviation).
- Mean starting delay (and standard deviation): The delay between the gap occurring and the click being made.
- Mean size of effective gap (and standard deviation): The size of the gap remaining after the delay
- Tight fits: Gaps that were accepted but where the approaching car would have been dangerously close. If the car is approaching from the far side then this is a gap of less than 1.5 times the crossing time. If the approaching car is in the near-side lane then it is a gap of less than the crossing time.
- Missed opportunities: A gap of a least 1.5 times the crossing time that was not accepted.
- Splats: An accepted gap that would result in the pedestrian being hit by the car. If the car is approaching from the far side then this is a gap of less than the crossing time. If the approaching car is in the near-side lane then it is a gap of less than half the crossing time.
- Attempts: The total number of mouse clicks over the three sites. (Maximum 18).

At the first school (School A) the software was designed so that the child could not click the mouse within 5 seconds of the previous click - the time it would take for the pedestrian to cross the road. Since the pedestrian did not actually cross the road in the test this was felt to be inappropriate and was changed to 1 second for tests in the subsequent schools. There were a small number of cases where a mouse click did not register as the child had inadvertently moved the mouse from its correct position, and some others that did not register because of errors in the software. However, it is felt that the number of times this happened was sufficiently small not to significantly affect the overall test results. The software problem was rectified, and the area for registering a mouse click was enlarged following the validation tests.

3.1.2 The roadside visual timing and gap selection test

The traffic conditions at the roadside sites varied from site to site, and throughout the day. At School A, School C and School E (in 30mph zones) the traffic was particularly heavy, with few large gaps, especially during the first tests of the morning (which started at about 9.30). At School B and School D there tended to be larger gaps in the traffic. School B was in a 50mph zone, while School D was 40 mph (although most of the traffic exceeded the speed limit). At School A, School C and School E there were pelican crossings nearby. At School D there was a controlled crossing facility (school crossing patrol) before and after school.

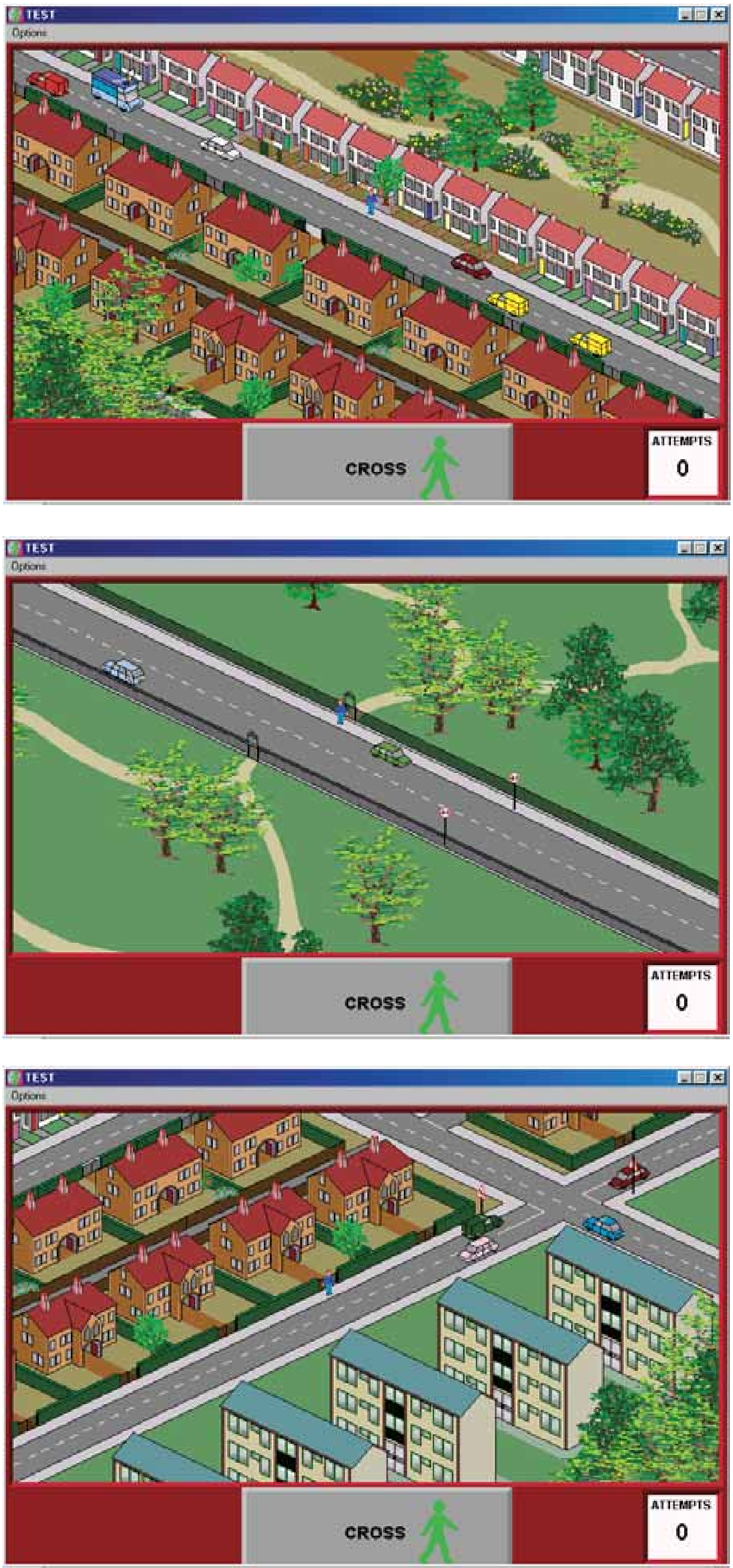

Figure 3.1 Scenes for PC gap acceptance tests

Each child was escorted individually to the pre-selected roadside test site by TRL's teacher consultant. The child's hand was held at all times and the child and teacher wore reflective jackets. The child was instructed to raise an arm when he/she thought it was safe to cross the road. The child was given a short practice before starting the test. A video camera was placed on the opposite side of the road to record the tests, and the teacher raised an arm to indicate the start and finish of the test. A test continued until a child had indicated 10 crossings, or for 10 minutes, whichever was the sooner.

The video was subsequently analysed for each test. The start time and end time of each accepted gap was recorded, and also the time at which the child raised an arm to indicate a crossing. From these timings the mean accepted gap, mean delay and mean effective gaps were calculated, and number of tight fits, splats and total attempts calculated. Missed opportunities were also recorded directly from the video. The definitions of tight fits and splats were simplified slightly for those calculated by the PC software to ease analysis as follows:

- *Tight fits:* Accepted gap that is less than 1.5 times the crossing time.
- *Splats:* Accepted gap less than crossing time.

This minor change in the definitions is unlikely to have affected the overall results significantly.

3.2 Results

Table 3.1 shows the results of Pearson correlations for the measures of crossing skills from the PC and roadside tests. Many of the correlations are low, but this is perhaps not surprising as traffic conditions in the roadside tests were not controlled, and some very large gaps occurred in the traffic. These were sometimes far greater than the gaps on the PC tests, and much greater than actually required for a safe crossing. The occurrence of these large gaps was not consistent across all schools, or even across the day at any particular school. Even so, there was a highly significant (P=0.001) correlation between PC and road mean effective gap size at School A, and a significant correlation (P=0.02) for mean accepted gap size for School D. Missed opportunities, tight fits, splats and number of attempts each showed some significant correlations, and were significantly correlated for all 30 children together.

Measures which should not be affected by large gaps in the traffic are the percentage of safe crossings, and the percentage of missed opportunities. These were calculated for both the PC and roadside tests as follows:

Percentage of safe crossings = ((attempts - tight fits - splats)/ attempts) * 100

Percentage missed opportunities = ((missed opps/ (missed opps + attempts - tight fits - splats)) * 100

The Pearson correlations between the PC and roadside values of these factors are highly statistically significant (P=0.01) for children from all schools together, and significant (P=0.05) for some measures at some schools when considered individually. Several others have high correlation coefficients but are significant at p=0.1 only (see Table 3.2). The percentage safe crossings and percentage missed opportunities for the PC versus roadside tests for all schools together are shown in Figure 3.2.

Table 3.2 Pearson correlations for PC *v* roadside test: percentage safe crossings and percentage missed opportunities

	Percentage safe crossings		*Percentage missed opportunities*		
	r	*P*	*r*	*P*	*Sample size*
School A	0.75	0.07	0.70	0.06	6
School B	0.77	0.04*	0.59	0.11	6
School C	0.50	0.15	0.16	0.38	6
School D	0.91	0.01*	0.74	0.05*	6
School E	0.51	0.15	0.31	0.28	6
All schools	0.67	0.001#	0.58	0.001#	30

r = correlation coefficient.
P = probability.
* *Significant at 0.05 level (one-tailed).*
\# *Significant at 0.01 level (one-tailed).*

Generally, School A, School B and School D tests resulted in higher PC/road correlations than School C and School E. The poor performance at School E might be due to the fact that the children were 7/8 year olds from Year 3 rather than the 8/9 year olds from Year 4 as at the other schools. This is because the instructions did not reach the school prior to the tests, due to postal difficulties, and Year 4 pupils were unavailable for the tests. This suggested that future tests should be with Year 4, if possible. The poor performance of School C school is more difficult to explain.

