Computer-based pedestrian training resource (No.27)

Contents

EXECUTIVE SUMMARY

Practical training in pedestrian skills is known to be highly effective at improving theperformance of children as young as 5 years of age. When conducted at the roadside,however, this training can be time-consuming, labour intensive, and subject to disruptionfrom poor weather and a lack of traffic situations of the types required. Training based onsimulations offers a way round these difficulties, and experimental work suggests it has thepotential to yield learning of comparable levels to roadside training. The current projectaimed to realise this potential by producing computer-based training materials covering arange of pedestrian skills within a single programme. The effectiveness of this programmewas then evaluated via an implementation study involving children aged 5 to 11 years.

The training programme focused on four broad and related areas of pedestrian skill:

- *safe place finding* perception of the dangers posed by aspects of road layouts (for example,blind bends, junctions), and adjustments of crossing routes to deal with these;
- *roadside search* awareness of potential and actual vehicle movements, and theirimplications for road crossing;
- *gap timing* co-ordinating road crossing with vehicle movements; and
- *perception of others' intentions* awareness of cues to drivers' future actions, and theneed to adjust road crossing decisions to fit.

Each skill was addressed by a distinct module of simulation materials, which shared,however, the same small town setting and a common cast of characters to emphasise therelationship between the skills. These modules each provided the basis for four trainingsessions of around 30 minutes apiece, intended for use by an adult trainer working with agroup of three children.

In each module, the software presented a series of problems of a specific type (decidingwhere, when or whether it was safe for an on-screen character to cross a road). Theseproblems required children to learn and exercise key elements of the skill being trained inorder to arrive at correct solutions. The software was designed to help this happen byencouraging two forms of interaction known from previous research to be central tolearning: *adult guidance* on ways of doing things; and *peer collaboration*, especiallydiscussion, over why a particular procedure was necessary and how it should be adapted todifferent circumstances.

This was achieved by keeping the problems sufficiently basic for children always to be ableto take a lead in suggesting answers. Wrong decisions led to the computer providingnegative feedback, and gave the adult trainer an opportunity to draw children's attentionto features of the road or of traffic movements that they had not considered previously,encouraging them to discuss the significance of these for their decision. Various on-screenresources, such as alternative viewpoints, were available to assist trainers in doing this.Since the activity was child-led, the adult's input was typically non-directive, and tailed offnaturally as children became more proficient. This left children space to focus ondiscussion about the extension and flexible application of what they had learnt.

Evaluation of the computer-based training programme was carried out by means of a largescalestudy involving children in three age groups (56, 78 and 910-year-olds at theoutset). These children attended schools in two areas of Glasgow. One had a relativelyhigh accident rate and low socio-economic status (SES) population, whilst the other had alower rate and was more socially mixed. Over the space of two school years, approximately75 children from each area worked through each of the four modules of the trainingprogramme in turn, under the supervision of adult trainers drawn from amongst the parentsof children at the participating schools. These parent volunteers had all been through aninduction course prior to the training sessions, to familiarise them with the objectives ofpedestrian training, the software and the non-directive guidance methods that they neededto adopt.

Training in each skill followed a pre-test used to measure the baseline performance ofchildren on that skill. A subsequent post-test served to establish the effects of the trainingrelative to this baseline. A delayed post-test, which took place after training and testing onthe *next* skill in the programme, allowed the longer-term impact of the training to beassessed. Testing was carried out at the roadside in order to evaluate the effects of trainingon actual behaviour, and incorporated measures of explicit understanding of the rationalefor that behaviour.

Control children of the same age and area who received no training were tested at thesame time points. This allowed the effects of training to be disentangled from those ofrepeat testing and increased experience due to everyday exposure to road environments.The study design also enabled the *cumulative* effects of training the four skills within oneprogramme to be determined. Better performance than the controls in the pre-test for aparticular skill would indicate a knock-on effect from training in previous skills, whilstimprovements between post-test and delayed post-test would suggest a knock-on effectfrom training in a subsequent skill.

The results of the evaluation study were almost uniformly positive. For *safe place finding*,training doubled the number of safe judgements made by 8- and 10-year-olds, andsubstantially improved their ability to offer insightful justifications for these judgements.There were, moreover, signs of cumulative benefits arising from subsequent training inroadside search, since performance improved between post-test and delayed post-test.Untrained children showed no gain whatsoever. The only negative point was that traininghad a much more limited impact on the 6-year-olds, who showed no improvement injudgements, and only small gains in understanding.

There was, however, good evidence that safe places training benefited the *roadside search*performance of the 6-year-olds. They, in common with the two older age groups, did betterat pre-test than the controls on both the pick-up of information concerning vehiclemovements, and explanation of its significance. Training in roadside search led to furtherimprovements on both aspects of performance in all three age groups, whilst controlchildren showed little or no progress. Once more, there were gains between post-test anddelayed post-test, suggesting that training in gap timing produced a further boost inperformance.

The outcomes for training in *gap timing* presented a similar picture. At pre-test, trained children made more cautious and more skilful judgements than control children, indicating a knock-on effect from previous input. Training led to further improvements, almost all of which were absent in the control sample, although in this case there was no continued increase between post-test and delayed post-test. Trained children showed improved ability to estimate crossing time and better anticipation of upcoming gaps in traffic. This allowed them to identify smaller gaps for crossing without any increase in risk, which meant in turn that they missed fewer potential opportunities. Training also produced improvements in children's conceptual understanding of what the gap timing task involved.

Previous training had no apparent impact on *perception of intentions*, and both trained andcontrol children started at the same level. Once more, though, training itself producedclear benefits, with trained children showing improvements in judgement of what driverswere likely to do, identification of the cues permitting such judgements to be made, andunderstanding of the implications for crossing decisions. None of these gains were apparentamongst the control children.

The computer-based training programme was a considerable success, then. It led tosubstantial improvements in both roadside behaviour and children's understanding in allfour of the skills dealt with, and in all three age groups. Beyond this, there were evenindications that the group-based nature of the training sessions had served to improve theverbal skills of children. The sole exception to this pattern of success was the limitedadvance shown by the 6-year-olds on safe places. Even here, the fact that safe placestraining had a positive impact on roadside search performance suggests that youngerchildren may simply have taken longer to grasp the connection between the computersimulations and the roadside, rather than that the training was ineffective. The broadpattern of improvement indicates that none of the four skills was too difficult for youngerchildren to grasp, or too easy for older children to show benefit. There is, therefore, no agewithin the primary school range at which use of any section of the training software wouldbe inappropriate. The cumulative effects of training in the different skills suggest thatthere are, however, clear benefits to be gained from children working through the wholepackage, and in the order employed here.

It is important to note three caveats. Firstly, these results do not amount to evidence thatcomputer-based training can act as a substitute for roadside training. There are signs that,for the younger end of the primary age range in particular, a combination of the two is infact required for children to grasp the connection between computer and roadside, andthus for computer-based training to work to its full potential. More generally, it wouldseem preferable to regard computer-based training as a *supplement* to roadside training albeit one that adds considerable value in that it is only the latter that can providechildren with the opportunity to fine-tune judgements in the context in which they areultimately to be employed. Secondly, despite the substantial improvements achieved, thecomputer-based training programme did not promote anything resembling adult levels ofpedestrian skill. It is important, therefore, that it is thought of as assisting children tobecome more effective *learners*, who should still be kept under parental supervision.Finally, the success of the computer-based training is not separable from the adult-groupinteraction that took place. The software was designed to be employed in this manner, andthere is no reason to believe that individual use of it by children working on their ownwould be effective.

CHAPTER 1:
Overview of project aims, training resource design, and evaluation design and methodology

1.1 RATIONALE AND AIMS OF THE PROJECT

In order to be a safe pedestrian, an individual must possess the skills and strategic thinkingnecessary to solve the many problems posed by the traffic environment (Thomson, Tolmie,Foot & McLaren, 1996). In order to acquire these skills and learn how to deploy themproperly, children need appropriate training and experience. It is now clear thatprogrammes of practical training, in which children actively make judgements aboutconcrete traffic events and receive feedback about the adequacy of those judgements, areamongst the most effective means of meeting that need and can substantially improve thebehaviour of children as young as 5 years of age (for example, Rothengatter, 1981, 1984;van der Molen, 1983; Young & Lee, 1987; van Schagen 1988; Thomson, Ampofo-Boateng, Pitcairn, Grieve, Lee & Demetre, 1992; Demetre, Lee, Grieve, Pitcairn, Ampofo-Boateng & Thomson, 1993; Ampofo-Boateng, Thomson, Grieve, Pitcairn, Lee& Demetre, 1993; Thomson & Whelan, 1997). Recently, several training resourcescapitalising on the benefits of practical training have been developed for professional use(for example, Davies, Guy & Murray, 1993; Thomson, 1997).

The ideal context for practical training would seem to be the roadside and there is nodoubt that roadside training can be highly effective. This is perhaps not surprising, sincethis context enables children to gain experience of making traffic judgements in exactlythe environment in which they will ultimately have to be carried out for real.Unfortunately, roadside training is also time-consuming, labour intensive and potentiallyconstrained by factors such as the weather. More importantly, the roadside experiencesavailable to the child are always limited by the traffic situations that can conveniently andsafely be found at the time of training. For this reason, *simulations* may have an importantsupporting role to play in road safety education because they offer opportunities to expand,in a systematic and controlled fashion, the range of traffic problems that children can beasked to solve. Moreover, previous research using a variety of simulation techniques (forexample, table-top models, video and computer animations) shows that trainingprogrammes using such materials do lead to improvements in roadside behaviour, providedthey require children to make judgements corresponding to those made under naturalconditions (Thomson *et al*.,1992; Tucker, 1993; Ampofo-Boateng *et al*.,1993; Tolmie,Thomson, Foot, McLaren & Whelan, 1998).

Nevertheless, the simulation-based resources developed to date have been largelypiecemeal and experimental in character. To capitalise on the advantages that simulationshave to offer, what is required is the development of a comprehensive, scientifically designed package of simulation-based resources. From this point of view, computer-basedsimulations hold particular attraction because they permit the construction of a widerrange of dynamic events than would be readily achievable using models, whilst allowing farmore opportunities for active engagement with the materials than would be possible withfilm or video. In addition, our own previous research suggests that there may, in some casesat least, be a more reliable correspondence between children's computer performance andtheir roadside performance than between their roadside performance and performance on avideo simulation (Tolmie *et al*., 1998). With these points in mind, the present project hadtwo major objectives:

1) to realise the potential of computer simulations in road safety education by producingcomputer-based training materials aimed at promoting a clearly-defined range of trafficskills within a single, coherent programme; and

2) to evaluate the effectiveness of this programme in improving the roadside behaviourand understanding of children in the age range 5 to 11 years.

1.2 THE PEDESTRIAN SKILLS TO BE TRAINED

On the basis of previous research, four core pedestrian skills were selected for inclusion inthe training programme. These were:

- **Safe place finding** (for example, Thomson & Whelan, 1997);
- **Roadside search strategies** (Tolmie *et al*., 1998);
- **Visual timing and gap selection** (for example, Young & Lee, 1987; Demetre *et al*.,1993); and
- **Perception of other road users' intentions** (Thomson & Whelan, 1997; but see alsoThornton, Andree, Rodgers & Pearson, 1998).

These skills were selected in part because previous research suggests they are crucial intheir own right. In addition, they are generic and can be argued to build on each other in aprogressive manner, making it appropriate to tackle them in an integrated and sequentialfashion within a single training programme. The first addresses children's perception of thedangers posed by *topological* features of the traffic environment (for example, intersections,bends, brows of hills, parked vehicles) and is one of the first skills that must be learned.The second builds on this by developing children's atunement to the more *dynamic*features of the environment, especially vehicle movements. The third further develops thisby requiring children to relate information about vehicle movements to their ownpotential *actions* for example, in judging whether gaps in moving traffic are large enoughto pass through safely. The last develops children's sensitivity to cues signalling the*intentions of other road users*, and how this should inform and influence their own intendedactions. Together, these span a significant section of the traffic competences that havebeen identified as necessary for safe pedestrian behaviour. If children's proficiency could beincreased across all four, it seems likely that this would significantly enhance their overallability to deal with the multifarious traffic scenarios confronting pedestrians in their dailylives. Greater detail on what each skill individually involves is provided in the ensuingchapters of this report.

1.3 DESIGN OF THE COMPUTER-BASED TRAINING RESOURCE

The simulation materials that formed the basis of the training programme comprised fourdistinct software modules, each corresponding to one of the four core skills identifiedabove. However, these modules were thematically unified by embedding them in a sharedsetting (a simulated small town) and by using a common set of child characters who wouldnavigate around the setting as pedestrians. It was intended that the commoncharacteristics of the modules would act as prompts, helping children see connectionsbetween the problems encountered in different modules and aiding the process ofgeneralisation from one to another. It was also hoped that the familiar neighbourhood andcharacters would be liked, helping to maintain children's interest and motivation over thecourse of the programme.

Within each module, the software was designed to present a series of decision-making tasksthat required use of the skill being trained. In each case, the task was some variant on thetheme of deciding *where*, *when* or *whether* it was safe for the on-screen character(s) to crossa depicted road. Once a decision had been made, the children could attempt to make thecharacter enact it on-screen. The computer would then provide feedback on the adequacyof the decision, for example, by permitting the character to walk across the road andcontinue his/her journey; by refusing to allow the character to execute the agreed action;or by showing what the undesirable consequences of executing the action would be (forexample, in Module 3 characters stepping into the street too close to an oncoming vehiclewould turn into ghosts). Thus, the modules permitted a degree of *interaction* with thesoftware, and provided *feedback* concerning the adequacy of the interactions.

All software was authored using Macromedia Director 6.0 on the PC platform. Thisallowed us, on the one hand, to create a realistic 3D environment featuring high-qualityanimation routines and some degree of interactivity. At the same time, it permitted us toproduce run-time versions of the software that would happily work on low-end computersof the type that might be found in many schools or homes. Examples of what the simulatedenvironments looked like can be found in the Appendices although, of course, all dynamicfeatures are absent, as is sound.