Table 3.1 Pearson correlations for PC v roadside test

	School A	*School B*	*School C*	*School D*	*School E*	*All schools*
Mean accepted gap size	0.25	0.17	-0.39	0.83*	0.51	0.21
Mean effective gap size	0.99#	0.16	0.66	0.67	0.01	0.11
Mean starting delay	0.09	-0.30	0.30	0.39	0.49	0.22
Number of missed opportunities	0.70	0.75*	0.27	0.59	0.40	0.49#
Number of tight fits	0.83*	-0.48	0.42	0.50	0.72	0.38*
Number of splats	0.76	0.41	0.77*	0.53	-0.32	0.42*
Number of attempts	0.79*	–	–	0.53	0.86*	0.52*
Sample size	6	6	6	6	6	30

* *Significant at 0.05 level (one-tailed).*

\# *Significant at 0.01 level (one-tailed).*

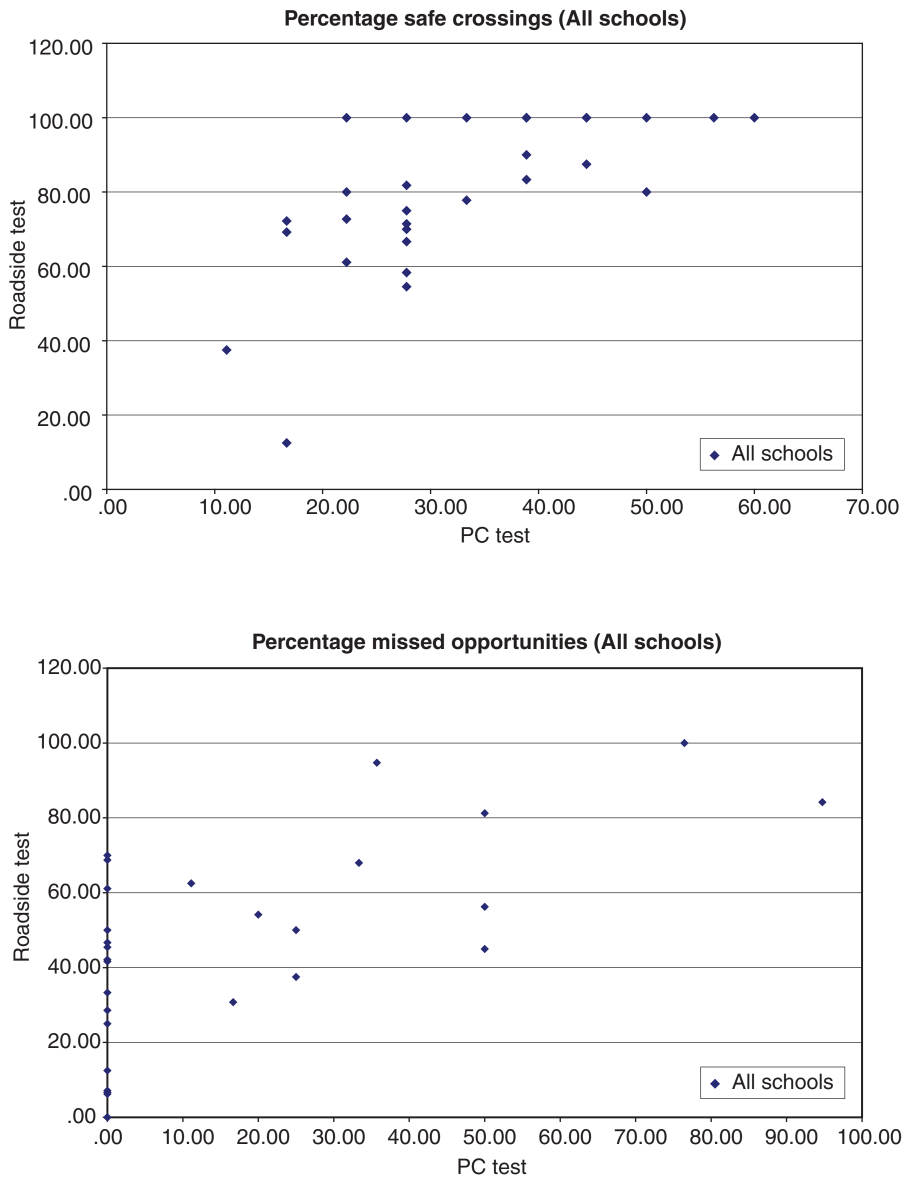

Figure 3.2 Percentage safe crossings and missed opportunities (all schools)

The children were generally much more cautious in the roadside tests, with more safe crossings and more missed opportunities. School B scored particularly badly on the percentage of safe crossings in the PC test compared to the roadside tests, although the difference is difficult to explain.

3.3 Conclusions from PC validation tests

- The significant correlations for the percentage safe crossings and the percentage missed opportunities suggested that the PC test should be used in the main comparison of skills of pupils from the calmed and the control areas.
- It was decided that, in addition to the PC test, a small number of those pupils taking the PC test would complete a roadside test. A selection of the best and worst performers on the PC test would be chosen, so that the performance of pupils with a spread of abilities could be compared.

4 Phase 2: Measurement of pedestrian skills of children from calmed and un-calmed areas

4.1 Selection of schools and pupils

Primary and junior schools within the calmed and control areas were first contacted by phone to determine whether they would help with the road safety tests. After disappointing responses, letters were sent to 6 schools (3 in the calmed and 3 in the control area), explaining the purpose of the study and offering a small donation to the school for every pupil participating in the tests. Four schools agreed to help: Schools 1 and 2 in the calmed area, and Schools 3 and 4 in the control area. School 1 was located well inside the calmed area. School 2 was located just outside the calmed area, and pupils who participated in the tests (i.e. living in the calmed area) had to cross a main road which was supervised by a school crossing patrol to get to and from school. Schools 3 and 4 were located well inside the control area.

The schools were sent maps/list of streets within the calmed or control area as appropriate, and asked for names of Year 3 (7-8) and Year 4 (8-9) pupils living in the specified streets. Three of the four schools provided names, while the fourth provided names, addresses and school year of all pupils living in the specified streets from which TRL could select pupils to test. A target of 25 pupils from each school was set, and TRL chose to test predominantly Year 4 pupils since these were perhaps more likely to show skill differences between the calmed and control areas (see Section 3.2). Year 3 pupils were included where the sample of Year 4 pupils was low. In one school, however, Year 4 pupils were (unexpectedly to TRL) involved in other activities on the first day of the TRL visit, so this school has a higher proportion of Year 3 pupils than the other schools (see Table 4.1). Where more names were available from a school year than were required, the test pupils were selected randomly, although roughly equal numbers of boys and girls were chosen.

Table 4.1 Characteristics of children tested in the calmed and control areas

	Calmed area		*Control area*	
	School 1	*School 2*	*School 3*	*School 4*
Gender				
Male	13	14	11	12
Female	15	12	12	12
School year				
Y3	6	8	13	6
Y4	22	18	10	18
Academic ability*				
1	5	9	5	8
2	14	6	10	12
3	9	10	8	4
Key Stage 2 score#	3.94	3.97	3.89	3.92
Total children tested	28	26	23	24
	54		47	

* *As rated by teachers – the brightest pupils are coded 1.*
\# *Target level =4.*

The teachers at each school were asked to give an assessment of the academic ability of the pupils taking the tests. The ratings are given in Table 4.1, which suggests the academic ability of those taking part in the tests varied a little between schools, but most represented a mix of ability from within the school. The overall academic ability of the participating schools can be compared from statistics on the World Wide Web. The Primary School Key Stage 2 scores are given in Table 4.1. These show little difference between the schools, although the scores would suggest the general academic ability was slightly lower in control area schools, particularly in School 3.

4.2 The skills tests

4.2.1 The PC based visual timing and gap selection tests

4.2.1.1 Method

The PC-based visual timing and gap selection test as used for the validation study and described in Section 3.1.1 was used for these tests.

4.2.1.2 Results

The mean results of the tests for the pupils from the calmed and control areas are given in Table 4.2. None of the differences in means between calmed and control areas were statistically significant (t-test). The standard deviations for some measures, particularly missed opportunities and splats, were very large, indicating a wide range of scores across the pupils. For comparison, the mean results for validation tests (all schools combined) are included in Table 4.2. It can be seen that the standard deviation of the measures are larger for the validation test scores, which is not surprising since the 5 validation schools varied in character. Also the differences between mean scores for the Worcester Park tests and the validation tests were greater than the differences between scores for calmed and control areas within Worcester Park.

Table 4.2 Comparison of means of measurements of crossing skills of children from calmed and control areas (PC tests)

	Pupils from calmed area		*Pupils from control area*		*Pupils in validation tests*	
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
Mean accepted gap size	5.79	0.50	5.82	0.46	5.86	0.62
Mean effective gap size	4.59	0.59	4.64	0.53	4.56	0.61
Mean starting delay	1.20	0.36	1.18	0.29	1.30	0.50
Number of missed opportunities	1.35	2.59	1.30	2.62	2.23	4.32
Number of tight fits	7.98	1.68	8.15	1.60	7.30	2.26
Number of splats	3.61	2.91	3.66	2.25	4.16	2.05
Number of attempts	17.72	0.94	17.74	1.47	17.00	3.25
Mean ability rating	2.09		1.98		–	
Sample size	54		47		30	

Because the validation tests had suggested that Year 3 pupils might perform less well in the tests than Year 4, and there were slightly more Year 3 pupils in the control group, the analyses were repeated for Year 4 pupils only. The results are shown in Table 4.3. Again, differences in scores between the pupils from the calmed area and the control area were small, and none were statistically significant.

Table 4.4 shows the difference in mean scores for Year 3 and Year 4 pupils, from the calmed and control areas together. Again the difference in mean scores were small, with only the starting delay differing statistically significantly, the delay being slightly greater for Year 3. The number of splats was also slightly greater for Year 3, although this difference was not statistically significant.

The Key Stage 2 scores varied slightly between schools, with one school (School 3) in the control area having

Table 4.3 Comparison of means of measurements of crossing skills of children from calmed and control areas for Year 4 pupils only (PC tests)

	Pupils from calmed area	*Pupils from control area*
Mean accepted gap size	5.77	5.88
Mean effective gap size	4.61	4.74
Mean starting delay	1.16	1.14
Number of missed opportunities	1.30	1.46
Number of tight fits	8.02	8.12
Number of splats	3.53	3.25
Number of attempts	17.70	17.64
Mean ability rating	2.05	2.00
Sample size	40	28

Table 4.4 Comparison of means of measurements of crossing skills of children from Year 3 and Year 4 (PC tests)

	Year 3 pupils	*Year 4 pupils*
Mean accepted gap size	5.78	5.82
Mean effective gap size	4.51	4.66
Mean starting delay	1.27	1.15*
Number of missed opportunities	1.24	1.37
Number of tight fits	8.06	8.06
Number of splats	4.09	3.41
Number of attempts	17.85	17.68
Mean ability rating	2.06	2.03
Sample size	33	68

* *Difference significant at P<0.05 (t-test).*

slightly lower score (see Section 4.1). To determine whether overall differences in ability between schools were masking any possible calmed/control road safety skill differences, the mean skill scores for the two schools (School 1 (calmed), and School 4 (control)) which matched most closely on Stage 2 scores (see Table 4.1) were compared. This comparison is also perhaps a more rigorous test of the influence of traffic calming on child pedestrian skills development, as the children from School 1 were generally less exposed to un-calmed roads than the pupils from the calmed area who attended the other school used in these tests (see Section 4.1). Results are shown in Table 4.5.