1.4 TASKS AND INSTRUCTIONAL CONTEXT

1.4.1 The Role of Adult Guidance and Peer Collaboration in Learning

Whilst critical as a first step, the development of an effective training resource requiresmore than the identification of key skills and the production of simulation materials aimedat galvanising those skills. Unless the designer is satisfied with a purely hit-or-missapproach, the simulations and the tasks employing them must engage, exercise and honethe desired skills in a systematic and predictable way. However, in order to achieve this, it isnecessary to consider who will be using the materials (both as trainer and learner) and whatthe natural activity of these users would tend to be, since this has a major impact on whattakes place. For example, previous simulation research (Tolmie *et al*., 1998) found thatchildren working on a one-to-one basis with adults co-ordinated their activity and dialoguein quite a different fashion to small groups of children collaborating on ostensibly the sametask. These different forms of interaction gave rise in turn to differences in learning.

It has in fact consistently been found that adult-child interaction and peer collaboration produce patterns of activity with contrasting outcomes across a variety of areas of education (Damon & Phelps, 1989; Rogoff, 1990). Adult-child interaction has been found to be more suited to promoting the acquisition of effectively organised *procedures* (for example, learning the steps to go through in baking a cake) whereas peer collaboration is better suited to promoting children's *conceptual understanding* (for example, why you would cook some things in an oven). These findings open up the possibility of deliberately selecting a particular combination of participants in order to produce a certain pattern of activity, and consequent learning outcomes. In areas like pedestrian skill acquisition, however, where the problems that the child must learn to solve are complex and highly variable, it is crucial that the acquisition of procedures goes hand in hand with the development of conceptual understanding. This is because the latter is known to be central to the ability to generalise procedures in a flexible fashion (see for example, Karmiloff-Smith, 1992). When children learn procedures in the absence of appropriate conceptual underpinning, they show little or no ability to adapt these to the needs of even slightly different circumstances. This observation has frequently been reported in road safety education (see for example, Rottengatter, 1981; Thomson, 1991). Where a greater degree of generalisation is required (as it often is), such children may even fail to recognise the link between the learned procedure and the task at hand at all (for example, Brown & Campione, 1986). It was therefore considered critical to devise training methods capable of promoting both procedural *and* conceptual growth in an integrated manner.

This was achieved by combining peer collaboration techniques with adult guidance in amanner similar to that described by Thomson, Tolmie & Foot (1998). Essentially, thisinvolved an adult trainer working with children in small groups of three. However, sinceadult-child and child-child interactional styles can undermine each other unless properlyco-ordinated (Tolmie & Howe, 1994), it was also important that very careful considerationbe given to the organisation of activity during training. This was dealt with by adopting anapproach in which the focus would gradually shift, as training progressed, from an adultchildmode of interaction to a child-child mode. Thus, the trainer would initially take arelatively proactive role, making suggestions, offering explanations and encouragingdiscussion. As time went on, the trainer would aim to retreat into the background, withthe children themselves taking over the role of making suggestions, offering explanations,etc. There is, in fact, good reason to suppose that these interactional patterns alsounderpin the success of practical training at the roadside (Thomson *et al*., 1992; Ampofo-Boateng *et al*., 1993; Thomson & Whelan, 1997). As a central part of the effort to achievethis shifting pattern of interaction, the simulation software, the tasks it presented, and theon-screen support it offered were all designed to facilitate adult-child and child-childpatterns of interaction, and the transition between them, capitalising on procedures foundto be productive in earlier research on computer-based pedestrian training (see Tolmie,Thomson & Foot, in press).

1.4.2 Key Features of the Collaborative Training Procedure

At its most basic level, the software presented pedestrian problems where the requireddecisions were essentially simple (for example, cross versus don't cross). Thus, although theconsiderations leading a skilled pedestrian to make one or other of these decisions wouldoften be complex, the way the problems were presented permitted even the least skilledchildren to make some kind of a response. Once made, these responses (which were oftenwrong) provided the trigger for adult guidance aimed at initiating discussion about, forexample, the decision-making procedures children were adopting versus those they *should*be adopting. This represented the start of the learning process. Adult intervention was always done indirectly by means of prompts, questions or suggestions, and never directlythrough instructions or commands. Crucially, trainers had at their disposal various onscreenresources, such as alternative viewpoints, which helped them give prompts, andenabled them to illustrate what they meant when making suggestions as to what childrenmight do or offering explanations as to why particular elements might be important.However, the aim was always to guide children's thinking so that they would makedecisions on the basis of their *own* reasoning, rather than on that of the trainer. Becausechildren were always encouraged to take the lead in decision-making, with adult inputsecondary to this, it was perfectly natural for adult guidance to taper off over time and forchildren to engage in increasingly confident dialogue amongst themselves about therationale underlying their decisions, building on the suggestions and explanations offeredby the adults at an earlier stage.

Successive items within a task were also carefully selected to fit in with this sequencing.To begin with, children were confronted with relatively simple problems that addressedbasic aspects of the skill in question. This allowed adult guidance to cover the main pointsof importance in a structured and straightforward fashion. Later problems required childrento deploy what had previously been learnt in increasingly complex ways and underchanging circumstances. This provided scope for children to apply (rather than merelyrepeat) points that had initially been dealt with by the adult, which in turn helped buildmore generalised and flexible conceptual understanding. A further point to note is that thesoftware for each skill included items deliberately designed to echo issues covered intraining on a previous skill, together with others presaging issues that would be dealt within subsequent modules. This was intended to help children make specific connectionsbetween the different skills being trained, and to see them as part of a broader whole.

Greater detail is provided in subsequent chapters about the precise tasks, software anddialogue that were used to achieve these aims in relation to each skill. However, thegeneral principles outlined above were adhered to in each instance, so as to systematicallyfacilitate the development of children's procedural and conceptual understanding. It iscrucial to note that the end product of the development work was therefore not just a setof computer-based training materials, but software that would *support specific patterns oftrainer-child interaction* known to promote learning optimally. In other words, what theproject developed was a training *procedure*, of which the computer materials were only oneelement. It is this full procedure that any future use of the software would need to employ,in order to do justice to the design principles involved.

1.5 EVALUATION METHODOLOGY KEY CONSIDERATIONS

The second major objective of the project was to evaluate the effectiveness of thecomputer-based training programme in improving children's pedestrian skills and roadsidebehaviour. In designing the evaluation, the following key factors were identified at theoutset.

- Although it was intended that the programme would ultimately be employed as a*supplement* to roadside training (rather than as a complete substitute), it wasconsidered essential to measure its effect in the absence of other training elements, soas to gauge the nature and extent of the learning that could be specifically attributedto its use.
- Whilst the programme consists of four modules which could, in principle, be run inisolation from each other, it was felt to be important that children in the 'trainedgroup' undertook the whole programme covering all four skills. This was because eachmodule was designed to lay a foundation for the next and it was hoped this mightproduce cumulative effects, with children's competence on any one skill being furtherenhanced as a result of training on both preceding and subsequent skills.
- While all training was to take place via the computer simulations, as far as possiblepre- and post-testing of children's skills would be conducted at the roadside. This wasbecause the roadside is the only context in which, at the end of the day,'improvement' has any real meaning.
- Improvement would be measured both in terms of children's roadside *behaviour*, butalso their *conceptual understanding*, as revealed by the explanations and justificationsthey were able to provide for their behaviour. This would enable us to double-checkthat apparently skilful decisions were in fact, being made for the right reasons. It alsoallowed us to investigate the ways in which children's conceptual thinking changedover the course of training, and to examine the nature of the relationship betweenbehavioural improvement and conceptual growth.
- As in our previous studies, it would be important to establish, not just the immediateeffects of training, but how this affected children's behaviour and conceptual growthin the longer term. Thus a series of delayed post-tests was built into the design. Thesetook place several months after the conclusion of the relevant module, although, forpractical reasons, the exact length of the delay varied. The overall duration of theproject did not permit delayed post-testing of the final skill.
- Unlike previous studies, the programme would be undertaken by three separate agegroups (56, 78 and 910-year-olds at the start of the project). This would have twoadvantages.

Firstly, it would enable us to compare the scores obtained by youngerchildren after training with those obtained by older children before training. Thiswould provide an estimate of the extent to which training had succeeded inaccelerating children's normal development. Secondly, it would help establish whetherthere are optimal ages at which different parts of the programme should be introduced.For example, it might be that some skills are too demanding for young children andshould not be introduced until they older. Conversely, there might be no point inteaching some skills to older children on the basis that they had already acquiredthem anyway. Such data would help optimise the way in which the package would beused with children of different ages and levels of existing experience.

1.6 GENERAL METHODOLOGY

Bearing these points in mind, the pedestrian skills were introduced sequentially over aperiod of 24 months, beginning with safe place finding. Two skills (safe places and roadsideattention) were taught in the autumn and spring terms of Year 1, followed by gap timingand perception of intentions in the corresponding terms of Year 2. The programme wasundertaken in its entirety by three cohorts of children corresponding to the Primary 2, 4and 6 classes of participating schools at the start of the programme. Children's ages at thestart of the programme were therefore in the ranges 56, 78 and 910 years. By the timechildren completed the final skill, they were approximately 20 months older and inPrimary 3, 5, and 7 respectively. Precise details of children's ages at the time ofundertaking each module are given in the relevant chapters below.

All training was carried out by parent volunteers, recruited by project staff in co-operation with head teachers. Volunteers themselves received training so that they would clearly understand what they were supposed to be doing and why (see Section 1.9). Children received four training sessions for each skill, each lasting 2030 minutes, at a rate of about one session per week. Children were trained in groups of three (although occasionally the group might consist of two or four children, depending on absences) and each trainer was asked to take responsibility for a minimum of two groups. Volunteers trained only *other people's* children: they were never allocated their own child. Training was undertaken during school hours, with volunteers collecting the children from their classrooms at designated times and taking them to the special rooms set aside for the project. The running of the training programme thus depended on a close and mutually supportive collaboration between project staff, adult volunteers and local schools.

To assess the effectiveness of training, the evaluation scheme summarised in Figure 1.1 was devised and run separately for each skill. Prior to training, all children were tested at a number of pre-selected sites in the streets near their schools *(pre-test)*. This enabled us to establish baseline measures of skill against which the benefits of training would later be assessed. As soon as possible after training ended, these tests were repeated to see what changes had taken place *(post-test 1)*. A further test was run between two and eight months later to establish how robust the training proved to be in the longer term *(post-test 2)*. This last test was not run for the final skill (perception of intentions) due to time constraints.

Figure 1.1: Schematic representation of the evaluation design

Data were also collected from a large sample of control children who undertook pre- andpost-testing but did not receive any training. This allowed us to separate the effectsattributable to the programme from those attributable to confounding factors, such aschildren's increasing age. Control children came from neighbouring schools and werematched for age, gender and area of residence. A different control sample was selected foreach of the four skills to eliminate possible contaminating effects attributable to participatingin large numbers of test sessions. No control child took part in more than 3 of the 11 testsessions that were run, and never in more than 2 tests of the same skill.

1.7 MEASURING THE CUMULATIVE EFFECTS OF TRAINING

In addition to assessing the benefits of training on each skill individually, the evaluationprogramme also examined the possibility that training might produce *cumulative* effects that is, that training on one skill might have knock-on effects on other skills. Two types ofknock-on effect are possible. Firstly, training on one skill might enhance competence onanother skill that had not yet been taught. If this were the case, we would expect pre-testperformance on the second skill to be higher than it would have been, had the earlier skillnot been taught. Cumulative effects would thus be revealed if, over the course of theprogramme, trained children increasingly outperformed control children on the baseline tests.

Secondly, it is possible that skills introduced later in the programme might have aretrospective influence on skills that were taught earlier. For example, it is possible that training on Skill 3 (gap timing) might not only improve gap timing, but might furtherimprove Skill 2 (roadside search). This possibility can be investigated by means of thedelayed post-tests (post-test 2), each of which was run after the subsequent training module.Thus, delayed post-testing of Skill 1 (safe places) was run immediately after Skill 2(roadside search). Similarly, the delayed post-test for Skill 2 (roadside search) was runimmediately after Skill 3 (gap timing). If training was indeed having retrospective benefitson skills taught earlier in the programme, then we would expect performance in the delayedpost-tests (post-test 2) to further improve over the performances obtained in the immediatepost-tests (post-test 1). In previous research, such continuing improvements have seldombeen reported, with delayed post-tests typically being used to ensure that performance wasmaintained rather than continuing to improve. If identifiable improvements between posttests1 and 2 were actually found, this would thus be of some significance.

The evaluation, then, was designed in such a way that both prospective and retrospectiveinfluences on performance could be calculated across the four skills. This would helpestablish the overall benefits of running the programme as an integrated package, as well asthe benefits of running each module as an independent unit.

1.8 CHARACTERISTICS OF THE SAMPLE

Participating children were drawn from two distinct areas of the City of Glasgow, one inthe East End and the other in the West. The eastern area is a large, peripheral housingscheme of the kind developed in Glasgow in the 1950s and 60s as a means of alleviatinginner city housing problems. Like most such schemes in Glasgow it is characterised by alower socio-economic profile and, at the time of the study, had been identified by theRoads Department as suffering a high child pedestrian accident rate relative to the city as awhole. It was felt important to undertake the programme in such an area since highaccident areas are the ones most likely to be targeted by resources of the type beingdeveloped and evaluated. The second area is in a quite different part of the city (the WestEnd) and is characterised by a much more mixed socio-economic profile. At the time ofthe study, child pedestrian accident rates in this area were moderate by comparison to thenorm for the city. The aim was to ensure that the socio-economic profile of the sample as awhole was not exceptionally skewed and would cover a range of social, personal andenvironmental characteristics that might be relevant to accident rates. There was,however, no intention of systematically investigating the effects of such factors on theprogramme's effectiveness.