No statistically significant differences in mean skills scores were found between the pupils from each of these schools. Similarly when the skills of the pupils from the

Table 4.5 Comparison of means of measurements of crossing skills of children from School 1 (calmed) and School 4 (control) (PC tests)

	School 1 (Calmed)	*School 4 (Control)*
Mean accepted gap size	5.85	5.92
Mean effective gap size	4.68	4.75
Mean starting delay	1.18	1.16
Number of missed opportunities	1.75	1.67
Number of tight fits	7.86	8.04
Number of splats	3.25	3.08
Number of attempts	17.61	17.50
Mean ability rating	2.14	1.83
Sample size	28	24

two schools within the calmed area were compared no significant differences were found. The mean skill scores for the two control schools are given in Table 4.6.

Table 4.6 Comparison of means of measurements of crossing skills of children from two control area schools (PC tests)

	School 3	*School 4*
Mean accepted gap size	5.71	5.92
Mean effective gap size	4.53	4.75
Mean starting delay	1.19	1.16
Number of missed opportunities	0.90	1.67
Number of tight fits	8.26	8.04
Number of splats	4.26	3.08*
Number of attempts	18.00	17.50
Mean ability rating	2.13	1.83
Sample size	23	24

* *Difference significant at P<0.05 (t-test).*

Table 4.6 shows there was a significant difference in the mean number of splats for pupils from the two schools in the control area, with the school which had the lower Stage 2 score (School 3) having the higher mean number of splats. The School 3 pupils also tended to accept smaller gaps, missed fewer opportunities, and had more tight fits than School 4 pupils, although these differences were not statistically significant. School 3 also had a higher proportion of Year 3 pupils than School 4, which could also account for some of the differences observed in Table 4.6.

Table 4.7 compares the mean skills scores for those children of the highest academic ability compared with those of lowest (as scored by the teachers within the schools).

Table 4.7 Comparison of means of measurements of crossing skills of children of higher and lower academic ability (all schools and all school years) (PC tests)

	Ability rating 1	*Ability rating 3*
Mean accepted gap size	5.81	5.71
Mean effective gap size	4.64	4.46
Mean starting delay	1.17	1.25
Number of missed opportunities	0.78	1.13
Number of tight fits	8.37	8.03
Number of splats	3.52	4.10
Number of attempts	17.74	17.84
Sample size	27	31

While none of the differences in Table 4.7 are statistically significant, there are some noticeable differences. In particular the number of splats is higher for the lower ability group. Differences in skill scores due to differences in ability may be difficult to identify in these tests since the ability ratings were made within schools and may not be consistent across schools.

4.2.1.3 Conclusions

- The PC-based gap acceptance test failed to identify any differences in the pedestrian safety skills between those pupils from the calmed area and those from the control area. The individual differences between pupils/schools is probably greater than any calmed/control differences if they exist.

- There was some limited evidence that the academic ability of the children was related to the measured skills, and the Year 4 pupils performed slightly better than Year 3 pupils, although the two factors are probably correlated.

4.2.2 The roadside visual timing and gap selection tests

4.2.2.1 Method

Only two of the schools had a suitable road close by at which a roadside test could be conducted: School 2 (calmed area) and School 3 (control area). Both of the schools were within a short walk of the same A road on which the tests took place, although the test sites were some distance apart. From each school a sample of pupils who had taken the PC gap acceptance test were selected for the roadside test. As far as possible the pupils were chosen to include those with the best (safest) scores on the PC test, and those with the worst (i.e. pupils were chosen to represent a broad range of ability). In addition, only those children for whom a form signed by the parent/guardian giving consent for their child's participation in the test were selected. The characteristics of those participating from each of the schools are given in Table 4.8. Unfortunately the majority of children from School 2 (control area) were from Year 3 (as was the case in the PC test in the school – see Table 4.1). Also the School 3 pupils were of lower within-school rated ability, and of lower overall ability (Key Stage 2 score) than School 2 (calmed).

The test procedure for the roadside tests was the same as that described in Section 3.2.2 for the validation tests.

Table 4.8 Characteristics of children tested in the roadside tests

	Calmed area School 2	Control area School 3
Gender		
Male	8	8
Female	9	9
School year		
Y3	6	10
Y4	11	7
Academic ability*		
1	5	3
2	5	6
3	6	8
Key Stage 2 score#	3.97	3.89
Total	17	17

* *As rated by teachers – the brightest pupils are coded 1.*
# *Target level = 4.*

4.2.2.2 Results

The correlation coefficients for the scores on the PC test and roadside tests are given in Table 4.9. Generally the correlation coefficients are better for the pupils from the school in the calmed area (School 2) with significant correlations for the mean accepted gap size, the number of splats, and the percentage of safe crossings. The control area school gave a significant correlation for only the mean starting delay. The low correlations for School 3 are probably due to the lower academic ability of the pupils. The correlation coefficients for both schools combined are lowered by the results from School 3. Overall, the correlations from both schools combined were generally lower than from all schools in the validation study (see Tables 3.1 and 3.2), but again this is probably due to the poor correlations for School 3.

Table 4.9 Pearson correlations for PC *v* roadside test results

	Correlation coefficients		
	Calmed area School 2	Control area School 3	Both schools combined
Mean accepted gap size	0.58#	0.12	0.34
Mean effective gap size	0.37	0.03	0.19
Mean starting delay	0.14	0.53*	0.28
Number of missed opportunities	0.33	0.37	0.29
Number of tight fits	0.14	-0.13	0.01
Number of splats	0.61#	0.02	0.37*
Number of attempts	0.14	Cannot be computed†	
	0.09		
% safe crossings	0.56*	-0.35	0.22
% missed opportunities	0.40	0.24	0.30
Sample size	17	17	34

* *Correlation is significant at P<0.05 (one-tailed test).*
# *Correlation is significant at P<0.01(one-tailed test).*
† *Number of attempts was constant (i.e. maximum possible) for PC test.*

The comparison of PC and roadside gap acceptance test results, and observations of those conducting the tests would suggest that pupils from the lower school years/of lower academic ability perform less well on both tests.

Table 4.10 compares the visual timing and gap selection scores for the schools in the calmed and control areas. The pupils from the control area school (School 3) indicated that they would cross in larger gaps than those from the school in the calmed area (School 2), the difference being statistically significant for the effective gap size. The pupils from the control school missed significantly more crossing opportunities, suggesting that their crossing skills overall were not so good as pupils from the calmed area. Pupils from the control area also scored higher on the percentage of safe crossings (presumably because few crossings were indicated) and the percentage of missed opportunities, although the difference between their scores and those of pupils from the calmed area were not statistically significant. The differences could be due to differences in academic ability between calmed and control area pupils, rather than arising from their

Table 4.10 Comparison of means of measurements of crossing skills from calmed and control areas: roadside tests

	Calmed area	*Control area*
	School 2	*School 3*
Mean accepted gap size	10.24	11.49
Mean effective gap size	7.56	9.57*
Mean starting delay	2.09	1.92
Number of missed opportunities	3.47	7.35*
Number of tight fits	2.18	2.35
Number of splats	3.35	2.18
Number of attempts	11.47	11.59
% safe crossings	56.05	68.98
% missed opportunities	28.70	42.78
Sample size	17	17

* *Difference significant at P<0.05 (t-test).*

differences in experience in the road environment due to traffic calming.

The analyses were repeated for pupils from Year 4 only, and results are given in Table 4.11. The results show a similar pattern to that for the total sample, although no differences reached statistical significance. Sample sizes are, however, rather small.

Table 4.11 Comparison of means of measurements of crossing skills from calmed and control areas: roadside tests (Year 4 only)

	Calmed area	*Control area*
	School 2	*School 3*
Mean accepted gap size	10.28	11.19
Mean effective gap size	8.54	9.04
Mean starting delay	1.73	2.14
Number of missed opportunities	3.27	7.71
Number of tight fits	1.81	2.57
Number of splats	3.27	3.14
Number of attempts	11.09	12.86
% safe crossings	57.58	69.14
% missed opportunities	25.22	45.38
Sample size	11	7

4.2.2.3 Conclusions

- The roadside tests showed little difference in the skills of children from the calmed and control area.
- Where differences did occur, the tests indicated that the children from the calmed area were the more skilful at judging gaps for a safe road crossing, and the children from the control area were slightly more cautious. However, it is likely that the differences may have arisen from the higher level of academic ability of children from the calmed area, rather than any differences in skill development arising from living in a traffic-calmed area.

4.2.3 Safe place crossing location tests

4.2.3.1 Method

A table-top model road layout was constructed to a specification supplied by the Department of Psychology, University of Stathclyde. This layout had been previously tested and used by the University of Strathclyde. The model comprised a road layout on a roll-up laminated sheet, wooden model houses and cars, model trees, and play-mobile dolls. The layout was such that crossing at three locations (a junction, a blind bend, and by parked cars) could be tested (see Figures 4.1). At each location two starting points (A and B), and three destinations (C, D and E) were specified, and the child was asked to construct four routes, travelling from each starting point to two of the three destinations (i.e. A to C and D, and B to D and E). The child was therefore asked to indicate twelve routes in total. At each starting point the child was asked to imagine he or she wanted to cross the road to get to a destination on the other side of the road, and to chose the route he or she considered to be the safest. The destination was always a meaningful one, and indicated by a house doorway, or another pedestrian. The starting point was always such that walking straight across the road would not be a safe option. The children indicated their route by moving a doll across the model. The routes selected were recorded on a drawing of the layout.

The parked cars were placed on the layout only when crossings near parked cars were required, and then it was stressed that the cars were parked and not moving.

Scoring of the routes that the children chose were coded into four categories in accordance with practice in previous studies at Strathclyde University (Thomson *et al.*, 1992, Thomson and Whelan 1997) as described in Box 4.1.

To double check the child's judgement and ensure that safe routes were being proposed for the right reasons the children were asked to explain why they chose the route they did. The responses were classified into five categories as shown in Box 4.2.

The scales given above are considered by researchers at Strathclyde University to be roughly ordinal.

For each starting point and destination the majority of children chose one of a relatively small number of possible routes. For each of these, a score was agreed between a researcher and teacher consultant. Similarly conceptual scores were agreed for 'standard' explanations as to the choice of route. The same researcher then went on to score all the responses from both the calmed and control area, so that scoring would be consistent for pupils from both areas.