Two schools, one within each area, were enlisted to host the training programme. Twofurther schools in the West End and three in the East End acted as controls. The controlsample was larger than the trained sample because different children acted as controls foreach of the four skills. As explained earlier, this procedure was followed to eliminate thepossible contaminating effect that might arise if a single group of controls participated inlarge numbers of pre- and post-tests. At the start of the project, the trained sample consistedof 145 children, equally spread between the two schools and balanced for age and gender. Itwas intended that, as far as possible, this sample would remain constant throughout the 24months of the project, although a small attrition rate meant that slight discrepanciesoccurred between modules. The control population consisted of 307 children, dividedbetween five participating schools and balanced for age, gender and area of residence. Aswith the trained population, small attrition rates on the days of testing meant that thenumber of children for whom data are available varies from module to module. The largetotal participating populations ensured that these variations never compromised analysis.

Table 1.1: Evaluation study schedule, together with details of participating samples (P2P7 represent ages from 56-year-olds to 1112-year-olds)			
	Activity	**East End sample**	**West End sample**
Stage 1: *Safe places*			
Autumn term 1998	Pre-test	*Trained sample* School 1:	*Trained sample* School 5:
	Training	19 P2, 25 P4, 26 P6 Total = 70	25 P2, 32 P4, 18 P6 Total = 75
	Post-test 1	*Control sample*	*Control sample*
		School 2 (Set 1): 16 P2, 12 P4, 12 P6 Total = 40	School 6 (Set 1): 14 P2, 16 P4, 16 P6 Total = 46
Stage 2: *Roadside search*			
Spring term 1999	Pre-test	*Trained sample* School 1:	*Trained sample* School 5:
	Training	19 P2, 25 P4, 26 P6 Total = 70	25 P2, 32 P4, 18 P6 Total = 75
	Post-test 1	*Control sample*	*Control sample*
	Post-test 2 (Safe places)	School 3: 14 P2, 15 P4, 16 P6 Total = 45	School 7 (Set 1): 16 P2, 14 P4, 14 P6 Total = 44

Stage 3: *Gap timing*			
Autumn term 1999	Pre-test*	*Trained sample* School 1:	*Trained sample* School 6 (Set 2):
	Training	16 P3, 19 P5, 24 P7 Total = 59	23 P3, 20 P5, 27 P7 Total = 70
	Post-test 1*	*Control sample*	*Control sample*
	Post-test 2 (Roadside search)	School 2 (Set 2): 8 P3, 8 P5, 8 P7 Total = 24	School 6 (Set 3): 7 P3, 14 P5, 9 P7 Total = 30
Stage 4: *Perception of intentions*			
Spring term 2000	Pre-test	*Trained sample* School 1:	*Trained sample* School 6 (Set 2):
	Training	16 P3, 25 P5, 24 P7 Total = 65	23 P3, 18 P5, 24 P7 Total = 65
	Post-test	*Control sample*	*Control sample*
	Post-test 2 (Gap timing)*	School 4: 18 P3, 18 P5, 11 P7 Total = 47	School 7 (Set 2): 10 P3, 10 P5, 11 P7 Total = 31
*NB Only two-thirds of the ***Trained sample*** (randomly selected within age group) were tested here, due to the length of the procedure involved; the samples of control children were scaled down to reflect these lower numbers.			

One further point should be noted. Whilst, as already stated, the intention had been to maintain the initial training sample for the duration of the study, at the end of the first year the school that had provided the trained children in the West End area indicated that it was unable to continue to participate because of other demands on the children's time. As a result, it was necessary to recruit a new training sample for that area. It was arranged that one of the existing control schools would step in by providing access to 70 children from classes who had not previously participated in the study. Thus an overall total of 522 children participated in the evaluation. Precise details of participant characteristics are given separately for each of the four skills in Chapters 25 and in Table 1.1 above.

1.9 VOLUNTEER RECRUITMENT AND TRAINING

Training was undertaken by parent volunteers recruited through the schools in whichtraining was to take place, in accordance with the community-based approach adopted byThomson & Whelan (1997). In one school, the head teacher put project staff in touchwith individuals who already contributed to the life of the school and who were thoughtlikely to show interest in participating. In the other school, the deputy headteacher wasreluctant to target parents in this way and asked that we write to all parents of children inthe school, requesting support. Both approaches were successful in enlisting a sufficientlylarge number of volunteers to get the project off the ground without delay. Once theproject became established, new volunteers were recruited from time to time. The sourceof these additional recruits was almost always the cohort of existing volunteers, whobrought the project to the attention of friends and relatives.

A total of 35 volunteers took part in at least one phase of the project, with 17 contributingto at least two phases. With one exception, all were mothers of children in theparticipating schools, though not all had children in the participating classes. Theremaining volunteer was a grandmother. Each volunteer was asked to take responsibilityfor a minimum of two groups of three children and to train them at weekly intervals, as faras possible on the same days each week. In practice, a number of trainers undertooksubstantially more training than this. The exact amount of input made by individualtrainers was not controlled. Similarly, although an effort was made to ensure that trainersworked with the same children as far as possible, in practice this was not always possibleand there was, in fact, a good deal of variation in the composition of groups from week toweek. Since it is almost certain that such variation would have to be tolerated in any 'realworld' implementation of the programme, we did not attempt to achieve a higher degree ofcontinuity by artificial means.

Before beginning the programme, all volunteers themselves received training throughinduction courses organised and run by project staff. Separate courses were organised foreach of the four modules, and these were run separately in each participating school. Courseorganisation followed the general principles described in the *Kerbcraft* manual (Thomson,1997), modified in the light of the skills that were to be taught. Courses involved bothobservation of good teaching practice and guided practice of working with children.

Each course began with an introduction from staff, aimed at introducing the skill to bedealt with, the training software for that skill and the training procedures. Questions anddiscussion were encouraged throughout. Volunteers then had the opportunity to observegood teaching practice by watching project staff undertake a short training session with agroup of children. This was followed by further discussion. Volunteers then had theopportunity to acquire 'hands-on' experience of working with children themselves, withstaff providing guidance and feedback. For new volunteers who had not participated in aprevious round of training, particular emphasis was placed on learning how to use languageappropriate to the age of the children involved; how to direct children's activity in therequired non-didactic manner (that is, without giving constant commands or instructions);and how to encourage children to gradually take responsibility for their own progress asthey moved through the training activities. They were also given a reference manual forsubsequent use, which summarised the main features of the training.

For volunteers who had already participated in a previous round of training, a shortersession was employed, the principal aim of which was to familiarise them with the newsoftware and the key elements of the training procedure for that particular skill.

1.10 STRUCTURE OF WHAT FOLLOWS

This chapter has outlined the broad aims of the project and described the general features of software design and evaluation methodology. Chapters 2, 3, 4 and 5 deal in depth with the software and training outcomes for safe places, roadside search, gap timing and perception of intentions respectively. These chapters also present evidence relating to cumulative effects of training across these four skill areas. Chapter 6 details overall conclusions about the project outcomes and makes recommendations with respect to subsequent use of the computer-based training resource.

CHAPTER 2:
Skill one - Finding safe places to cross the road

2.1 RATIONALE

Most road safety education is concerned with the mechanics of the crossing task itself: thatis, with ensuring that the child stops at the kerb, looks in appropriate directions for traffic,walks across the road, and so on. However, these activities are only meaningful if the childfirst selects a suitable roadside location to carry them out. Many locations are unsuitablebecause they obscure the child's view of traffic, as well as a driver's view of the child.Examples include sharp bends; the brow of a hill; and positions close to parked vehicles orother obscuring street 'furniture'. Intersections pose special difficulty because the layoutmeans that traffic can arrive from several directions, thereby taxing the child's visualsearch, memory and information-processing capacities. Perhaps not surprisingly, suchlocations are over-represented in child pedestrian accidents (Thomson, 1991). Obviously,children must learn to recognise the danger implicit in such situations and know how todeal with them.

In practice, young children show little insight into the dangers posed by unsafe locationsand will happily choose to cross there if given the opportunity to do so (Ampofo-Boateng& Thomson, 1991). Indeed, children under the age of 9 years tend to think that such sitesare positively *safe*. This is because younger children judge the safety or danger of a locationprimarily on the basis of whether or not they can see cars nearby. If none is visible, theyassume that none exists. They fail to recognise that a sharp bend is a dangerous locationprecisely *because* traffic cannot be seen there. Only from about 9 years do untrainedchildren begin to realise in a systematic way the danger posed by such locations and startdeveloping strategies aimed at overcoming them, such as moving further away to a placewhere approaching vehicles can be seen well before they arrive.

A further problem is that children tend to assume the most direct route to a destination isthe safest way to get there. This means they will often walk *diagonally* across the road - aroute they may even prefer at crossroads where they would be exposed to traffic from severaldirections. Such choices are often justified on the grounds that the child is 'going straightacross the road' - an obvious misinterpretation of common advice to young children.

These trends have now been well documented (for example, Ampofo-Boateng &Thomson, 1991; Ampofo-Boateng *et al*., 1993; Demetre & Gaffin, 1994; Thomson, 1997).Several studies have also examined the extent to which children's understanding of suchdangers and their ability to deal with them can be improved through training (Thomson etal., 1992; Ampofo-Boateng *et al*., 1993; Thomson & Whelan, 1997; Thomson, Ampofo-Boateng, Lee, Grieve, Pitcairn & Demetre, 1998). It turns out that children as young as 5years of age can benefit substantially from short programmes (4 - 6 sessions) of practicalroadside training, producing improvements that would otherwise take several years tocome about. The improvements are also relatively robust, with no deterioration inperformance over periods of two to three months after the end of the programme.

The aim of this stage of the present study was to determine whether comparable resultswould be obtained if a computer-simulated traffic environment were substituted for thereal traffic environment as the locus of training. We also wished to assess the impact oftraining across a wider age range than had previously been studied. This would allow us toestimate the relative benefits of introducing the programme at different ages, and establishif there is an optimal age at which training should ideally begin. In other respects, thetraining process would be as similar as possible to that employed previously. Thus, childrenwould work in groups of three under the supervision of a parental volunteer who wouldprovide background assistance as the children attempted to solve a series of computerpresentedtraffic problems as independently as possible. The specific aims were as follows.

2.2 AIMS

- *to teach children how to recognise dangerous roadside locations where crossing should not beattempted (or where a special strategy is needed);*
- *to teach children how to construct routes that would avoid such locations;*
- *to teach children how to choose routes that would minimise their exposure to traffic;*
- *to increase children's conceptual understanding so that they would be able to deal flexibly witha wide range of situations;*
- *to determine the effect of training on children's real roadside traffic judgements and behaviour;and*
- *to assess the relative impact of the programme on children aged 6, 8 and 10 years at thebeginning of training.*

2.3 PARTICIPANTS

A total of 320 children drawn from six primary schools in the City of Glasgow took part. Of these, 145 children from two schools undertook the programme of training. The remaining 175 children, drawn from four primary schools, were allocated to the control condition. A small attrition rate meant that complete data were not available for 7 control children. The number of control children included for purposes of analysis is therefore 168. Of these, 86 undertook the pre-test and post-test 1. A different sample of 85 children undertook the delayed post-test (post-test 2), after having gone through the pre-test and post-test 1 for Skill 2 (roadside search). The general procedures for selecting schools and assigning children to treatment and control conditions is described in Section 1.8. Children's mean ages at the beginning of the week in which training commenced are shown in Table 2.1.

Table 2.1: Mean ages of participating children at the start of training			
TRAINED SAMPLE			
Year group	**Participants**	**Mean age**	**Range**
P2	44	6 years 1 month	22 months
P4	57	8 years 0 months	14 months
P6	44	10 years 2 months	17 months
CONTROL SAMPLE			
Year group	**Participants**	**Mean age**	**Range**
P2	55	6 years 1 month	12 months
P4	55	8 years 2 months	22 months
P6	58	10 years 1 month	13 months

2.4 THE COMPUTER SIMULATION AND TRAINING CONTEXT

The computer simulations used for training were designed within the general environment described in Section 1.3. This consisted of a residential neighbourhood within which routes to a variety of goals could be constructed. In the case of the present skill, a first route led from home to school; a second from home to the neighbourhood shops; and a third from school to the local swimming pool. On each route, children had to solve three problems in order that the depicted character(s) could complete their journey. These routes were presented over the course of the programme at the rate of one per test session. A fourth session presented the first route again, to allow recapitulation and consolidation of what had been learnt.

At the start of each session, children saw an opening screen introducing the task and character of the day. Clicking the start button generated a bird's-eye overview of the entire neighbourhood, which was initially cloud-covered. Some of the clouds would gradually clear to reveal the route of the day leading from a starting point (where the on-screen character could be seen waving a red handkerchief) to the goal. If the whole route could not be seen from a single screenshot, the computer automatically panned to the goal and then back again. The action then switched to the roadside, offering a kerbside view of the road to be crossed from a position immediately behind the character's back. Thus the participants' view and that of the character were essentially the same. Eyes drawn on the left and right hand sides of the screen offered views to left and right when clicked, allowing the children to see along the road in those directions. Sometimes a further view was available, usually when the character was positioned at a junction, so that participants' could look behind as well. At any stage, they could revert to the bird's-eye view by clicking a seagull at the top of the screen. This enabled the children to check the relationship between the individual site and the route as a whole, which was useful in helping children see how the short-term objective (getting the character across the road safely at that point) fitted in with the long-term objective of reaching the destination safely and efficiently. It also permitted children to compare the view that could (or could not) be seen from the roadside, with the roads along which traffic movements might actually be taking place. The different viewpoints that were available for one typical location are illustrated in Appendix 1.

On each route, the character would arrive at three roadside locations where crossingdecisions were required. At each, s/he would stop and wait for instructions. In each case, the character would have to cross the road somewhere in the vicinity in order to proceed.The children's task was to decide where and how. Sometimes, the initial location was safeand the character could cross there. However, this depended on a proper looking strategybeing employed: the character would not be allowed to cross until the view to right andleft along the road had actually been checked. In other cases, the location was dangerousand crossing could not safely be attempted. In this case, the software would permit thecharacter to be moved to another (sometimes several other) locations where furtherdecisions as to the safety of the location would be required. New views to right and left(and behind, if the position were close to a junction) would again be possible and, again,the on-screen character would be unable to cross if these views were not consulted. Onsome occasions, this new location would be safe. On others, it would be necessary to moveyet again. The programme was devised in such a way that children could never solve theproblem using 'blind' rules, such as assuming the first location would always be dangerous;or that moving the character in one direction would be preferable to moving in the other;or that the second site would turn out to be a safe one; and so on. They always needed toconsider the characteristics of the location to determine this. In addition, one of thetrainer's tasks was to ensure that decisions were based on appropriate reasoning and to steerthe children away from blind rule following.