4.2.3.2 Results

Table 4.12 shows the results of the safe crossing location tests for all pupils from the calmed and control areas. Children from the calmed area generally made safer crossings (scored higher on the safety score than those from the control area), although on only one of the twelve routes was a significant difference between the calmed and control area pupils' safety scores detected. This was for a crossing at a blind bend, where the children from the calmed area made the safer crossing. However, the children from the control area tended to score slightly higher on the conceptual score (i.e. they gave more relevant safety-related explanations for their choice of crossing). The conceptual score is probably less reliable than the safety score, since some children were shy and

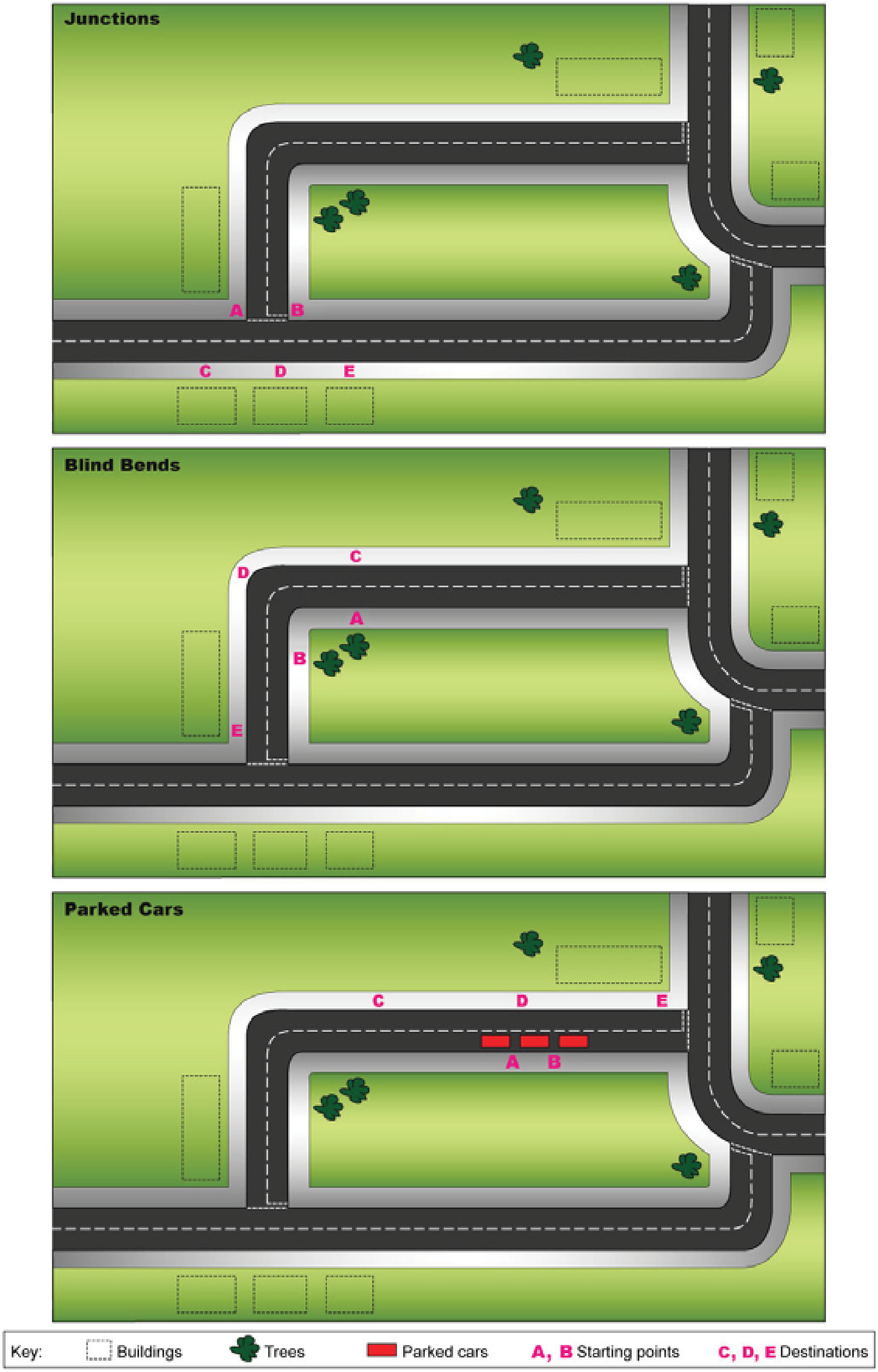

Figure 4.1 The table-top safe crossing location layout

Box 4.1 Safety score

1 Very unsafe. This is a route leading directly to the destination (often involving a long, diagonal traverse of the road). A route classified as very unsafe would also fail to take account of the dangerous features at the starting location (e.g. a parked car).

2 Routes falling into this category might involve the child walking directly across the street (i.e. they took a line perpendicular to the road rather than the target-directed diagonal of the previous category). However, the child continues to ignore the dangerous road features at the starting point. Such choices are an improvement on (1) because they at least reduce the amount of time the child would spend on the road, but do not take account of dangerous roadside features.

3 This is a route that shows some conceptual understanding of the danger posed by particular features or road configurations. This rating might be awarded when the child moves away from the dangerous feature at the starting point, and attempted to find a safer place. The child would also have to explain that he or she was looking for a location away from the dangerous feature at the starting point. However, the child might end up too close to another dangerous feature, such as a junction or parked cars.

4 Safe. This is a route avoiding all dangerous features. Usually the child would have to make a significant detour from the starting point in order to find such a route. The child would also have to give an explanation for the route that suggested some understanding of the need to avoid the dangerous feature.

Box 4.2 Conceptual score

0 No response/don't know.

1 Wrong/response does not relate to the task *('I'd go this way because I don't want to walk on the grass').*

2 Explanation has traffic relevant elements but the danger is not identified *('There are no cars coming').*

3 Identifies the relevant dangerous feature but cannot explain how the selected route overcomes the danger *('……..because there are parked cars').*

4 Identifies the relevant dangerous feature and can explain how the selected route overcomes the danger *('I couldn't see cars coming because of the bend but from here I can see them while they are still a long way off').*

Table 4.12 Comparison of means of measurement of safe crossing location skills of children from calmed and control areas

	Safety score				*Conceptual score*			
	Calmed area		*Control area*		*Calmed area*		*Control area*	
Route	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
Junctions								
A to C	2.78	1.04	2.53	1.11	1.67	0.97	1.96	1.26
A to D	3.37	1.00	3.30	1.13	1.61	0.92	1.77	1.16
B to D	2.91	0.98	2.66	0.96	1.48	1.02	1.79	1.21
B to E	2.83	0.91	2.66	0.97	1.23	0.97	1.76#	1.19
All routes	2.97	0.66	2.74	0.77	1.49	0.77	1.90*	1.10
Blind bends								
A to C	2.41	0.92	2.14	1.05	1.74	1.18	2.24#	1.35
A to D	2.81	1.08	2.39#	1.18	1.89	1.19	2.18	1.37
B to D	2.64	1.08	2.53	1.13	1.71	1.19	1.97	1.39
B to E	2.07	0.89	2.07	0.87	1.71	1.04	2.04	1.28
All routes	2.49	0.84	2.26	0.88	1.76	0.88	2.20*	1.22
Parked cars								
A to C	2.07	1.18	2.15	1.24	2.63	1.00	2.59	1.16
A to D	2.83	0.93	2.71	1.06	2.22	1.19	2.47	1.25
B to D	3.04	0.91	2.89	0.92	1.73	1.34	2.08*	1.34
B to E	2.30	0.82	2.33	0.91	1.74	1.15	2.07*	1.19
All routes	2.56	0.69	2.45	0.74	2.07	0.92	2.44	1.09

* *Calmed significantly different from control at P<0.05 (t-test).*
\# *Calmed significantly different from control at P<0.01 (t-test).*

reluctant to give a reason, and were therefore scored zero although their reasons might have been sound. The different interviewers (through encouragement) may have had differing degrees of influence on the extent to which the children were willing to give a response. Differences between the calmed and control pupils were less consistent at the 'parked cars' location for both the safety and conceptual scores.

Because of the possibility that the pupils' age might affect their ability to select safe crossing locations, and because there were slightly more Year 3 pupils in the control group, the analyses were repeated with Year 4 pupils only. The results are given in Table 4.13, where it can again be seen there was a significant difference in safety scores between pupils from calmed and control areas on only one of the twelve crossing routes. Significant differences on the conceptual scores were fewer than for the total sample of pupils.

Table 4.14 compares the scores for Year 3 and Year 4 pupils from both areas. No statistically significant differences were found between the scores for the two school years.

The results from schools which matched most closely on Key Stage 2 scores – School 1 (calmed) and School 4 (control) - are given in Table 4.15. Pupils from School 1 were less exposed to un-calmed roads (see Section 5) than pupils from the other school in the calmed area, making the comparison perhaps a more rigorous test of differences the road safety skills of children from calmed and un-calmed areas. Table 4.15 shows, as with total sample, the pupils from the calmed area score slightly higher for

Table 4.13 Comparison of means of measurement of safe crossing location skills of children from calmed and control areas for Year 4 pupils only

	Mean safety score		Mean conceptual score	
Route	Calmed area	Control area	Calmed area	Control area
Junctions				
A to C	2.92	2.46	1.65	2.30*
A to D	3.28	3.36	1.70	1.86
B to D	2.80	2.57	1.53	1.71
B to E	2.75	2.61	1.26	1.93*
All routes	2.94	2.75	1.53	1.97
Blind bends				
A to C	2.42	2.11	1.82	2.43
A to D	2.90	2.11#	1.79	2.11
B to D	2.62	2.54	1.67	1.82
B to E	2.07	2.15	1.69	2.18
All routes	2.52	2.21	1.74	2.13
Parked cars				
A to C	2.03	2.11	2.70	2.46
A to D	2.80	2.57	2.35	2.68
B to D	2.98	2.71	1.77	2.36
B to E	2.33	2.29	1.70	2.19
All routes	2.53	2.42	2.13	2.46
Sample size	40	28	40	28

* *Calmed significantly different from control at P<0.05 (t-test).*
\# *Calmed significantly different from control at P<0.01 (t-test).*

Table 4.14 Comparison of means of measurement of safe crossing location skills of children from Year 3 and Year 4 pupils

	Mean safety score		Mean conceptual score	
Route	Year 3	Year 4	Year 3	Year 4
Junctions				
A to C	2.36	2.74	1.64	1.91
A to D	3.55	3.31	1.52	1.76
B to D	2.85	2.71	1.73	1.60
B to E	2.76	2.69	1.64	1.54
All routes	2.87	2.86	1.62	1.71
Blind bends				
A to C	2.22	2.29	2.00	2.07
A to D	2.47	2.57	2.42	1.93
B to D	2.69	2.58	2.09	1.74
B to E	2.09	2.10	1.88	1.90
All routes	2.37	2.39	2.11	1.91
Parked cars				
A to C	2.18	2.06	2.55	2.60
A to D	2.79	2.71	2.27	2.49
B to D	3.00	2.87	1.94	2.01
B to E	2.24	2.31	2.09	1.90
All routes	2.55	2.49	2.20	2.26
Sample size	33	68	33	68

Table 4.15 Comparison of means of measurement of safe crossing location skills of children from School 1 (calmed) and School 4 (control)

	Mean safety score		Mean conceptual score	
Route	School 1 Calmed	School 4 Control	School 1 Calmed	School 4 Control
Junctions				
A to C	2.82	2.48	1.46	1.77
A to D	3.61	3.35	1.46	1.74
B to D	3.00	2.35*	1.25	2.13#
B to E	2.86	2.35*	1.07	2.04#
All routes	3.07	2.63*	1.31	1.96*
Blind bends				
A to C	2.61	2.18	1.57	2.39*
A to D	2.93	2.18*	1.86	2.57*
B to D	2.85	2.45	1.52	2.17
B to E	2.18	2.09	1.48	2.09
All routes	2.67	2.23	1.61	2.30*
Parked cars				
A to C	1.96	2.04	2.57	2.52
A to D	2.79	2.48	2.29	2.48
B to D	2.96	2.65	1.74	2.17
B to E	2.18	2.39	1.67	2.05
All routes	2.47	2.39	2.06	2.35
Sample size	28	24	28	24

* *Calmed significantly different from control at P<0.05 (t-test).*
\# *Calmed significantly different from control at P<0.01 (t-test).*

safety, while the control area pupils scored higher on the conceptual skills. Slightly more of these differences were statistically significant than were for the total sample, and again results for the parked car locations were more varied.