Once a decision had been made about what the character should do, a set of five on-screenarrows permitted the character to walk straight across the road; diagonally across the road(to right or left); or along the pavement to left or right in search of a better crossinglocation. These arrows would only work if the proposed action was safe. For example, asalready noted, even if the site was safe (that is, it offered clear views in all directions andthere were no cars in the vicinity), the character would not cross unless the children hadclicked the buttons allowing them to look all round. In the case of the diagonal arrows,these would never work as crossing the road diagonally was deemed never to be safe.Whenever the children attempted to make such non-permitted actions, the trainer wouldinitiate a discussion as to why the proposed action was not allowed. Feedback about thesafety of the decisions was thus provided both by the computer and by the trainer, withlearning taking place during the subsequent discussion aimed at identifying the error andproducing fresh decisions. If the children had guided the character to a safe location; hadclicked the eyes enabling them to look all round for traffic; and did not attempt to makethe character cross diagonally; then the character would automatically cross, looking allround and listening as s/he did so. On arriving at the other side, the character would stopand wait for further instructions.

Twelve such problems were presented over the course of the four training sessions. Thelatter were held, as far as possible, at weekly intervals. Across the first three sessionsproblems were graded for difficulty, with the early routes being relatively easy and the laterones more complex.

2.5 TRAINING PROCEDURE

Children were trained in groups of three, as far as possible by the same trainer, althoughthis could never be guaranteed for practical reasons. Assignment of trainers to children wasrandomised. Each session lasted approximately 30 minutes.

At each location, one child was selected from the group and asked to decide whether itwould be safe to cross at this point, and to explain why. The child was given control of themouse so that s/he could click to obtain different views of the road in making this decision. The other children were then asked to discuss and comment on the proposal.If they decided it was safe, they could attempt to make the character cross by clicking anarrow on the screen. If the route was, in fact, safe - and the children had pressed the 'eye'buttons allowing them to look all round during their decision-making - then the characterwould automatically cross (looking all round and listening as s/he did so). If the site wasnot safe, or the children had not pressed the buttons enabling them to look round, thenthe character would not move. The trainer would then initiate a discussion as to why theproposed action was not allowed. Trainers used questions and prompts in order to guidechildren's thinking, insofar as this was necessary.

Whenever children agreed a decision, they tested it out by clicking the appropriate 'action' button. This was permitted even where the decision was wrong. In that case, the character would again fail to move, providing a basis for further discussion and decision-making. This process continued until the correct button was eventually pressed. The character would then automatically walk along the road to a new location, where the procedure would begin again. At that stage, the trainer would select a different child to make the initial suggestion as to whether or not the site was safe. This procedure continued through all the problems presented in each training session. Children thus all had an equal number of opportunities to act as 'proposer' and 'commentator' across the course of the programme.

Training adopted a structured learning approach, aimed at guiding the children's thinkingso that they would reach decisions on the basis of their *own* reasoning rather than that ofthe *trainer*. A particular concern was that the children should not just memorise sets ofrules. For this reason, children were never at any stage told that 'parked cars aredangerous', or given lists of 'dangerous places' to be memorised.

Figure 2.1: Example of interactions between children and a trainer - Route 2
Adult: "OK, Neil it's your turn - what do you think? Would it be safe for Jimmy to cross here?" **Neil:** "Emm, yeah I think so." **Adult:** "Why?" **Neil:** "Because no cars have passed." **Adult:** "What does everyone else think?" **Laura:** "Yes, because there aren't any cars coming." **Christopher:** "I'm not sure ..." **Adult:** "How does Jimmy know if there are any cars coming?" *... silence ...* **Adult:** "Well, how do you know if there are cars coming when you want to cross the road?" **All three kids:** "You have to look and listen." **Adult:** "Well maybe we'd better make Jimmy look before we decide if it's safe for him to crossthere?" **All three kids:** "OK." *... Neil clicks on the 'eyes' to give the left and right views down the road ... there aretwo parked cars just to Jimmy's right ...* **Adult:** "What do you think now?" **Neil:** "Well there still aren't any cars coming, so I guess it's safe." **Adult:** "What about you Laura?" **Laura:** "The cars beside him might go ..." **Christopher:** "I don't think it's safe." **Adult:** "Why?" **Christopher:** "Coz of what Laura said - that those cars might go." **Adult:** "That's a good reason for not crossing there ... Can you think of any more reasons why itmight not be safe?" *... silence ... adult clicks arrow for Jimmy to look back at the cars ...* **Adult:** "What if another car was coming along the road?" *... silence ...* **Adult:** "Do you think Jimmy could see cars coming from where he's standing now?" Kids: "No!!" **Adult:** "What should he do?" **Christopher:** "He has to move away from the cars." **Laura:** "Aye, coz he can't see past the cars ..."

Adult: "What do you think Neil?"
Neil: "It wouldn't be safe to go there ... coz of the parked cars."
Adult: "OK then, move him along, and look to see if it's any better further away."

... Neil moves Jimmy and looks again ...

Laura: "That's better - he's far away now."
Adult: "Do you think it would be safe there Neil? ... Christopher?"
Christopher: "Yeah ... OK."
Neil: "Yes. Can I make him cross now?"

... Jimmy crosses safely to the other side from the safer position ...

Adult: "Well done!!! So, who can tell me why that was safe there?"
Kids: "Coz he could see if there were any cars coming!"
Adult: "Yes, and remember what Laura said earlier about the parked cars moving? ... if thathappened, he'd be able to see them moving before he started to cross ..."

Instead, the aim was to improve children's conceptual understanding by helping themdiscover for themselves the general factors that render some roadside locations dangerous,so they could apply the same principles to new situations, including ones which woulddiffer substantially from those encountered during training. Trainers used questions,prompts and demonstrations to assist in this. They also encouraged children to makesuggestions; to give explanations for any suggestions that they made; to listen to whatother children were saying; and to co-operate in coming to joint decisions. All of these are known to be associated with conceptual advance in children's thinking. Where thedecisions or reasoning seemed inappropriate, trainers avoided saying so directly. Instead,they would draw children's attention to features that might have been missed; providedadditional explanations as to why certain factors might be important; or suggested thatchildren consider something which had so far eluded them. They also made regular use of'referring back'; that is, drawing attention to similarities to previous problems encounteredin earlier problems. This was intended to help children see what different problems had incommon, which would promote the discovery of principles and thereby increase children'sability to generalise to new contexts and novel problems.

The approach was thus as non-directive as possible, with few instructions being given, and answers being provided by the trainer only as a last resort. Rather, the focus of learning was the interactions that took place between the children as they jointly decided what the character should do. Ensuring that these interactions were as productive as possible was the key aim for the trainers. An example of these interactions in the course of solving an actual problem is presented in Figure 2.1.

2.6 EVALUATION PROCEDURE

2.6.1 Setting

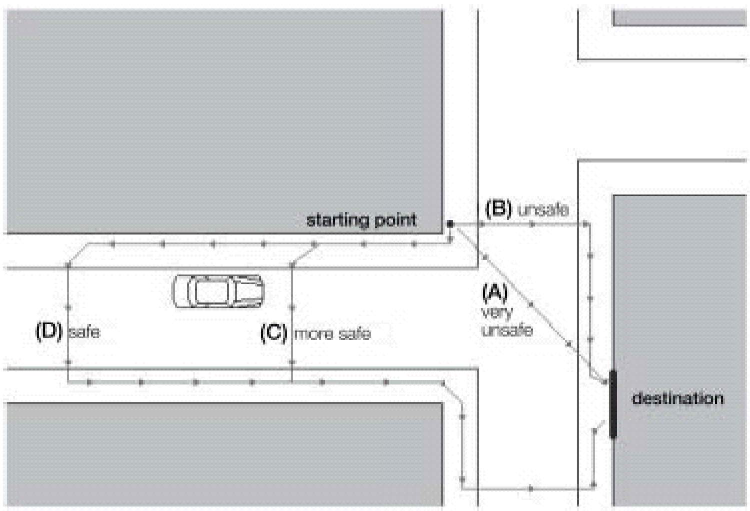
Although training took place via the computer simulations, all pre- and post-testing tookplace at the actual roadside. Children were tested individually at a set of pre-selected sitesin the streets near their schools. Separate sites were used for each school but these werematched as far as possible for overall layout and complexity. All were within easy walkingdistance. Three locations were visited during the course of each training session, twowhere visibility was restricted and one where traffic could emerge from several directions.The sites were organised into a 'traffic trail' such that they could be visited comfortablywithin a 25-30 minute session.

2.6.2 Pre- and Post-Testing Programme

During the two weeks prior to the commencement of training, children were individuallytested by a member of project staff to establish baseline measures of skill (pre-test).As soon as possible thereafter, the training programme began. Immediately after trainingended, children were re-tested to establish if any improvements in their judgements hadoccurred (post-test 1). A further test took place between two and three months later (posttest2). This was intended to assess the longer term effects of training. Control childrenundertook the testing programme in exactly the same way, except they did not take part inthe intervention.

At each of the three sites, the child was asked to construct 4 routes between specified locations, generating 12 routes per test session. An example of what these routes might look like at one test site is shown in Figure 2.2. Children received no advice or feedback during test sessions.

Figure 2.2: One of the sites used in the study, showing one starting point and destination. Arrows show examples of routes children might construct from (A) very unsafe to (D) safe



At each location, the child was instructed to imagine s/he was alone and wanted to crossto a destination a short distance along the pavement on the other side of the road. Thedestination was always a meaningful one, such as a doorway, garden gate or identifiableobject. The starting point was always at a dangerous location, such as a parked vehicle orsharp bend. Thus, simply walking across the road would never be a safe option. To performthe task successfully, the child would have to assess the surrounding traffic environmentand take relevant features into account in deciding how to reach the goal.

Children indicated their preferred route by pointing and describing it to the experimenter:they were never required to walk across the road. Once they had described the route theywould use, they were then asked to explain why they would go that particular way.The routes were recorded on schematic drawings of the locations, and notes were taken ofthe explanation offered. The schematic drawings were updated at the beginning of eachtest session to take account of changing conditions (for example, parked cars). Scoring wasthus always based on the conditions prevailing at the time of testing. If the site wasseriously distorted, testing was either postponed till a later date or a similar site was soughtnearby.

2.6.3 Scoring - Routes

The routes that children chose were coded into four categories in accordance with practicein previous studies (for example, Thomson *et al*., 1992; Ampofo-Boateng *et al*., 1993;Thomson & Whelan, 1997). The categories are explained in Figure 2.3. Scoring was basedprimarily on the *route* that children proposed to take, but took into account the *explanation*children offered for taking the route. This is because safe routes were sometimes chosen byaccident - for example, because the child wanted to avoid walking on wet grass and thealternative happened to be safe.

All scoring was done by the same rater, who was well versed in the principles underlyingthe scoring procedure. The rater was unaware of the group (trained or control) to whichthe records related, or whether they represented pre- or post-test scores.

Figure 2.3: Scoring system used in assessing children's route selection during pre- and post-testing
(A) Very unsafe This was usually a route leading directly to the destination (often involving a long, diagonal traverseof the road). A route classified as 'very unsafe' would also fail to take account of the dangerousfeatures at which the starting point was located (for example, a parked car). **(B) Unsafe** Most routes falling into this category involved the child walking directly across the street (that is,they took a line perpendicular to the road rather than the target-directed diagonal of the previouscategory). However, the child continued to ignore the dangerous road features at the starting point.Such choices were considered an improvement on (A) because they at least reduced the amountof time the child would spend on the road. On the other hand, neither route took account ofdangerous roadside features. Both routes would be very dangerous if chosen in real traffic. **(C) More safe** This was a route which showed some conceptual understanding of the danger posed by particularfeatures or road configurations. Usually, a 'more safe' rating was awarded when a child would moveaway from the dangerous features at the starting point (for example, a sharp bend) and attemptedto find a safer position. The child would also have to explain that s/he was looking for a locationaway from the dangerous features at the starting point. However, the child might end up too closeto another dangerous feature, such as a junction or parked vehicle. Whilst still not a maximally safechoice, 'more safe' routes constitute a significant advance on the previous two categories.Moreover, since it was often not possible to find a maximally safe position, many thoughtful routesrepresenting the best choice available under the circumstances received

'C' ratings.

(D) Safe
This was a route avoiding all dangerous features and configurations. Usually, the child would haveto make a significant detour from the starting point in order to find such a route. The child wouldalso have to give an explanation for the route that suggested some understanding of the need toavoid the dangerous features located at the starting point. In practice, it was often difficult to findroutes avoiding all hazardous features and the child was often faced with choosing the lesser ofseveral evils. However, such 'best option' routes would be scored 'C', not 'D'.

2.6.4 Scoring - Conceptual Measures

The above measures reflect the safety of the routes children proposed to follow, togetherwith their understanding of why the routes were safe. The latter measure was introducedprimarily as a means of double-checking the child's judgements and ensuring that 'safe'routes were being proposed for the right reasons. However, since children were alwaysasked to explain why a particular route was chosen, the nature of the explanations theygave can be explored, together with the ways in which this changed as a function oftraining. Preliminary analysis of the data suggested that almost all children's responsescould be classified into five categories as follows:

1. No response/don't know;
2. Wrong/response does not relate to the task *("I'd go this way because I don't want to walk on the grass")*;
3. Explanation has traffic relevant elements but the danger is not identified *("There are no cars coming")*;
4. Identifies the relevant dangerous features but cannot explain how the selected route overcomes the danger *("because there are parked cars")*;
5. Identifies the relevant dangerous features and can explain how the route overcomes them *("I couldn't see cars coming because of the bend but from here I can see them while they're still far away")*.

These categories represent a roughly ordinal scale, with each level representing somedegree of conceptual advance over the preceding one. For example, although Level 1(wrong) answers are still wrong, this can be regarded as a conceptual advance over Level 0responses (don't know), because at least the child was engaging with the task. Withoutsuch engagement, learning cannot hope to take place. Similarly, although Level 3responses are not well focused and often suggest elements of rote learning, they relate tothe problem and are not wrong. We were thus interested to see how training would affectthe likelihood of children giving responses of these different kinds, and how this wouldrelate to the quality of the route they constructed.

2.7 RESULTS

2.7.1 Main Effect of Training

Table 2.2 shows the mean number of routes falling into each of the four safety categories as a function of age (6-, 8-, 10-year-olds); training (trained versus control); and test phase (pre-test, post-test 1, post-test 2). Gender has been omitted because it failed to produce either a main effect or an interaction with any other factor in the statistical analysis. A preliminary analysis was also done on area (West End versus East End). Whilst children in the West End (that is, the socially mixed area) did perform better overall than children in the East End (that is, the high accident, low socio-economic-status area), this trend did not quite reach significance (p=.054). There was no interaction with age or test phase. As a result, area has been excluded from the following analyses.

Table 2.2: Proportion of judgements falling into each safety category as a function of age, training and test phase (A=very unsafe, B=unsafe, C=more safe, D=safe)

		TRAINED				CONTROL			
		A	B	C	D	A	B	C	D
Pre-test	6 years	**.20**	**.61**	**.16**	**.01**	**.27**	**.55**	**.18**	**0**
		.20	.23	.12	.02	.26	.28	.19	0
	8 years	**.08**	**.69**	**.20**	**.03**	**.05**	**.67**	**.25**	**.03**
		.12	.17	.16	.07	.06	.24	.23	.06
	10 years	**.06**	**.62**	**.27**	**.06**	**.07**	**.59**	**.30**	**.04**
		.13	.21	.19	.08	.10	.22	.20	.10
Post-test 1	6 years	**.15**	**.69**	**.14**	**0**	**.23**	**.61**	**.15**	**.02**
		.21	.21	.13	.07	.27	.23	.16	.05
	8 years	**.01**	**.58**	**.27**	**.14**	**.12**	**.63**	**.20**	**.05**
		.03	.27	.20	.19	.19	.22	.15	.12
	10 years	**.01**	**.43**	**.38**	**.19**	**.03**	**.54**	**.32**	**.12**
		.03	.27	.22	.23	.07	.26	.17	.16
Post test 2	6 years	**.15**	**.68**	**.17**	**.02**	**.16**	**.78**	**.06**	**.01**
		.24	.23	.16	.06	.16	.21	.13	.02
	8 years	**.02**	**.52**	**.31**	**.16**	**.12**	**.62**	**.17**	**.09**
		.04	.25	.21	.19	.16	.23	.12	.19
	10 years	**.02**	**.37**	**.41**	**.20**	**.06**	**.59**	**.26**	**.09**
		.05	.26	.17	.21	.19	.27	.20	.11

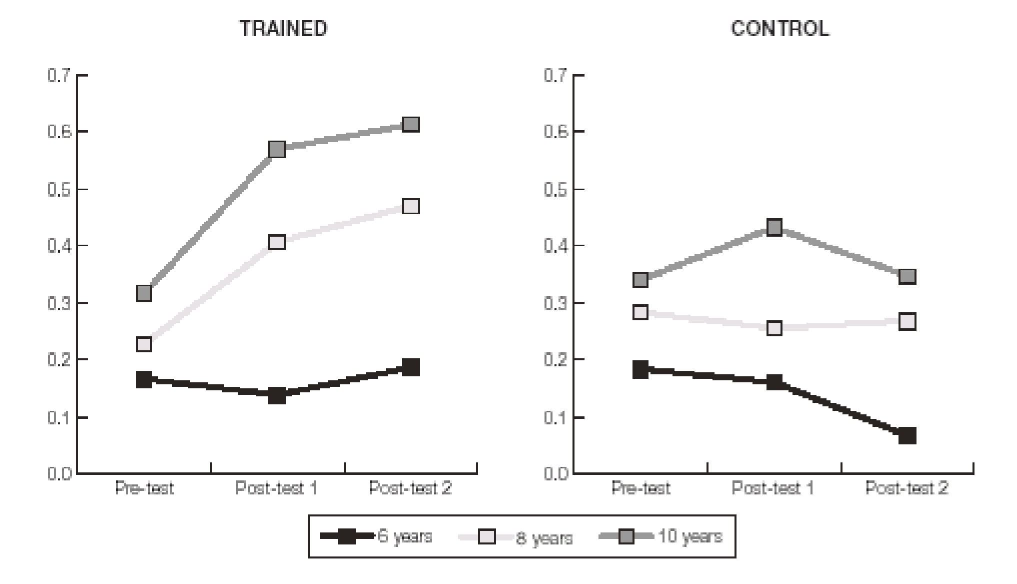
Note. Figures in bold = mean values. Other figures = standard deviations.

It can be seen that, prior to training, the vast majority of children's judgements fell intocategories A and B (that is, 'unsafe' or 'very unsafe'). Over 80 per cent of the youngestchildren's judgements fell into these categories. By age 10 improvement is evident but,even so, approximately two-thirds of the oldest children's judgements were classified as'unsafe' or 'very unsafe'. Clearly, there was considerable room for improvement in all agegroups.

Following training, the situation changed markedly. Among 10-year-olds, the proportion of'unsafe' and 'very unsafe' routes fell from 68 per cent in the pre-test to 39 per cent in posttest2. Correspondingly, the number of routes falling into categories C and D (that is, intothose categories showing conceptual awareness of roadside dangers and how to deal withthem) increased substantially, from 33 per cent in the pre-test to 61 per cent in post-test 2.An even greater improvement can be seen in the performance of the 8-year-olds, wherethe proportion of C and D responses increased from 23 per cent in the pre-test to 47 percent in post-test 2. Moreover, no deterioration in performance took place over the two- tothree-month period following cessation of training. On the contrary, comparison of posttests1 and 2 shows that performance actually *improved* over this period, and in both agegroups. In the control group, by contrast, no such improvements were found: scores inpost-test 2 almost exactly mirrored those obtained in the pre-test.

It is important to stress, however, that this pattern of improvement was entirely absent among the 6-year-olds. Table 2.2 and Figure 2.4 show that, in this age group, the proportion of routes falling into each of the four categories remained remarkably stable across all three test phases, largely mirroring the results obtained from control children. This result stands in marked contrast to studies using roadside training methods, which have consistently been found to induce substantial improvements in children's safe route finding, and in children as young as 5 years (Thomson *et al*., 1992; Ampofo-Boateng *et al*., 1993; Thomson & Whelan, 1997; Thomson *et al*., 1998). We discuss reasons for this divergence in Section 2.8.

Figure 2.4: Mean proportion of safer (C+D) routes constructed by children as a function of age and test phase



These trends in the descriptive statistics were analysed by means of two-way analysis ofvariance (ANOVA) with age (6-, 8-, 10-year-olds) and test phase (pre-test, post-test 1,post-test 2) as factors. Separate analyses were carried out for the trained and control groups.

For the purpose of statistical treatment, we have used the combined C and D score achieved by each child as the unit of analysis. This is because these categories represent conceptually more advanced choices in which the child showed evidence of insight into the dangers posed by the road layout, and proposed routes which took them at least partially into account. Although a shift from

Category A to Category B (that is, from 'very unsafe' to 'unsafe') would also represent an improvement, we did not concern ourselves with such shifts because a child performing at the 'unsafe' level would still have little insight into the factors rendering roadside locations safe or dangerous. The pattern that emerges when the data are treated in this way is shown in Figure 2.4.

The results for the trained group showed significant main effects of both age ($F(2, 120)=32.43$, $p<.001$) and test phase ($F(2, 240)=34.88$, $p<.001$). There was also a significant interaction between these factors ($F(4, 240)=10.37$, $p<.001$). Figure 2.4 shows that the interaction is due to the fact that the 6-year-olds made no improvement as a result of training, whereas the other two groups showed substantial gains.

In the control group, there was a significant main effect of age ($F(2, 120)=17.61$, $p<.001$), confirming that older children generally performed better than younger children. There was no effect of test phase but the interaction with age was significant ($F(4, 130)=3.33$, $p<.02$). Examination of Figure 2.4 shows that this is because the 6- and 10-year-olds actually performed worse in post-test 2 than they did in earlier test sessions.

2.7.2 Conceptual Changes Following Training

The explanations that children offered for their proposed routes were recorded at the roadside and later classified using the coding scheme described in Section 2.6.4. Mean frequencies for each of the five explanatory categories are presented in Table 2.3. The data are presented graphically in Figure 2.5.

The hypothesis underlying this analysis was that the safer routes constructed by trainedchildren would reflect their growing conceptual understanding of such traffic problems andhow to solve them. This conceptual understanding would, in turn, be revealed by theexplanations that children provided for their proposed routes. Our expectation was thattraining would lead to a decrease in certain categories of response and an increase in others.For example, we anticipated a decrease in the number of 'don't knows', wrong answers, andanswers which did not properly address the task, all of which are common in untrainedchildren. Correspondingly, we anticipated an increase in the number of responses focusingon the danger inherent in the different traffic situations; and an increase in the number ofexplanations elaborating on why the proposed route would overcome these dangers.

Table 2.3 and Figure 2.5 show that, in trained 8- and 10-year-olds, these expectations were substantially confirmed. The number of Category 0 responses (*no response/don't know*) decreased substantially in both age groups whereas, in the control groups, they actually went up. Similarly, Category 1 responses (*wrong answers/answers not addressing the task*) decreased in trained children while remaining largely unchanged in controls. Conversely, Category 3 and 4 responses (*identifying the relevant dangers; elaborating on how the route overcame the dangers*) increased substantially between the pre-test and post-test 2 in trained children. In the control group, such improvements were either absent or much more modest.

Table 2.3: Mean frequencies for different categories of explanation offered by children for the routes they proposed to cross as a function of age, training and test phase. Total score (across the five categories) = 12

	TRAINED	CONTROL

		6 years	8 years	10 years	6 years	8 years	10 years
Pre-test	**0**	2.38	1.31	.72	.97	.32	.61
	1	4.05	2.70	2.40	3.62	4.29	2.89
	2	4.88	6.26	5.88	6.90	5.39	6.11
	3	.64	1.40	2.14	.52	1.64	1.71
	4	.05	.32	.86	0.0	.36	.68
Post-test 1	**0**	1.43	.22	.14	1.75	.62	.85
	1	4.78	.14	.88	3.43	2.85	2.41
	2	4.7	5.63	5.02	6.11	6.46	4.48
	3	1.00	3.02	3.56	.71	1.31	3.33
	4	.13	1.71	2.40	0.0	.77	.93
Post-test 2	**0**	1.53	.50	.10	3.21	2.04	1.29
	1	3.79	.93	.67	4.36	2.63	1.67
	2	5.16	5.04	4.17	3.96	5.08	5.54
	3	1.24	3.59	4.43	.39	1.04	2.58
	4	.18	1.96	2.64	.07	1.21	.88

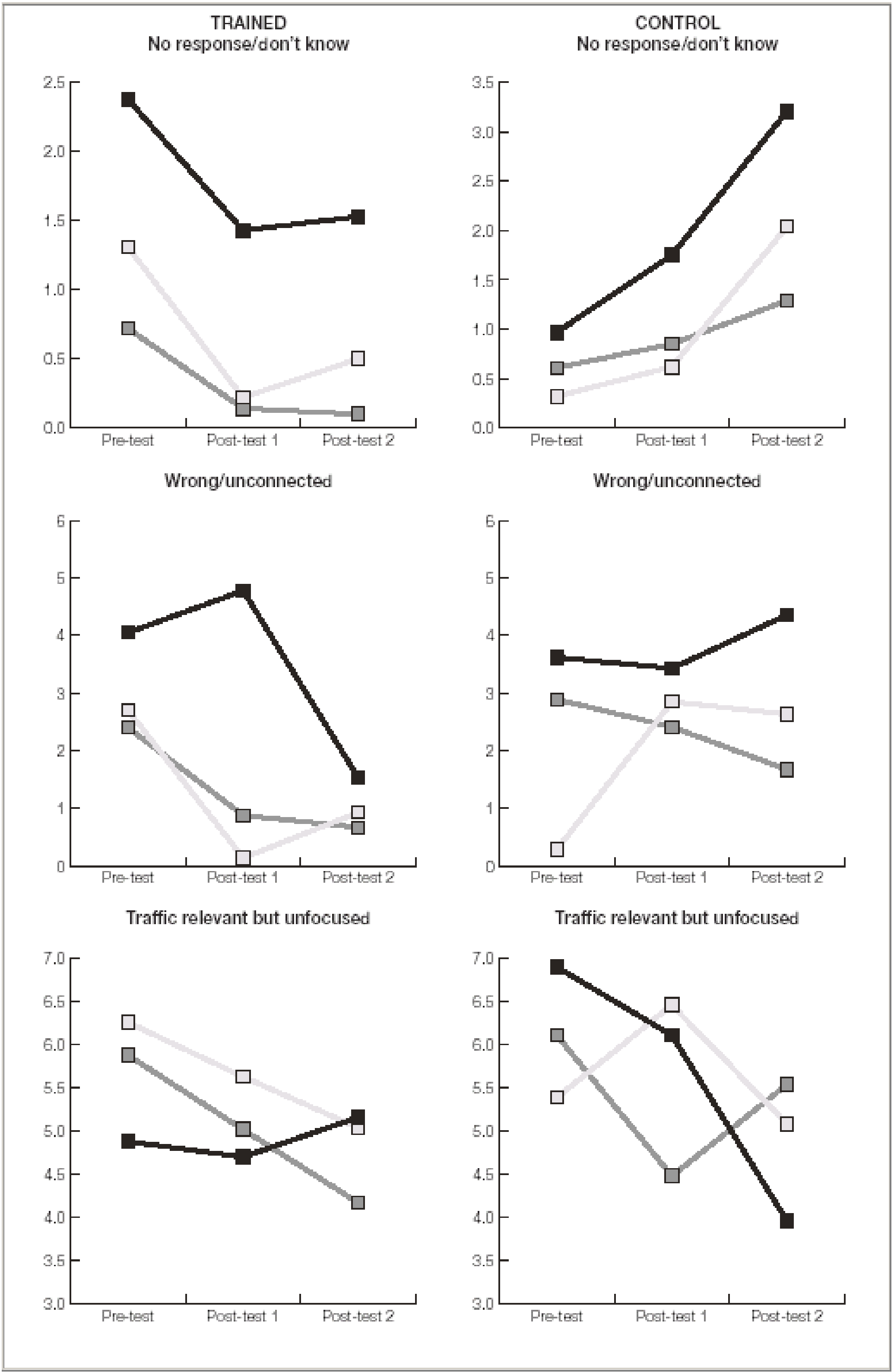
Response categories
0 = No response/don't know
1 = Wrong/unconnected know
2 = Explanation has traffic relevant features but not clearly focused
3 = Cleary identifies danger but does not elaborate
4 = Identifies danger and elaborates on reasons for route selection

In 6-year-olds, all these trends were much less marked, as would be expected given the lack of effect that training had on their construction of safe routes. Improvements were not altogether absent, however. Indeed, Figure 2.5 shows that all the trends are in the hypothesised direction, albeit on a much more modest scale than in older children. This implies that even the youngest children were deriving *some* benefit from the training, although not on a scale that greatly influenced their safe route selection. We comment later in this report on the possible longer term advantages of these gains.