Tables 4.16 and 4.17 compare safe crossing location scores for the two schools in the calmed area and the two schools in the control area. The table shows no significant differences in scores for either the two schools in the calmed area, or the two schools in the control area. However, although differences were not significant, the tables illustrate that scores appear to differ systematically between schools, particularly for the schools in the calmed area.

When safe crossing location scores for pupils of high academic ability (1) were compared with those of low academic ability (3) as rated by the teachers (i.e. within school ratings), no significant differences were found.

Table 4.18 shows Pearson correlations for key measures on the table-top safe crossing location and PC gap acceptance tests for children from the calmed and control areas.

Table 4.18 shows that generally correlations were poor, with some reaching statistical significance at the 0.05 level only, and these were roughly evenly distributed between the calmed and control areas. The correlations between table-top safety scores and the number of splats is perhaps counter intuitive, since those with the highest safe crossing location scores also scored the highest number of splats. However, there is a problem with trying to interpret correlations between the table-top model and PC test, since those children with poor gap acceptance skills might be over cautious and score high on missed opportunities and low on tight fits and splats. Alternatively they might be

Table 4.16 Comparison of means of measurement of safe crossing location skills of children from the two schools in the calmed area

	Mean safety score		*Mean conceptual score*	
Route	*School 1*	*School 2*	*School 1*	*School 2*
Junctions				
A to C	2.82	2.73	1.46	1.88
A to D	3.61	3.12	1.46	1.77
B to D	3.00	2.81	1.25	1.73
B to E	2.86	2.81	1.07	1.40
All routes	3.07	2.87	1.31	1.70
Blind bends				
A to C	2.61	2.19	1.57	1.92
A to D	2.93	2.69	1.86	1.92
B to D	2.85	2.42	1.52	1.92
B to E	2.18	1.96	1.48	1.96
All routes	2.67	2.32	1.61	1.93
Parked cars				
A to C	1.96	2.19	2.57	2.69
A to D	2.79	2.88	2.29	2.15
B to D	2.96	3.12	1.74	1.72
B to E	2.18	2.42	1.67	1.81
All routes	2.47	2.65	2.06	2.09
Sample size	28	26	28	26

Table 4.17 Comparison of means of measurement of safe crossing location skills of children from the two schools in the control area

	Mean safety score		*Mean conceptual score*	
Route	*School 3*	*School 4*	*School 3*	*School 4*
Junctions				
A to C	2.38	2.48	2.21	1.77
A to D	3.46	3.35	1.79	1.74
B to D	2.79	2.35	1.54	2.13
B to E	2.79	2.35	1.88	2.04
All routes	2.85	2.63	1.85	1.95
Blind bends				
A to C	2.04	2.18	2.42	2.39
A to D	2.25	2.18	2.08	2.57
B to D	2.71	2.45	1.83	2.17
B to E	2.17	2.09	2.08	2.09
All routes	2.28	2.23	2.10	2.30
Parked cars				
A to C	2.21	2.04	2.54	2.52
A to D	2.75	2.48	2.79	2.48
B to D	2.88	2.65	2.38	2.17
B to E	2.17	2.39	2.38	2.05
All routes	2.50	2.39	2.52	2.35
Sample size	23	24	23	24

Table 4.18 Correlation of scores for safe crossing location tests compared with PC visual timing and gap selection tests for the calmed and control areas

	Table-top safety score: junctions		*Table-top safety score: blind bends*		*Table-top safety score: parked cars*	
PC test scores	*Calmed*	*Control*	*Calmed*	*Control*	*Calmed*	*Control*
Mean accepted gap	-0.06	-0.26	-0.26*	-0.23	-0.32*	-0.29
Mean effective gap	-0.14	-0.40*	-0.13	-0.20	-0.23	-0.15
Missed opportunity	+0.00	-0.38*	-0.20	-0.38*	-0.24*	-0.02
Tight fit	-0.08	+0.44*	-0.05	+0.16	-0.08	-0.12
Splat	+0.11	+0.23	+0.10	+0.35	+0.25*	+0.35

* *Correlation is significant at the 0.05 level (one-tailed test).*

impulsive and score low on missed opportunities and high on tight fits and splats. More fundamentally, poor correlations might arise because the tests measure different abilities, which is the reason why these two particular tests were chosen for the study (see Section 2.3).

4.2.2.3 Conclusions

- The safe crossing location tests showed little difference between safety scores for children from the calmed or control areas, with very few differences in scores being statistically significant.
- Safety scores from the calmed area were generally very slightly higher from pupils from the calmed area, suggesting their crossings were, on average, very slightly safer than those from the control area, but their explanations as to their route choice were slightly less sound than those from the control area.
- School year or assessed academic ability had little effect on safe crossing location scores.

4.3 Conclusions from the skills tests

- Neither the PC test nor the roadside test of visual timing and gap selection distinguished differences that could reliably be attributed to differences in skill development resulting from living in traffic calmed or un-calmed areas. Differences arising are more likely to be attributable to differences in academic ability.
- Younger pupils (Year 3) appeared to perform less well on both the PC test and the roadside test, and it is suggested that the necessary skills to perform these tests are not well developed for the majority of pupils of this age.
- The PC test appeared to give reasonably reliable results for the older pupils and, in view of the many problems involved in conducting roadside tests, would be recommended for future research of this nature.
- The safe crossing location tests showed little difference between safety scores for children from the calmed or control areas, with very few differences in scores being statistically significant.

5 Phase 2: Interviews with parents/ guardians of children participating in the skills tests

5.1 Method

The schools were asked for the addresses of the pupils taking part in the test, so their parents or guardians might be interviewed about the child's journeys to and from school, and the extent to which he/she was allowed out unaccompanied by an adult. The Head Teacher of one of the schools in the control area (School 3) did not want parents/guardians to be interviewed. However, names were supplied by the other control area school (School 4) for all Year 3 and 4 pupils living in the control area. A sample of parents/guardians of these pupils who had not participated in the school tests was therefore interviewed to increase the control area sample size. However, as the Key Stage 2 scores for School 4 were slightly higher than for School 3, this might have biased the sample to the parents of more able pupils.

Letters were sent to parents or taken home by the children to hand to their parents/ guardians explaining the purpose of the survey and saying that an interviewer would be calling. Details of those interviewed, the child tested, and household details are given in Table 5.1.

Table 5.1 shows the samples in the calmed and control area (as represented in the household survey) were reasonably matched, suggesting that the children participating in the school tests were also reasonably matched in respects other than the traffic calming within their home streets. Slightly more of the children from the calmed area did, however, come from homes where the head of household was socio-economic group DE, and lived in homes that were rented. More of the children in the calmed area lived in semi-detached houses, while more in the control area lived in mid-terraced houses.

5.2 Results

5.2.1 The journey to and from school

Table 5.2 shows the mode of travel to school in the morning and details of those accompanying children who walked for any part of the school journey.

Results were generally comparable, but a higher proportion of children were taken to school by car in the traffic calmed area than in the control area, although the difference was not statistically significant. This could well be due to personal circumstances rather than concerns over road safety (e.g. the child may be dropped at school as the parent drives to work). Slightly more children were accompanied by children older than themselves in the control area, but this is probably a reflection of the slightly higher average age of other school children in the households in the control area (see Table 5.1). There were no significant differences in travel mode or accompaniment between the two schools in the calmed area. However, the samples for comparison were very small.

Table 5.3 shows the types of roads and crossing facilities encountered on the way to school for the calmed and control areas. While those from the calmed area

Table 5.1 Characteristics of children, parent/guardian interviewed and the household

			School 4	
	Control area School 1	*Control area School 2*	*Children tested*	*Children not tested*
Gender of child				
Male	14	11	12	10
Female	13	10	11	11
School year of child				
Y3	6	7	6	8
Y4	21	14	17	13
Academic ability of child				
1	5	7	8	–
2	14	5	11	–
3	8	8	4	–
Relation of respondent to child				
Mother	17	17	18	14
Father	8	3	4	3
Step parent	0	0	0	1
Grandparent	1	0	1	3
Aunt/uncle	0	1	0	0
Brother/sister	0	0	0	0
Other	1	0	0	0
Mean number of adults at address (16+, including respondent)				
	2.3	2.2	2.0	1.9
Mean number of other children at address				
	1.0	1.2	1.4	1.2
Mean age of other children over 5 living at address				
	(7.1	)	(8.3	)
Gender of respondent				
Male	8	4	4	4
Female	19	17	19	17
Age of respondent				
17-21	0	0	0	0
22-29	1	2	0	0
30-44	20	19	22	17
45-59	5	0	1	1
60+	1	0	0	3
SEG of respondent				
AB	2	4	2	4
C1	7	4	8	4
C2	10	9	11	12
DE	7	4	2	1
Length of time at address				
<1 year	1	1	0	0
1but <3 years	5	4	2	1
3 but <5 years	2	1	3	1
5 years +	19	15	15	19
House ownership				
Owned	22	18	23	21
Rented	5	3	0	0
Type of house				
Detached	1	0	0	0
Semi-detached	15	10	5	3
End terrace	6	3	6	7
Mid terrace	5	7	11	11
Number of cars in household				
0	2	0	1	0
1	11	8	5	8
2+	14	13	17	13
Sample size	27	21	23	21

Table 5.2 Mode and accompaniment on the journey to school

	Calmed area		Control area	
Mode of transport (more than one mode could be specified)				
Walk	34		36	
Bicycle	1		0	
Car	13		8	
Public transport	0		0	
Accompaniment when walking				
	All way	*Part way*	*All way*	*Part way*
Alone	3	2	1	1
With adult(s)	28	3	31	1
With brothers/sisters	13	1	12	1
With friends	4	2	1	5
Age of brothers/ sisters friends walked with				
Same school year	4		2	
School year above	4		10	
School year below	11		5	
Sample size	48		44	

Table 5.3 Types of roads and crossing facilities on the journey to school

	Calmed area	Control area
Walks along roads that are:		
Traffic calmed	16	1*
Un-calmed	0	33*
Some calmed, some un-calmed	18	1*
Crosses roads that are:		
Traffic calmed	19	1*
Un-calmed	5	32*
Some calmed, some un-calmed	9	1*
Crossing facilities along route to school		
Pelican crossing	6	0
Zebra crossing	3	1
School crossing patrol	30	0*
Central refuge	20	0*
Crossing facilities used on the way to school		
Pelican crossing	4	0
Zebra crossing	1	1
School crossing patrol	17	0*
Central refuge	12	0#
Sample size	34	36

* *Difference between calmed and control statistically significantly different at P<0.001.*

\# *Difference between calmed and control statistically significantly different at P<0.01.*

encountered both calmed and un-calmed roads, those from the control area generally encountered only un-calmed roads. Those in the calmed area encountered more types of crossing facility than those in the control area. However, the crossings were situated close to the school, and not widespread throughout the calmed area.

Table 5.4 shows the roads encountered and crossing facilities for the two schools in the calmed area. It can be seen that pupils from School 1 predominantly walked along or crossed calmed roads only, while those from School 2 walked along or crossed both calmed and un-calmed roads. This is to be expected as School 2 was just outside the calmed area: although the pupils tested lived within the calmed area they would have crossed the un-calmed road at a supervised crossing to get to school.

Table 5.4 Types of roads and crossing facilities on the journey to school for two schools in calmed area

	School 1	School 2
Walks along roads that are:		
Traffic calmed	14	2
Un-calmed	0	0
Some calmed, some un-calmed	5	13
Crosses roads that are:		
Traffic calmed	16	3
Un-calmed	1	4
Some calmed, some un-calmed	1	8
Crossing facilities along route to school		
Pelican crossing	0	6
Zebra crossing	1	2
School crossing patrol	17	13
Central refuge	7	13
Crossing facilities used on the way to school		
Pelican crossing	0	4
Zebra crossing	0	1
School crossing patrol	9	8
Central refuge	7	5
Sample size	19	15

Tables 5.5 and 5.6 show details of the journey home from school. Reponses are similar to the journey to school. Differences between the calmed and control area were not statistically significantly different for modes of travel or accompaniment on the journey home from school.

Table 5.5 Mode and accompaniment on the journey home from school

	Calmed area		Control area	
Mode of transport				
Walk	36		37	
Bicycle	1		0	
Car	11		7	
Public transport	0		0	
Accompaniment when walking:				
	All way	*Part way*	*All way*	*Part way*
Alone	1	4	2	1
With adult(s)	26	3	29	1
With brothers/sisters	11	1	12	1
With friends	4	2	1	3
Age of brothers/ sisters friends walked with:				
Same school year	5		2	
School year above	2		6	
School year below	10		4	
Sample size	48		44	

Table 5.6 Types of roads and crossing facilities on the journey home from school

	Calmed area	Control area
Walks along roads that are:		
Traffic calmed	10	1*
Un-calmed	0	32*
Some calmed, some un-calmed	17	1*
Crosses roads that are:		
Traffic calmed	13	1*
Un-calmed	5	31*
Some calmed, some un-calmed	8	1*
Crossing facilities along route home from school		
Pelican crossing	6	0#
Zebra crossing	3	1
School crossing patrol	22	0*
Central refuge	16	0*
Crossing facilities used on the way home from school		
Pelican crossing	5	0
Zebra crossing	1	1
School crossing patrol	12	0*
Central refuge	8	0#
Sample size	30	37

* *Difference between calmed and control statistically significantly different at P<0.001.*

\# *Difference between calmed and control statistically significantly different at P<0.01.*

5.2.2 Going out/playing outdoors

Table 5.7 and 5.8 show the places where children from the calmed and control areas play/spend time outdoors, and the frequency of walking/ playing/ spending time in the streets near home. There were no statistically significant differences between children from the calmed and control areas in these respects. This is in agreement with the findings of Allott and Lomax (1999) who found that street activity did not increase after the introduction of a 20mph zone with engineering measures. The analysis of MVA data reported in Section 2.2 found that children from calmed areas made fewer trips than those from un-calmed areas, but stayed out for longer when they did go out.

Table 5.7 Where child plays/spends time outdoors in the evenings or at weekends

	Calmed area	Control area
Own back garden	46	42
Own front garden	12	14
Someone else's back garden	15	18
Someone else's front garden	5	3
In park or play area	22	19
In the street near home	18	17
In street but not near home	1	1
Never plays/spends time outside	1	1
Sample size	48	44

Table 5.8 Frequency of child walking/playing/spending time in the streets near home in the evenings or at weekends

	Calmed area	Control area
Never	25	22
Less than once a week	7	8
1-2 days a week	7	6
3-5 days a week	3	5
6-7 days a week	5	2
Sample size	47	43

Tables 5.9 and 5.10 show the accompaniment of the children from the calmed and control area when walking/ playing/ spending time in the streets outside. Again there were no statistically significant differences between the two areas, although children from the control area were slightly more likely to be accompanied by children older than themselves. This again is likely to be because the average age of school children was slightly higher in the control area (see Table 5.1).

Table 5.9 Accompaniment when child walks/plays/ spends time in streets

	Calmed area	Control area
Alone		
Always/almost always	1	1
Sometimes	1	0
Hardly ever/never	13	11
With adult(s)		
Always/almost always	1	1
Sometimes	3	3
Hardly ever/never	11	9
With brothers/sisters		
Always/almost always	8	9
Sometimes	9	5
Hardly ever/never	6	2
With friends		
Always/almost always	14	13
Sometimes	0	2
Hardly ever/never	3	1
Sample size	48	44

Table 5.10 Age of brothers/ sisters/ friends accompanying child when walking/playing/spending time outside

	Calmed area	Control area
Same school year	8	3
School year above	7	14
School year below	6	4
Sample size	48	44

5.2.3 Using the road

Parents/ guardians were asked whether their child would be able to cross the road safely by himself/ herself at a number of types of crossing facilities. The results are shown in Table 5.11.

Table 5.11 Ability of child to cross the road safely by himself/herself at various facilities

	Number saying child was able to cross safely	
	Calmed area	*Control area*
At a school crossing patrol	45	37
At a pelican crossing	40	32
At a zebra crossing	34	29
At a central refuge	20	15
At a road junction	21	13
Near parked cars	21	21
A quiet street	44	39
A busy street	13	9
Sample size	48	44

The proportion of parents/guardians who said their child would be able to cross the road safely at the various crossing facilities did not differ significantly between respondents from the calmed and control area. However, the proportion of parents from the calmed area saying their child could cross the road safely at the various facilities was higher for all but one of the facilities. Those who considered their child was not able to cross safely were asked at what age he/she would be able to do so. The age at which child would be able to cross safely by himself/herself did not differ significantly for children from the calmed and control areas.

Parents/guardians were also asked if they would allow their child to undertake certain activities. These are listed in Table 5.12, where the numbers allowing the child to undertake the activity in the calmed and control area are shown.

Again there was no significant difference in the proportion of parents/guardians from the calmed or control areas saying their child would be allowed to undertake the various activities. However, the proportion allowing their child to undertake the activities was always slightly higher in the calmed area. Those who would not allow their child to undertake the activities were asked at what age they would. The age at which parents/guardians felt their child would be able to undertake the activities did not differ significantly between the calmed and control areas.

5.2.4 Parent/guardian's attitude to road safety

Parents/ guardians were asked to rate their street in terms of safety from traffic and safety from crime on scales from 0 to 6 where 0 meant 'not at all safe' and 6 meant 'very safe'. The results are given in Tables 5.13 and 5.14.

The streets in the calmed area were considered very slightly safer with respect to road traffic, while the control area was considered very slightly safer with respect to crime, although differences were not statistically significantly different.

Table 5.12 Parent/guardian allowing child to undertake activities

	Number saying child would be allowed to undertake activity	
	Calmed area	*Control area*
Walk alone to the local shops	6	2
Walk to the local shops with brother/sister/friend	23	22
Walk alone to local park/playground	2	1
Walk to local park/playground with brother/sister/friend	22	15
Walk alone to a friend's house in your street	36	29
Walk to a friend's house in your street with brother/sister/friend	39	31
Walk alone to a friend's house in a nearby street	18	11
Walk to friend's house in a nearby street with brother/sister/friend	31	25
Play in street outside your home without adult supervision	20	17
Play in street but not outside your home without adult supervision	10	6
Sample size	48	44

Table 5.13 Parent/guardian's rating of safety from road traffic for their street

	Calmed area	*Control area*
0 Not at all safe	3	4
1	2	2
2	6	10
3	18	8
4	11	12
5	6	8
6 Very safe	2	0
Mean	3.31	3.05
Sample size	48	44

Table 5.14 Parent/guardian's rating of safety from crime for their street

	Calmed area	*Control area*
0 Not at all safe	1	0
1	3	1
2	2	2
3	9	5
4	7	13
5	19	17
6 Very safe	7	6
Mean	4.15	4.39
Sample size	48	44

Respondents were asked how responsible they, as parents or guardians, should be for their children's road safety education, and how responsible the school should be. The results are shown in Tables 5.15 and 5.16.

There was little difference between parents/guardians from the calmed or control area with respect to road safety education, with parents from both areas accepting a very

Table 5.15 Parent/guardian's rating of their own responsibility for the road safety education of their children

	Calmed area	*Control area*
Very responsible	46	44
Fairly responsible	2	0
Not very responsible	0	0
Not at all responsible	0	0
Sample size	48	44

Table 5.16 Parent/guardian's rating of the school's responsibility for the road safety education of their children

	Calmed area	*Control area*
Very responsible	31	26
Fairly responsible	17	18
Not very responsible	0	0
Not at all responsible	0	0
Sample size	48	44

high level of responsibility themselves. In both the calmed and control area parents/guardians thought schools should be either very responsible or fairly responsible for road safety education.