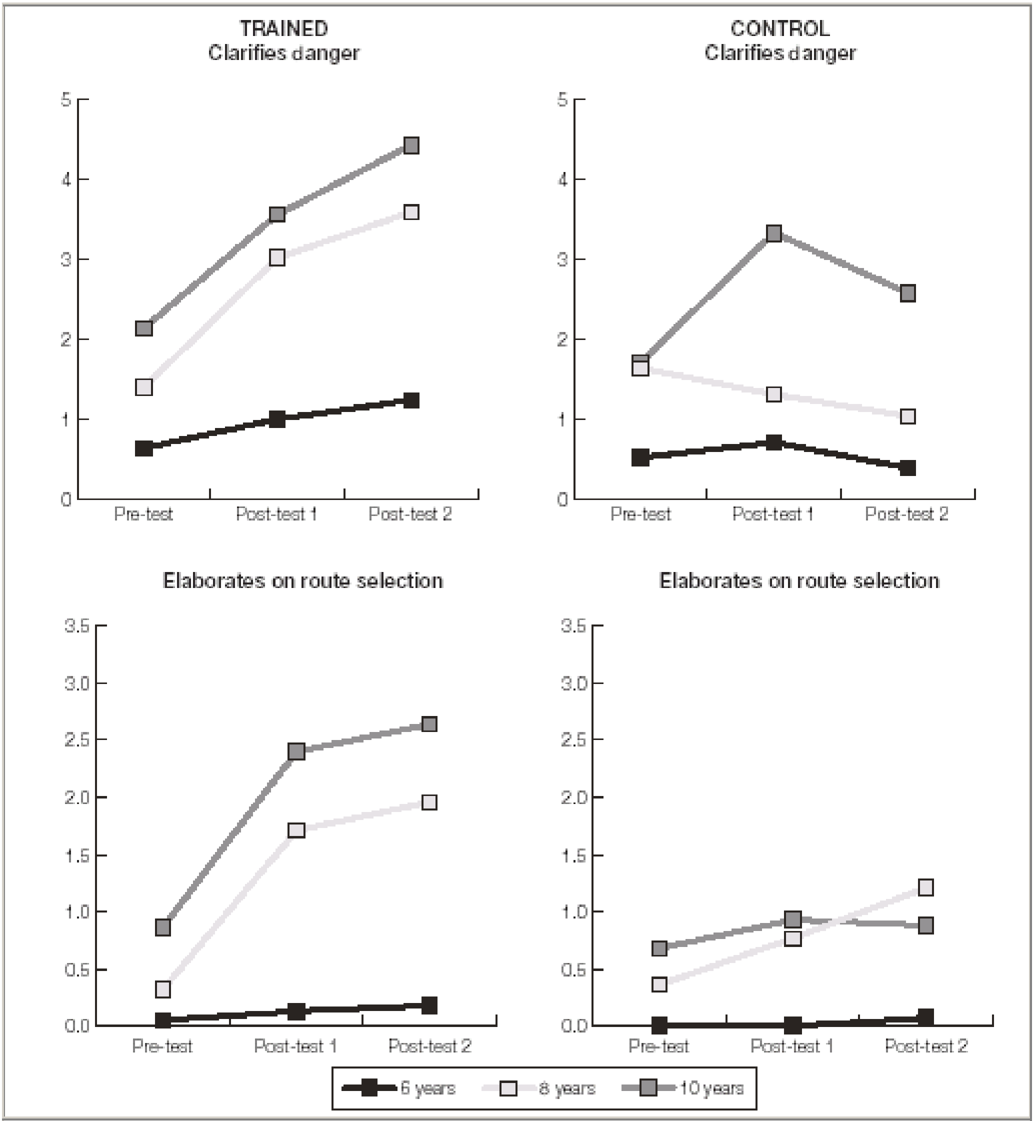
The trends were investigated for each response category by means of two-way ANOVAwith age (6-, 8-, 10-year-olds) and test phase (pre-test, post-test1, post-test2) as factors.Separate analyses were conducted on the trained and control groups. In trained children,the Category 0 responses (*No response/don't know*) gave rise to significant main effects ofage (F (2, 120) = 11.55, p<.001) and test phase (F (2, 240) = 10.34, p<.001) but nointeraction. This shows that, whilst there were differences in the overall level ofperformance in the different age groups, all age groups improved as a function of training.For Category 1 responses (*wrong answers/answers not addressing the task*), there were againmain effects of age (F (2, 120) = 17.33, p<.001) and test phase (F (2, 240) = 11.35,p<.001). There was also a significant interaction between these factors (F (4, 240) =

3.56,p<.01). Figure 2.5 shows that the interaction is due to the fact that the 8- and 10-year-oldsgave fewer wrong or unconnected answers in post-test 1 whereas, in the 6-year-olds, thisimprovement was delayed until post-test 2. For Category 2 responses (*explanations withtraffic relevant features but not clearly focused*) there was a significant main effect of testphase (F (2, 240) = 3.38, p<.05) but no effect of age and no interaction. Figure 2.5 showsthat this is because all age groups showed a reduction in such responses, and to about thesame extent.

Figure 2.5: Mean frequency of responses for each explanation category as a function of age, training and test phase



TRAINED
No response/don't know
CONTROL
No response/don't know
Wrong/unconnected
Wrong/unconnected
Traffic relevant but unfocused
Traffic relevant but unfocused
Pre-test
Post-test 1
Post-test 2



For Category 3 responses *(identifies the danger but does not elaborate)* there were significant main effects of both age (F (2, 120) = 18.70, p<.001) and test phase (F (2, 240) = 23.07, p<.001) as well as a significant interaction (F (4, 240) = 2.60, p<.05). Figure 2.5 shows that the interaction is due to the fact that improvements in the 6-year-olds, although present, were substantially smaller than in the other two groups. Finally, for Category 4 responses *(identifies danger and elaborates on how this affected route selection)* there were again main effects of age (F (2, 120) = 20.51, p<.001) and test phase (F (2, 240) = 18.96, p<.001) as well as a significant interaction (F (4, 240) = 4.14, p<.005). Again, Figure 2.5 shows that this is because improvements in the youngest children were less marked than in the older groups.

This analysis was also carried out for the control group, where most of these positive trends were absent. Indeed, whereas the number of non-responses and 'don't knows' decreased in trained children, these actually *increased* in controls, giving rise to a highly significant main effect of test phase (F (2, 240) = 53.94, p<.001). Far from indicating improved conceptual thinking, this shows that control children became even less likely to offer any explanation at all. Such explanations as they were able to give did not improve to any extent over the course of the study. There was no significant change in the number of wrong or unconnected (Category 1) responses, although there was a decrease in the number of Category 2 *(traffic relevant but unfocused)* responses (F (2, 240) = 4.44, p<.02). There was also a significant age x test-phase interaction for Category 3 (F (4, 240) =

11.61, p<.006). This occurred because the 10-year-old controls were somewhat more likely at post-test to identify the inherent dangers of the location whereas, in the 6- and 8-year-olds, this trend was reversed. None of the groups was able to say how this would inform their route selection, however. The overall pattern of findings for trained and control children is summarised in Tables 2.4 and 2.5.

2.7.3 Individual Differences and Their Effect on Training

Previous studies have shown that children of a given age do not all start from the samebaseline level of traffic skill. In safe route-finding, for example, some children start off verypoorly and produce almost no routes in the C and D categories at all (Thomson &Whelan, 1997). Other children, by contrast, may start close to - or even above - theperformance level of much older children (Thomson & Whelan, 1997; Whitebread &Neilson, 1998). These differences would presumably reflect previous, probably informal,learning on the part of the child.

The existence of such variations in baseline levels of performance provides an opportunityto examine the relationship between starting performance and subsequent learning.For example, do children who start at a higher baseline show more improvement over agiven number of training sessions than children who start from a weaker position? Wouldthe latter require more sessions to catch up with their initially more advanced classmates?Or are there some children who, for one reason or another, do not improve at all?By examining the improvement rates of children with different baseline levels of skill wecan gain insight into these issues.

Table 2.4: Pattern of explanations given by the Trained Group as a function of test phase

Response category	Significant change?	Direction of change	In which age group
0 - No response/don't know	Yes	Decrease	All, but more marked in 8- and 10-year-olds
1 - Wrong/unconnected	Yes	Decrease	All
2 - Traffic relevant but unfocused	Yes	Decrease	All
3 - Clarifies danger	Yes	Increase	More marked in 8- and 10-year-olds
4 - Elaborates on route selection	Yes	Increase	More marked in 8- and 10-year-olds

Table 2.5: Pattern of explanations given by the Control Group as a function of test phase

Response category	Significant change?	Direction of change	In which age group
0 - No response/don't know	Yes	Increase	All
1 - Wrong/unconnected	No	No change	

2 - Traffic relevant but unfocused	Yes	Decrease	All
3 - Clarifies danger	Yes	Increase	In 10-year-olds only
4 - Elaborates on route selection	No	No change	

Table 2.6: Mean post-test scores for trained children as a function of pre-test score and age. Ranks correspond to top, middle and bottom thirds of the sample

	Pre-test		**Post-test 1**		**Post-test 2**	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
6-YEAR-OLDS						
Bottom rank (N=14)	**.05**	.05	**.15**	.10	**.10**	.11
Middle rank (N=14)	**.15**	.04	**.14**	.13	**.14**	.13
Top rank (N=14)	**.30**	.07	**.20**	.25	**.32**	.22
8-YEAR-OLDS						
Bottom rank (N=18)	**.05**	.04	**.21**	.16	**.30**	.25
Middle rank (N=18)	**.20**	.04	**.42**	.24	**.54**	.19
Top rank (N=18)	**.43**	.12	**.57**	.29	**.56**	.23
10-YEAR-OLDS						
Bottom rank (N=14)	**.10**	.06	**.42**	.24	**.51**	.26
Middle rank (N=15)	**.32**	.07	**.55**	.22	**.58**	.25
Top rank (N=14)	**.54**	.12	**.74**	.28	**.72**	.30

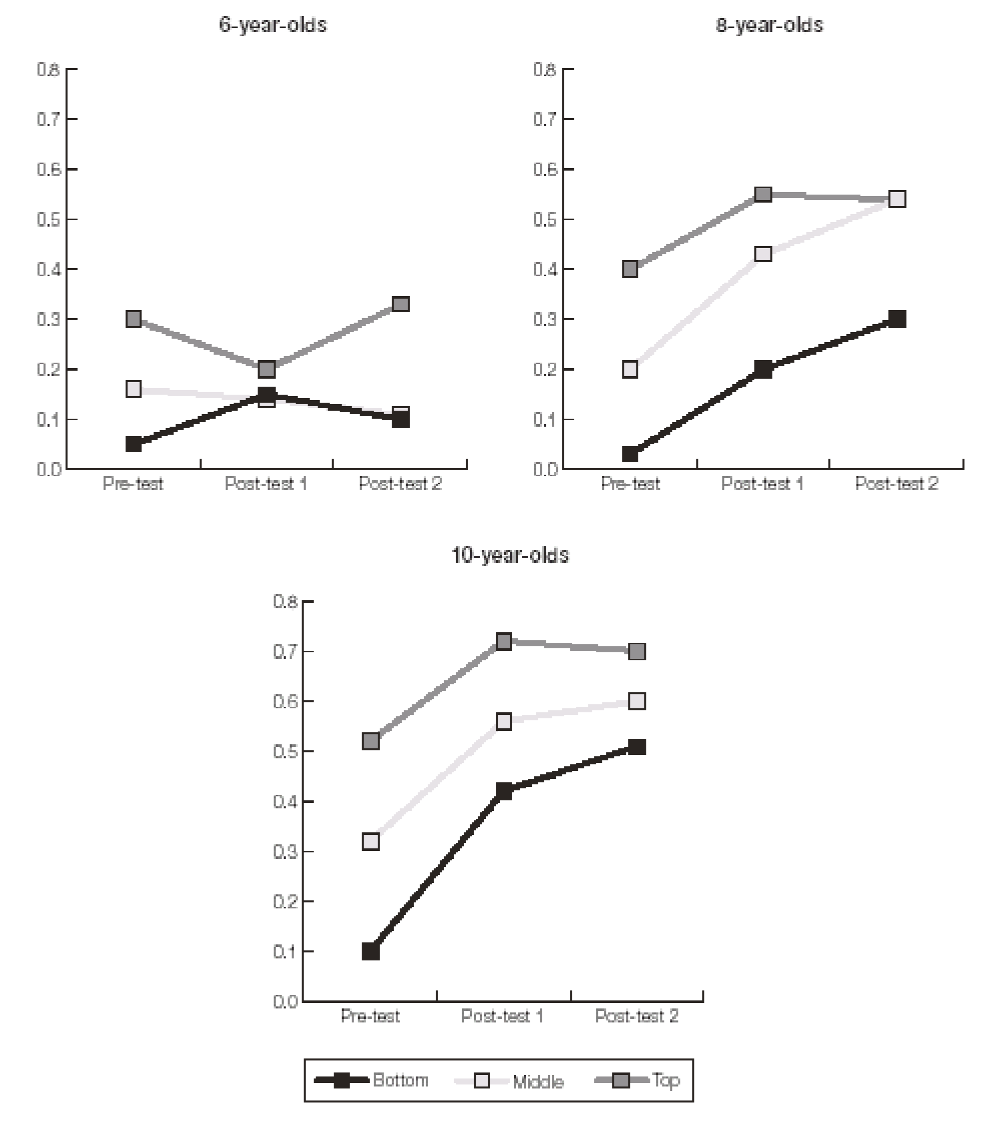
We attempted to answer these questions by dividing the children into three groups in accordance with their pre-test scores. These consisted of the top, middle and bottom thirds of the sample for each age group. We then calculated the post-test scores obtained by each group following training. The results are shown in Table 2.6 and Figure 2.6. It can be seen that there were indeed quite marked differences in pre-test performance between the three groups, and for each age group. In the 10-year-olds, the proportion of C and D routes constructed during the pre-test ranged from a mean of only 10 per cent in the bottom third of the sample to 54 per cent at the top. The same trend is apparent in the younger children, with scores ranging from 5 per cent to 30 per cent in the 6-year-olds and 5 per cent to 43 per cent among 8-year-olds. One-way ANOVAs with rank (bottom, middle, top) as factor were carried out separately for each age group. Significant effects were obtained in each case (6-year-olds: $F(2, 41)=83.07$, $p<.001$; 8-year-olds: $F(2, 53)=109.39$, $p<.001$; 10-year-olds: $F(2, 42)=85.89$, $p<.001$). Follow-up tests showed the differences between the three ranks to be significant in each case and for all three age groups (Bonferonni test, $p<.001$ in all cases). This confirms that there is indeed considerable 'natural' variation in children's skill levels, and over a wide age range. Interestingly, however, the effect of training amongst the 8-and 10-year-olds (where the benefits were clear-cut) was to *decrease* this variation. The significance of this point is considered in Section 2.8.3.

2.8 CONCLUSIONS

2.8.1 Impact of the Programme on the 8- and 10-Year-Olds

The main aim of this part of the study was to see if children's ability to construct saferoutes through the traffic environment would be enhanced following a programme oftraining in which computer simulations rather than the roadside would be used as thecontext for learning. So far as the 8- and 10-year-olds are concerned the simulation provedto be an excellent training platform, with both groups making substantially improvedroadside judgements as a result of training. By the end of the programme, the proportion ofsafer (C+D) routes constructed by the 8-year-olds had increased from 23 per cent to 47 per cent whilst in 10-year-olds the improvement was from 33 per cent to 61 per cent.

Figure 2.6: Proportion of safer (C+D) routes constructed as a function of pre-test score, age and test-phase



These improvements in the routes children constructed were mirrored in the explanationsthat children gave for choosing the routes. In both age groups, there was a markedreduction in the number of 'don't knows' offered by way of explanation, suggesting thatchildren's reasoning was becoming conceptually clearer and therefore more explicit.That their reasoning was conceptually clearer is also supported by the fact that they alsogave many fewer wrong or irrelevant explanations, both of which are common inuntrained children. They were much more likely to focus directly on the factors thatrendered the different sites dangerous, and also to elaborate on why the proposed routeswould overcome the identified problem. All these changes suggest improvement inchildren's conceptual understanding of the problem and how to solve it. In controlchildren, by contrast, there was very little evidence of conceptual change. Indeed, thenumber of 'don't knows' and non-responses actually *increased* over the course of testing, inspite of the fact that the children were now significantly older and could reasonably beexpected to say more, rather than less, when questioned.

Following previous practice, post-test 2 was introduced to ensure that any gains seen in the immediate aftermath of training would prove robust in the longer term. In fact, far from falling off over the ensuing months, children's performance actually *improved* over this period. This is possibly because the more sophisticated thinking fostered by training continued to incubate once the programme ended, leading to further improvements in the longer term. The continuing improvement in conceptual scores is certainly consistent with this. It needs to be explained, however, why this very welcome trend was so much more marked than in any previous study, where performances have tended to remain stable, or improve only slightly (Thomson *et al*., 1992; Ampofo-Boateng *et al*., 1993; Thomson & Whelan, 1997; Thomson *et al*., 1998).

There seems little doubt that the continuing improvement is at least partly due to the effect of the roadside search training which, in the present study, intervened between post-tests 1 and 2. In previous research, this period has always been a 'dead' one, with no further activities taking place that might further enhance performance. In the present study, by contrast, we wished to see if undertaking the second stage of the programme would have (in addition to its primary objectives) retrospective benefits on what had previously been achieved in Stage 1. The expectation that this might happen was not overly optimistic, since the different stages of the programme deliberately built on each other in a progressive way. In the case of roadside search (see Chapter 3), many of the features on which children were expected to focus attention echoed the safe places training (parked vehicles, intersections, blind corners, etc.). Thus, an effort was made to keep the issues raised by the safe places training alive. It seems that this recapitulation, albeit in the context of a new skill, paid a sizeable dividend. It is also consistent with the suggestion made in Chapter 1, that the programme might work best when presented as an integrated whole, rather than as a series of independent units. This suggestion will be considered further in later chapters where other spin-off effects are noted.

2.8.2 Learning in the 6-Year-Olds

While these trends were very clear in the 8- and 10-year-olds, it must be stressed that no such improvement was seen in the routes constructed by the 6-year-olds. Not even the most able 6-year-olds (that is, those forming the top third of the sample at pre-test - see Section 2.7.3) made any significant progress over the course of the programme. This finding contrasts markedly with the findings obtained when the roadside rather than a computer simulation is used as the locus of training, where improvements of up to 300 per cent have been reported in children as young as 5 years of age (Thomson *et al*., 1992; Ampofo-Boateng *et al*., 1993; Thomson & Whelan, 1997; Thomson *et al*., 1998). The finding would seem to confirm the importance of context in young children's learning. Although the simulated environment was three-dimensional, quite realistic and offered roadside (as well as bird's-eye) views, training did not succeed in inducing learning - or at least transfer of learning to the roadside (since we did not measure learning on the simulation itself). The finding stresses once again the importance of validating training materials, as well as the importance of doing so across all the age ranges with whom the materials might be used. In this case, it appears that a realistic computer simulation cannot compete with the roadside as a context of training for very young children.

It should be noted, however, that the training was not completely wasted on the 6-yearolds, for they did show some limited improvement in their conceptual thinking over the course of the programme. Like their older friends, the 6-year-olds gave fewer 'don't knows' and wrong or irrelevant answers following training. There was also a small improvement in the number of answers identifying the factors that made the site dangerous, though their ability to say how this would modify their choice of route improved only very marginally. This is, of course, why the actual routes did not improve as a result of training. Nevertheless, these modest conceptual improvements increased between post-tests 1 and 2, implying that training may have succeeded in triggering a set of thought processes that might, in the long run, still accelerate the natural process of learning. We comment further on this point in Chapter 3.

2.8.3 Individual Differences in Pre-Test Performance and Their Effect on Learning

Not all children start from the same baseline level of competence, a fact highlighted by Thomson & Whelan (1997) and Whitebread & Neilson (1998). Indeed, Whitebread & Neilson showed that some untrained 5-year-olds were able to outperform much older children, including some of the 11-year-olds in their sample. Table 2.6 confirms that there is considerable diversity in children's baseline levels of competence. The question is, how does this affect their subsequent learning? Given that those with higher scores in the pretest are likely to be operating at a more conceptually advanced level to begin with, it might be expected that training would benefit them disproportionately, pushing them to even greater heights relative to children who started at a more modest level. We might be even more inclined to expect such an effect in the present study because children received only four training sessions whereas, in previous studies, they received six. This would leave the weaker children fewer opportunities to 'catch up' than was previously the case.

In fact, the picture that emerged was quite different. As in previous studies, there was no evidence that the children starting from a higher baseline made undue progress relative to the weaker children. Indeed, Figure 2.6 shows that it was the initially weaker children who made most progress. By post-test 2, the middle rank of 8-year-olds had caught up with the top rank, in spite of a large difference at the outset of training. In the 10-year-olds, both the middle and bottom ranks had closed the gap on the top rank. There is thus no evidence of the initially weaker children being disadvantaged relative to their more advanced classmates: if anything, the trend is in the opposite direction. Two factors are probably at work to account for this result. Firstly, since they came from a lower starting position, the weaker children probably had more capacity for improvement relative to their baseline. Secondly, notwithstanding the degree of improvement that can be realised by even a short programme of training, it seems likely that there is still a ceiling on what children of this age can attain. If so, the initially-stronger children (who start closer to the ceiling in the first place) would have less scope for further improvement. Training would thus tend to reduce the variance among children, making them more homogeneous as a group. This seems to be just what happened.

Two final comments are worth making. Firstly, notwithstanding the substantial difference in accident rates between boys and girls, no evidence was found of corresponding differences in the ability to recognise dangerous locations or to find safer ones. This, in fact, mirrors previous studies of safe place finding. Whatever factors are responsible for the difference in accident rates, differences in the ability to recognise the danger posed by certain roadside situations does not seem to be one of them. Secondly, our preliminary analysis failed to identify a reliable performance difference as a function of area (West versus East). Nevertheless, the effect was only marginally non-significant, with children from the more socially mixed West End performing somewhat better overall. This suggests that a more systematic analysis of the relationship between pedestrian skill and social background, covering a larger number of schools and social backgrounds, might be warranted. We shall return to this issue in Chapter 3.

CHAPTER 3:
Skill two - Roadside search

3.1 RATIONALE

It is well established that a large number of child pedestrian accidents involve victimswho, for one reason or another, failed to detect the approaching vehicle (Thomson *et al.*,1996). Such errors may arise from a variety of causes, such as not looking for traffic at all,as in 'dart out' accidents (van der Linden & Goos, 1975); looking for traffic approachingfrom some directions but not others (van der Molen, 1981); or not recognising that certainroad sites offer only an obscured view of traffic (Ampofo-Boateng & Thomson, 1991). It isstriking that, in a significant proportion of accidents, children do seem to have looked fortraffic but somehow failed to 'see' it (Grayson, 1975). This suggests that poor perceptualsearch strategies and weaknesses in attentional control may have a role to play inchildhood accidents.

This would not be altogether unsurprising, given the complexity involved in effectiveroadside search. For example, to make a safe crossing decision, any pedestrian must firstisolate relevant visual and auditory information about the movement of vehiclesapproaching the intended crossing point (often from several directions), whilst filteringout information about vehicles that are receding, stationary or otherwise not relevant tothe crossing task. They must also be aware of conditions under which relevant informationmay be impaired (for example, near parked vehicles, blind corners, etc.). Finally, they mustbe capable of temporarily ignoring a wide range of irrelevant but interesting informationabout, say, the activity of other pedestrians, dogs, cats, ice cream vans, etc. Unfortunately,it is known that children are generally quite poor at distinguishing relevant from irrelevantinformation, and are often susceptible to distraction from personally salient but taskirrelevantstimuli as a result (DeMarie-Dreblow & Woody-Ramsey, 1988). Similarly, theyshow difficulty in sorting out their priorities when allocating attentional resources tocompeting tasks (Wright & Vliestra, 1975), and so may find it hard to switch attentionfrom tasks such as play, conversation or daydreaming to the demands of road-crossingwhen the need arises.

The critical question is what the source of such attentional difficulties might be. Onepossibility is that, prior to maturation of the metacognitive functions permitting consciousdirection of mental activity, younger children suffer from a fundamental lack of cognitivecontrol (see for example, Case, 1985). However, experimental evidence from studies ofchildren's attentional control specifically in the context of roadside search (Tolmie *et al.*,1998) suggests that, in this context at least, children's problems are more likely to reflectuncertainty about what it is they are supposed to be focusing attention on, rather than anyinherent inability to concentrate attention at all.

For example, when asked to report what they could see or hear that would be important indeciding whether or not to cross the road, 5- and 7-year-olds found it very difficult todifferentiate between features that were relevant and those that were irrelevant. Makingthe road-crossing focus of the task as explicit as possible made almost no difference to theirperformance, in marked contrast to older children who tailored the features they reported according to the demands of the task. At the same time, younger children were no moreaffected than older children by increasing the complexity of the scenes; increasing thenumber of distractors that were present; or reducing the time available for viewing thescenarios. Since these factors all impose extra demands from an information-processingpoint of view, one would expect them to have a disproportionate impact on youngerchildren's performance, if their problems were due primarily to difficulties in underlyingcognitive function. The fact that they did not implies that the problem for youngerchildren is that they lack the knowledge to determine what information is needed whenmaking road-crossing decisions, and therefore what information should be focused on.In the absence of such knowledge, it is perhaps unsurprising that children appear to fallback on what were functionally appropriate strategies at an earlier point in development,namely directing attention to the novel and the socially important.

This argument also raises a broader point, namely that selective attention should not beseen as at root a generic ability. Tuning in to relevant features and filtering out theirrelevant requires knowledge of what is and is not relevant to the particular task andcontext at hand. Moreover, any sophisticated level of performance would imply anunderstanding of what relevant features signify; why they matter; and what they offer thatassists in decision-making. It is this understanding which would ultimately underpin thesearch process, since it would specify the information that is needed to carry out the task.This would also be central to recognising when the pick-up of information is impaired (asit is at parked vehicles, for example).

These issues are important for a number of reasons. Firstly, if poor performance is due to a lack of knowledge rather than inherent cognitive limitations, this implies that roadside search should be trainable, even in young children. Secondly, it reinforces the importance of the link made in Chapter 1 between conceptual grasp and behavioural performance, and the need for training to address both elements. Thirdly, the features that roadside search needs to focus on include both the dynamic (for example, vehicle movements) and the static (for example, road layout and the effect this can have on vehicle movement *and* visibility). The obvious link between the latter and safe place finding gives strong grounds for anticipating that training in roadside search should be able to build on previous training on safe place finding, with cumulative benefits as a result. Indeed, this has already been discussed in relation to the improved post-test 2 performances seen in the previous chapter.