5.3 Conclusions from interviews with parents/guardians

- The home interview survey suggests that the samples of children from the calmed and control areas were reasonably matched on factors other than the traffic calming in their streets. More of the children in the calmed area were driven to school, but this may be due to personal circumstances rather than road safety considerations.
- While children from the control area walked along/ crossed only un-calmed roads on their journey to/ from school, some children in the calmed area walked on both calmed and un-calmed streets. Those children attending School 1 walked or crossed predominantly calmed streets, while those in the other calmed area school walked along/crossed both types of roads. Comparison of road safety skills of children from calmed versus control might therefore be most likely to show any differences, if they exist, if results from School 1 only are considered (see Section 4).
- There was no difference in the types of areas in which the children played or spent time outside, or in the time spent walking/ playing/ spending time in the streets near home.
- When asked whether their child would be able to cross the road safely by himself/herself at various crossing facilities, slightly more of the parents from the calmed area than from the control area said he or she would be able to cross safely. However, the differences in numbers were not statistically significant. Similarly when asked if the child would be allowed to undertake certain activities (e.g. walk alone to the local shop), parents from the calmed area tended to be slightly more permissive, although differences between the calmed and control area were not statistically significant.
- Overall, the results suggest little difference in the extent to which children are allowed out on the local roads in the calmed and control areas. Differences in the development of road safety skills are therefore unlikely to results from differences in exposure (either length of time exposed, or types of areas visited).

6 Discussion

As the main objective of the research was to identify whether differences exist between the road safety skills of children from calmed and un-calmed areas, it is important to look for any factors in the groups of children tested, or in skills tests used, that might have resulted in real differences remaining undetected.

A fundamental problem of the research is finding matched calmed and control sites for study. Ideally, of course, the sites should be very closely matched on everything except the fact that one area is calmed and the other is not. Also it might be expected that traffic speeds in the un-calmed area would be significantly higher than in the control area. However, as traffic calming is becoming increasingly widespread on residential streets with high traffic speeds, the task of finding such matched sites becomes increasingly difficult, with any potential control sites likely to have some degree of traffic calming. This is illustrated by the sites chosen, since between the time of recommendation of the sites and the implementation of the study, three streets within the control site had been calmed (although a considerable number of streets remained un-calmed). The speeds on the remaining streets of the control area were not that much greater than those of the calmed area. This is exacerbated by the requirement that the calmed area should have been treated for some considerable time, as the children need to have lived and grown up in the area. In the interim, it is likely that other nearby areas will also have been calmed. This might be overcome if the control were to be selected from an entirely different location in the UK, but then the areas would not be matched in other respects.

An additional problem once the calmed and control sites have been selected is obtaining the co-operation of schools within the areas. This is becoming increasingly difficult with the high administrative demands being placed on schools. Despite financial incentives being offered to schools, the favoured schools did not wish to participate, and one of the 'calmed' schools was not ideal, since it was located just outside the calmed area. Although the pupils tested were from the calmed area, they had to cross an un-calmed road to get to school.

Only two of the schools were situated close to a road suitable for the roadside visual timing and gap selection test. Although one was in the calmed area and one in the control area, they were not the most suitably matched schools in other respects. Unsurprisingly, the school located well within the calmed area did not have a suitable road nearby, so the school just outside the calmed area was used. The control school was not the most suitable, since its Key Stage 2 scores were slightly lower than the other schools. The roadside tests were, however, on the same road, although some distance apart. These issues illustrate the problems of conducting roadside tests, particularly if results from two schools are to be compared.

The PC visual timing and gap selection test has obvious advantages in that it does not require a suitable road nearby, has no potential on-road safety problems, and test conditions are constant from school to school. Those children who are not skilled in judging traffic gaps may however, respond in one of two ways. Either they may be impulsive, and indicate that they would cross when the gap is too small, or they may be over cautious, and fail to indicate a crossing unless the gap is very large. This occurs with both the PC and roadside tests, although in the PC test the tendency is for the children to accept gaps that are two small, while at the roadside they are more likely to be over cautious. It could be expected that differences occur in this respect between children from calmed and un-calmed areas, but the analysis indicated no significant differences in the test results for the two samples of children.

The table-top safe crossing location tests was scored by a researcher, involving an element of judgement, as opposed to the PC visual timing and gap selection test which was scored by the computer software. However, scores were agreed between two researchers for various scenarios, and then all tests were coded by one researcher to ensure consistency between tests and schools. However, in this sense perhaps the results may be considered less reliable than the PC visual timing and gap selection test. The conceptual scores for the safe crossing location tests were perhaps less reliable, since some of the children, probably through shyness, would not explain why they had selected their route, despite the fact that the route selected was a good one. This was coded as zero. There is no reason to suspect there would have been any differences between the various schools or between those pupils from the calmed or control areas in this respect, so comparisons should not be affected.

Since it was not possible to select schools that drew pupils from both the calmed and the control areas, the comparison of skills relies on their not being a systematic difference for any reason between the schools themselves. The Key Stage 2 results for the four schools were checked, and found to be reasonably consistent, although one of the control schools scored slightly lower than the others. The school heads were asked about any road safety education within the schools. This proved to be consistently lacking in all schools, except for a visit from an outside body when the pupils were in Year 1. Another possible difference between schools that might affect comparisons for the PC test is familiarity with the use of PCs. This was not systematically investigated, but most pupils appeared familiar with their use, and many said they also used a computer at home. Since the calmed and control areas were reasonably matched on demographic variables, there is no reason to expect that use of computers at home varied between the two sites.

The range of capabilities of the pupils tested from both the calmed and un-calmed area was very broad. A similar study in which the road crossing ability of 7 year old children was tested using road traffic scenes displayed on two videos also found large individual differences in ability (Pitcairne and Edlmann, 2000). Differences were attributed to the factors ‘impulsivity’ and ‘motor co-ordination’. This range of abilities, together with the problems in finding suitably matched calmed and control sites and co-operative schools, suggests it is unlikely that tests at further sites, with different age groups, or with different skills tests would be able to detect any differences in the road safety skills of those children from calmed areas compared with those from control areas. However, ‘Home Zones’ are now being installed throughout the country. With Home Zones it is emphasised that all road users have equal priority within the street, giving a change of ‘ownership’ in the street. The difference between the behaviour of motorists towards children in a Home Zone compared to a normal street may well be greater than that for conventionally calmed streets. It may therefore be of value to investigate the development of road safety skills of children growing up in Home Zones when these schemes have been established for sufficient time. However, unless these zones are large it is unlikely the children aged 7 to 9 would not have also had considerable experience of traffic outside the zone.

7 Summary and conclusions

1 A literature review found no direct research on the development of child pedestrian skills in traffic calmed areas. Some indirect evidence suggested that the type of road traffic environment may influence factors affecting the development of pedestrian skills. In particular, research suggests that the interaction between the perceived safety of an environment, the type of safety advice given to children by adults (which itself may be dependent on the environment), and the level of independent exposure afforded to children may influence skills development. The literature also suggested that modified sites may not necessarily be perceived as safer than untreated sites, and that there was some limited evidence that independent exposure may increase in modified sites.

2 A re-analysis of child pedestrian exposure data found some indication that children from calmed areas make more journeys on foot and less by car, and are less likely to be accompanied by somebody over 16 years of age, and that young males from calmed areas spend more time making trips than young males from un-calmed areas.

3 A review of road safety skills and their measurement suggested a number of tests that may be used to detect any differences in skills between children from calmed and un-calmed areas. Of these, two were selected for study: a ‘visual timing and gap selection’ test and ‘safe place crossing location’ test. The first was thought to be most pertinent to this study, since children from calmed

areas might be expected to have difficulties if they encounter fast moving traffic on un-calmed roads. The latter test compliments this as it tests a different set of skills. A PC ‘visual timing and gap selection’ test has clear advantages as a research tool over its roadside equivalent, but had not been validated against the roadside test prior to this study. An exercise to validate the PC visual timing and gap selection test against roadside tests conducted in schools local to TRL with 7-9 year old pupils showed results from the two tests to compare favourably. On the basis of these validation tests it was decided to use the PC version of the test in the main study, but to complement this with a limited number of roadside tests.

4 It was considered that three age groups might be of interest in examining possible differences in road safety skills of those children from calmed and un-calmed areas: 7-9, 10-11 and 11-12 years. The first category was selected for this study as this is the age at which learning increases significantly, and where it is thought that any measurable skill differences that might result from the different environments will start to emerge.

5 A large traffic-calmed area in Worcester Park, Surrey was chosen for study, together with a nearby control area . Four primary/junior schools, 2 in the calmed area and 2 in the control area, agreed to co-operate in the study, and approximately 25 pupils aged 7-9 in each school took part in the road safety skills tests.

6 The PC visual timing and gap selection test detected no difference in skills between those pupils from the calmed area and those from the control area. There were some small improvements in skills from Year 3 to Year 4, and for those of higher rated ability than those of lower rated ability, suggesting that the test was able to identify differences in skills where they exist. The roadside visual timing and gap selection test detected some differences in skills of children from the calmed and control area, with the children from the calmed area appearing to be the more skilful. However, these differences are likely to be attributable to differences (mean age and academic ability) in the two samples of children rather than exposure to calmed or un-calmed streets.

7 The safe crossing location test was scored for the safety of the crossing locations selected (safety score), and separately for the reasons given for the choice of crossing location (the conceptual score). Pupils from the calmed area generally scored very slightly higher on the safety scale (i.e. their crossing locations were more safe) than those from the control area, although the difference rarely reached statistical significance. However, they tended to score lower on the conceptual scale (i.e. their reasons were less sound) than those from the control group. There were no differences between scores for pupils from different school years or of different assessed ability.

8 Interviews with parent/guardians suggested that the children from the calmed and control areas were reasonably well-matched on factors other than the traffic calming in their street. However, slightly more of the children in the calmed area were driven to school. There were no differences (calmed versus control) in the types of areas in which the children played or spent time, or in the time spent walking, playing etc. in the streets near home. When asked whether their child would be able to cross safely at various crossing facilities, slightly more of the parents from the calmed area said he or she would be able to cross safely, although the difference in numbers were not statistically significant. Similarly when asked if the child would be allowed to undertake certain activities (e.g. walk alone to the local shop) the parents from the calmed area were slightly more permissive, although differences between the calmed and control area were not statistically significant. Overall, the results of the interview survey suggest little difference in the exposure of children on local roads in the calmed and control areas.

9 Overall, the study has not identified any substantial evidence that the road safety skills of those children living in a traffic calmed area differ from those living in an un-calmed area. It is likely that individual differences in pupils’ road safety skills due to (for example) the attitudes of parents towards road safety, and differences between schools are greater than those resulting from living in a calmed or un-calmed environment. It is thought that further testing at different sites/with different age children/using different skills tests is unlikely to provide any better evidence of differences, because any differences are likely to be very small, and because of the intrinsic difficulty of matching calmed and control sites. Further testing of child pedestrian skills’ development within Home Zones may be worthwhile when these schemes have been established for sufficient time.

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9 References

Allott and Lomax Consulting Engineers (1999). *Urban street activity in 20mph zones. Study report following zone implementation. After survey 2 (Twelve months after implementation)*. Final zone report. Salford: Seedly.

Ampofo-Boateng K and Thomson J A (1991). Children’s perception of safety and danger on the road. *British Journal of Psychology*, 1991, 82, 487-505.

Ampofo-Boateng K, Thomson J A, Grieve R, Pitcairn T, Lee D N and Demetre J D (1993). A developmental and training study of children's ability to find safe routes to cross the road. *British Journal of Developmental Psychology*, 1993, 11, 31-45.

Björklid P (1992). *Children's traffic environment and road safety education from the perspective of environmental and developmental psychology*. Paper presented to FERSI Conference, Berlin, Germany 1992.

Christie N (1995). *The high risk child pedestrian: socio-economic and environmental factors in their accidents*. Project Report PR117. Crowthorne: TRL Limited.

Department of Environment, Transport and the Regions (1998). *A new deal for transport: Better for everyone*. A summary of the Government's White Paper. London: Department for Transport.

Johansson B S and Drott P (1996). *Zone of free movement and children's traffic accident risks*. Proceedings of the VTI Conference Road Safety in Europe, Birmingham UK. September 9-11,1996.

Jones P and Childs R (1999). *Home zones - a step towards Europe Transport Planning, Policy and Practice*. Proceedings of Seminar B, AET European Transport Conference, 27-29 September 1999, Cambridge UK. Volume P430. London: PTRC Education and Research Services Ltd.

Lynam D A and Harland D G (1992). *Why does the UK have a comparatively poor child pedestrian safety record?* Paper presented to FERSI Conference, Berlin, Germany, 1992.

Mackie A and Webster D (1995). *Monitoring of 20mph zones. Traffic management and road safety*. Proceedings of seminar G 23rd PTRC European Transport Forum University of Warwick Sep 11-15, 1995, vol. 394.

MVA Limited (1999). *Comparative study of European child pedestrian exposure and accidents*. Woking: MVA Ltd.

Pitcairn T K and Edlmann T (2000). Individual differences in road crossing ability in young children and adults. *British Journal of Psychology*, 91, 391- 410.

Preston B (1995). Cost effective ways to make walking safer for children and adolescents. *Injury Prevention*, 1996;1:187-190.

Thomson J A, Ampofo-Boateng K, Pitcairn T, Grieve R, Lee D N and Demetre J D (1992). Behavioural group training of children to find safe routes to cross the road. *British Journal of Educational Psychology*, 1992, 62, 173-183.

Thomson J A and Whelan KM (1997). A community approach to the development of pedestrian skills in young children: the Drumchapel Project. London: Department for Transport.

Tight M R (1987). *Accident involvement and exposure to risk for children as pedestrians on urban roads*. Unpublished PhD Thesis, University College London.

Ward H A, Cave J, Morrison A, Allsop R, Evans A (1994). *Pedestrian activity and accident risk*. Basingstoke: AA Foundation for Road Safety Research.

Webster D and Mackie A (1996). *Review of traffic calming schemes in 20mph zones*. TRL Report TRL215. Crowthorne: TRL Limited.

Whitebread D and Neilson K (1998). *Cognitive and metacognitive processes underlying the development of children's pedestrian skills*. London: Department for Transport.

Appendix A: Analysis of child pedestrian exposure data

A.1 Overview of data

The MVA data were collected with the purpose of comparing Great Britain, the Netherlands and France. It was not feasible to obtain exposure data for those who were accident involved and so two surveys were undertaken.

Samples of 500 fatal or serious child pedestrian accidents from each country were selected. The sites of the accidents were visited and a structured site information sheet completed. The data include considerable detail about the site, the traffic, the road engineering etc. but nothing about the casualty other than age and gender, i.e. data from Stats19 (or equivalent). Each country was categorised into 10 regional areas.

The other sample was of 1000 children per country selected in a structured way, in order to generate a representative sample. The child selected from a household was interviewed about journeys they had taken the previous day, (with some help from a parent if necessary). Each journey was described in stages of walking, riding, by bus, or car in considerable detail. A single journey was walked by the interviewer who confirmed the link times between parts of the journey and recorded detail of traffic, road engineering etc. In this way a comprehensive picture was built-up of exposure to risk in terms of crossing roads, handling traffic etc.

Analysis of these data was either of accident or exposure data, there was no link between the data-sets. The accident site data obviously gave data on sites where there had been an accident to a child pedestrian. The data could therefore be used to compare accident involved sites. In practice the analysis took regions as replicates within country and tried to model the accident rate in terms of road characteristics.

The exposure data was analysed to try and explain why there is a difference in accident rates for the three different countries, and if this difference could be due to exposure measures and road characteristics.

The objectives in the context of this project are to identify possible differences between child pedestrian accident risk and road engineering features. The MVA data was not designed with this objective in mind, but to compare different countries. The accident data is by definition for roads where there has been a child pedestrian accident. It therefore does not have data for 'safer' roads.

A feature of the way the sample was selected (i.e. killed or seriously injured casualties), means that it was not possible to collect environmental or exposure data about the individuals. This limited the extent to which the data were relevant to this study.

A.2 Derivation of calming status of home area

The exposure data consists of a carefully selected sample of school aged children. They were asked about all their trips on the previous day. These were split into stages, such as walking, cycling, in a car, etc. A walking (or roller-blade) stage was then selected at random from one trip. Only the detail relating to this stage had information about traffic calming measures. The stage was split into sections relating to each crossing and journey alongside a road. All sections were coded for the one stage in the one trip. (There were various sampling conditions to cover the situation with no trips or no walking stages).

The age and gender of the child were coded, as was the housing type. However, the road type was not coded. There was however a way of deducing the road type provided that the following have been selected:

- The first section of the first stage in the first trip of the day, or
- The last section of the last stage in the last trip of the day.

If these were available then the road type was available from the section information, and provided that the child started the day or ended the day at home, then this section should be their home street. From this it was deduced whether the child lives in a calmed street or not. It should be remembered that these are a sub-set of all the trips and stages in the database.

A calmed area was defined as one that has:

- Road humps/obstacles in road to slow down traffic.
- Artificial curves in road designed to slow traffic.
- Road narrowing to provide pedestrian islands, with parking bays, designed to slow traffic.
- Different types of road surfacing in some places, e.g. bituminous, brick, paving etc.
- Other things to slow traffic.
- Pedestrianised road with some vehicular access.

All other roads were defined as un-calmed (including those with speed cameras).

Any detailed stage analysis of exposure data that requires the 'home calming' deduced variable will necessarily be for a stage in a trip that either starts from home or ends at home. The 'home calming' deduced variable was not available for any other stages. There was thus a built-in bias in the sub-set of data that was analysed.

However, it was also possible to analyse trip diary data. This contained limited information about all the previous day's trips. Only those respondents identified as calmed or not could be analysed, but assuming that these are not biased then these data provide useful information on some simple trip factors.

Appendix B: Traffic and accident data for calmed and control areas

Table A1 Traffic data for Worcester Park traffic calmed area and control area recorded 9/10 Feb 2001

	Calmed area			*Control area*	
	Green Lane	*Browning Ave*	*Ebbisham Road*	*Windsor Ave*	*Brocks Drive*
Mean speed* mph (Fri)	25.1	20.1	20.4	22.9	23.6
85%ile speed* mph (Fri)	30	24	25	28	28
Mean Speed* mph (Sat)	25.6	19.7	19.7	23.6	22.8
85%ile speed* mph (Sat)	30	24	24	28	29
12hr flow-all vehicles (Fri)	1495	2500	912	1822	506
16hr flow-all vehicles (Fri)	1787	2881	1064	2223	612
12hr flow-all vehicles (Sat)	1014	1898	720	1653	437
16hr flow-all vehicles (Sat)	1231	2155	825	1922	486

12hr = 0700-1900hrs

16hr = 0600-2200hrs

* *Speeds taken between humps in calmed area, so average speed will be lower than this.*

Table A2 Number of child pedestrian casualties for Worcester Park calmed area and control area (from STATS19)

	Calmed area	*Control area*
1986-1989 (pre-calming)	5 (2 serious, 3 slight)	9 (2 serious, 7 slight)
1993-1997 (post-calming	3 (1 serious, 2 slight)	9 (4 serious, 5 slight)
Pre:post ratio	0.6	1.0

Table A3 Other data re Worcester Park traffic calming scheme (from Webster and Mackie, 1996)

Mean speed before calming	29.6mph
Mean speed* after calming	17.1mph
Reduction in speeds (mph)	12.5%
Reduction in accidents	77%
Reduction in traffic flow	22%
Increase in accidents on surrounding roads	14%

* *Mean of 'on humps' and 'between humps' speeds*

Abstract

Engineering measures, such as traffic calming, are effective in reducing accidents for vulnerable road users such as child pedestrians and cyclists. However, their effect on the development of child pedestrian skills is unknown. This project reviewed relevant literature and re-examined existing data on child pedestrian exposure in calmed and un-calmed areas. This was followed by an empirical study which compared the pedestrian skills and exposure of children growing up in a traffic calmed area to those in a nearby 'untreated' control area. Pupils in schools local to each area were tested, and their parents/guardians interviewed.

The study found little difference in the total exposure of children to traffic on local roads in calmed and control areas, although the patterns of exposure changed to some extent. Samples of 7-9 year old children from schools within the calmed area and the un-calmed control area were given both PC based and roadside tests of visual timing and gap selection, and a safe crossing location test. Although small differences were detected, none of the results showed any major difference in scores between children from the two areas, although scores did improve with age. It is possible that individual differences in pupils' road safety skills is due more to factors such as the attitudes of parents towards road safety, and differences between schools (overall academic ability) than to whether they live in a calmed or un-calmed environment.

Further publications

TRL360 *Helping parents to protect pre-school children from accidents* by G Davies, J Davies, G Harland, G Murray and S Levene. 1998 (price £35, code H)

TRL215 *Review of traffic calming schemes in 20mph zones* by D Webster and A Mackie. 1996 (price £35, code H)

PR117 *The high risk child pedestrian: socio-economic and environmental factors in their accidents* by N Christie. 1995 (price £35, code H)

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