Evidence from previous studies of computer-based training on roadside search supports atleast some of these points. For instance, following four sessions of one-to-one adult-childtraining using a computer simulation, Tolmie *et al*. (1998; in press) found that 6-year-oldsshowed a marked shift towards reporting relevant features in other simulated scenarios,together with an increase in insightful explanations of why these were important.Moreover, both of the latter were associated with greater reporting of relevant featuresat the roadside, consistent with the idea of a linkage between conceptual grasp andsearch performance. Adult-group training using the same software produced evengreater improvements.

However, the evidence available from these studies has a number of limitations. First of all,the software used for training was much more rudimentary than that developed in thepresent project, and it offered much less in the way of systematic support for productiveinteractions. In addition, the data on roadside performance were restricted in that only asingle test location was utilised, and the measure of conceptual grasp depended on children*spontaneously* justifying their observational reports. There was also no preceding training insafe place location to allow any cumulative effects to be identified. Last but not least, these studies only looked at 6-year-olds, whereas there would appear to be room for improvementin roadside search performance even amongst older children, since the available dataindicate that they remain some way from adult levels of performance (Tolmie *et al*., 1998).

3.2 AIMS

The aims of this stage of the project, therefore, were:

- *to provide training aimed at sensitising children to the features that are relevant when makingroad-crossing decisions; improving their understanding of why such features are important;and strengthening their capacity to filter out irrelevant information;*
- *to implement this training via systematic use of the adult-group procedure outlined in Chapter1, together with software specifically constructed to support productive adult-child and childchildinteraction;*
- *to evaluate the effects of training, in both the short- and longer-term, in children aged 6, 8and 10 years at the start of training;*
- *to examine the impact of training on roadside performance over a broader range of locations,and with more explicit regard to conceptual grasp; and*
- *to assess the cumulative effects on roadside search of training in other areas of pedestrian skill.*

3.3 PARTICIPANTS

A total of 145 children, distributed approximately evenly across the East End (high accident) and West End (mixed) samples, undertook training. Of these, complete data for the pre- and immediate post-test (post-test 1) were available for 127 children, the remainder being absent at one or other stage of testing. All of these children had previously undergone training and testing in safe place location. Eighty-nine control children, drawn from schools in the same areas as those making up the training sample, were also pre- and post-tested. Of these, complete data were obtained from 78 children. At the time of pre-testing, none of the control children had participated in any other stage of the evaluation, although they subsequently undertook the delayed post-test (post-test 2) for the first skill, safe place finding. Details of children's ages at the start of pre-testing are given in Table 3.1.

The characteristics of the sample for the delayed post-test (post-test 2) in roadside searchwere complicated by the withdrawal from the evaluation in summer 1999 of the schoolthat had provided the initial training sample in the West End. This meant that only theEast End trained children were available at the time of post-test 2. Of these, a total of 59from the original sample were tested and provided complete data across pre-test, post-test 1and post-test 2. This sample was supplemented for the purposes of analysis by 52 childrenfrom the substitute West End training school, who were closely matched in age to thechildren they were replacing. These children received post-test 2 for roadside search afterhaving been trained and tested on gap timing. They did not, however, receive training inroadside search itself. The trained sample at post-test 2 consisted of 111 children in total,then, more or less evenly distributed across the three age groups.

Table 3.1: Composition of trained and control samples at the start of the pre-testing			
TRAINED SAMPLE			
Year group	**Participants**	**Mean age**	**Range**
P2 (later P3)	44	6 years 5 months	22 months
P4 (later P5)	57	8 years 4 months	14 months
P6 (later P7)	44	10 years 6 months	17 months
CONTROL SAMPLE			

Year group	Participants	Mean age	Range
P2 (later P3)	30	6 years 6 months	12 months
P4 (later P5)	29	8 years 5 months	22 months
P6 (later P7)	30	10 years 5 months	11 months

A further new sample of 49 children, drawn from both high accident and mixed areas andmatched in mean and range of ages to the trained sample, provided control data for posttest2. These children had not previously been tested on roadside search, but the majorityhad received pre- and post-testing in gap timing prior to this.

3.4 Training task and software design

The computer-based training developed for this stage of the project was focused by a roadcrossing task which involved identifying *if and when* it was safe for an on-screen characterto proceed across the road from a given location. This task, which was the same as thatemployed by Tolmie *et al*. (1998), had a carefully planned rationale. Central to this wasthe inclusion of distractors and other means of pressurising attentional resources in thescenarios about which judgements had to be made. This ensured that successful responsesdepended on children paying attention to relevant features and filtering out irrelevant, andon them garnering an understanding of what is relevant, and why. Thus it promotedacquisition of roadside search skills in an oblique and non-directive fashion, driven by thechildren's own task-specific needs and the discussion that took place around these, ratherthan simply attempting to instruct children in what they should pay attention to.In addition, judgements about whether the location was safe were included in the task in adeliberate attempt to connect back to, and build on, training in safe places. Timingjudgements, albeit not very precise at this stage, looked forward to training in the thirdskill area, gap timing. Cars indicating and turning were also included within the on-screenscenarios to presage work on the fourth area, perception of intentions.

As with safe places, the software framing this task consisted of four sessions worth ofmaterial, around which the training of children by adult volunteers took place. Eachsession's material involved, as before, an unaccompanied on-screen character undertakinga pre-determined journey that necessitated his crossing the road on three occasions.Movement along this route was automatic until the character reached a crossing point,whereupon s/he would stop and wait for the children to make crossing decisions on his/herbehalf. The software differed from that used for safe places training in two importantrespects. Firstly, children's view of the action was from an elevated perspective rather thaneither the full bird's-eye or the roadside perspectives previously employed. This ensuredthat the road scene and all relevant information could be viewed at one time on a singlescreen, but with more clarity than would have been possible had the full bird's-eyeperspective been employed. Secondly, the road scenes now also contained dynamic information in the form of traffic flow, as well as other kinds of movement. Each scene wasof around 30 seconds duration.

As indicated above, trainees' task was now to decide, not only *if* it was safe for thecharacter to cross at that point, but also *when* it would be safe to do so. To fit in with this,the traffic flow always contained one gap that, in principle, allowed enough time for thecharacter to cross. However, it was also the case that, on approximately one crossing inthree, the site was intrinsically unsafe because the character's viewpoint was obscured bybends, parked cars and so forth. At these points, the character would therefore not be in aposition to see that the gap was sufficiently large even if, from their privileged vantagepoint, the children could see that it was. This arrangement thus forced children to focuson the character's viewpoint rather than their own.

Children always had to determine first of all, whether the character's initial crossingposition provided an adequate view of the traffic, recapitulating aspects of their safe placestraining. If it did not, they had to move him or her to a position which was safe. Toprevent children simply identifying unsafe positions on a rote basis, which one of the threecrossings on a given route was unsafe was varied in ostensibly random fashion. Once thechildren had decided on a safe crossing position, they then had to identify when a gap inthe traffic flow of sufficient size for crossing presented itself, and press an on-screen buttonto start the character moving across the road. This task was made slightly morecomplicated by the fact that the traffic flow was never constant, but contained a variety ofgaps of insufficient duration for crossing as well as the one adequate gap.

In line with the general principles underlying software design laid out in Chapter 1, various on-screen resources were available to assist decisions about both location and time of crossing. These also provided a means for adult trainers to draw children's attention to key points and explain why these were important, especially during the earlier periods of training. So, for instance, potential obstructions to the character's view of the traffic flow were all plainly visible from the elevated perspective in which the main action was presented. However, a 'worm's-eye' view button allowed children to switch to a street level perspective similar to that used as the default in the safe places training software (see Appendix 2). This view was to aid children in deciding if the location was safe and, for that reason, no traffic movement was shown from this viewpoint so as not to distract children's attention from the safe places aspect of the task. Views to right and left of the crossing position could be accessed to check the potential visibility of traffic and to highlight any problems that would render the location unsafe. As in safe places, the character would be unable to cross the road until these views had been checked at least once. Again, as in safe places, arrow buttons permitted the character to move to an alternative position, should this be deemed necessary.

As regards identification of gaps in the traffic flow permitting crossing, the softwaredisplayed a pause/play facility which allowed the sequence to be halted at any point.This permitted consideration and discussion of the distances of vehicles from the crossinglocation in relation to their speed of movement, and whether these provided enough timefor the character to cross the road completely. Moreover, the entire sequence could beplayed through an unlimited number of times to allow careful comparison of different gapsbefore making a decision. Finally, as in the safe places software, the feedback provided onchildren's crossing decisions was only ever positive. That is, if a safe gap in a safe locationwas correctly identified, the character would automatically cross the road and move on tothe next decision point. If not, he refused to move. Similarly at the worm's-eye view, if anincorrect decision was taken to move the character, he would again refuse to move.

The only exception to this was that, after he had already been moved to a safe location, hecould go back to his start point in order to permit further comparison of the views fromboth positions. In both cases, the character's refusal to move was intended to serve as a cuefor discussion and further decision-making.

It should be reiterated that the goal of training in this phase was to help children learn tofocus on the features and information needed to make basic judgements about safecrossing. It was not to get them to make more precise judgements about the timing ofcrossing movements relative to traffic gaps. For this reason, the safe gaps were all of arelatively generous size, and 'tight fits' within them were not allowed. In other words, the'go' button had to be pressed early in the gap, otherwise the character would not cross.This also provided an implicit signal about not squandering time once a gap appearedwhich prefigured aspects of the gap timing training to come later.

Within these constraints, the difficulty in identifying safe gaps was systematically increasedacross routes and across decision points within routes. One way in which this was done wasby gradually introducing auditory and visual distracters, sometimes to coincide with theoccurrence of the safe gap. A second way was to gradually reduce the size of the safe gap(within limits), so that it became harder to spot. A third was by varying the lanes in whichthe vehicles forming the start and end of the gap were moving. In the early trials, bothwere in the nearside lane, which is the easiest configuration to deal with, since traffic fromonly one direction has to be considered, and no allowance needs to be made for crossing alane before encountering vehicles. Later on, one vehicle was in the far lane and one in thenear, thus presenting a more complex situation to attend to. Finally, traffic density was alsoincreased as the training sessions proceeded, and variations in the pattern of vehiclemovement (acceleration, deceleration and occasional overtaking) were introduced as well.

Thus the first route (that is, that used for the first training session) took the character fromhome to school. The crossing scenes all involved safe gaps of near-near type, with thelocation itself being unsafe on the third crossing. None of the crossing scenes contained anynon-vehicle distracters or any vehicle acceleration or deceleration. The second route ledthe character from home to the shops, and introduced variation in traffic speed; auditorydistracters (for example, an ice cream van and a pneumatic drill); and greater traffic density.One safe gap was now of near-far type, and one far-near. On this route, the first location wasunsafe. For the third route, the character walked from school to the local swimming pool,encountering on the way a mixture of near-near and far-near gaps. The second crossinglocation was unsafe, and the scenes now contained visual as well as auditory distracters(for example, an ice cream van, a slow-moving vehicle and a steamboat on the river).There was also greater variation in traffic speed, and occasional overtaking. The fourth andfinal route again took the character from home to school, underlining the point that agiven journey may not always involve the same hazards. This time the character neverstopped at an unsafe location (indicating that he had 'learned' from past experience). Safegaps were of mixed type, as on the third route, and there were now even more distracters(for example, a dog barking, someone getting a lift, a man falling off a ladder, roadworks anda passing police car). There was still greater variation in vehicle movements.

3.5 TRAINING SESSIONS

The organisation of training sessions followed the basic pattern laid out in Chapter 1, and elaborated on in Chapter 2. There were four sessions at weekly intervals, each of 20 to 30 minutes duration (depending on rate of progress), involving a trained adult volunteer working with a group of (usually) three children. From the outset, the adults encouraged children to take the lead in proposing decisions and discussing the basis for these between themselves. They gave prompts when necessary to draw children's attention to any points they had missed, using the software to underline these and to provide a commentary on their significance. In general, the adult gradually retired into the background over the course of the four sessions, provided children showed growing expertise at dealing effectively with the task by themselves. On occasion, children did get bogged down and were unable to identify the correct response. Under these circumstances, trainers were allowed to demonstrate the solution so as to obviate unproductive frustration: however, they were asked not to do this until all other avenues had been explored.

3.6 Pre- and post-testing

The roadside testing employed to evaluate the effects of training followed the general procedure reported in Tolmie *et al*. (1998), albeit with some important modifications. Thus, instead of testing children at a single roadside location, traffic trails were constructed encompassing six locations. These six locations always comprised three where there were visual obstructions (blind bends, blind summits and parked vehicles) impairing the view of traffic movements, and three with a clear view of a straight road with a reasonable traffic flow. Since a different trail had to be constructed for each school, care was taken to ensure that the selected locations were as comparable as possible. The same trails were used at all three stages of testing, save where different schools were involved in post-test 2 (see 3.3 above).

Testing, which took about 20 to 30 minutes, was carried out on an individual basis. Eachchild walked the traffic trail in the company of a project researcher, and halted at each ofthe six testing locations. At each location the child and researcher stood adjacent to thekerb and the researcher asked "What can you see and hear that you'd need to know aboutif you were trying to cross the road safely?" Once the child had given a reply, s/he wasasked, "Is there anything else you can see and hear that you'd need to know about?" Thisquestion served as a general prompt to encourage as full a response as possible. In a furtherdeparture from the procedure used by Tolmie *et al*., children were also explicitly requestedto justify their responses, in order to gauge their conceptual grasp of what was importantand why. Thus, after reporting a feature they were asked "Why would it be important toknow about that?" Questioning at each testing location continued in this fashion until thechild could identify no more features they regarded as important, whereupon child andresearcher walked on together to the next location, and the sequence of questions wasrepeated. All dialogue was recorded on audio tape for later transcription and analysis.

3.7 SCORING

Scoring focused on six measures, three relating to pick-up of information, and three toconceptual grasp.

With regard to **information pick-up**, each child was scored on:

- the number of features judged to be *relevant* to road-crossing that they had reportedacross the six test locations **(R)**;
- the number of *irrelevant* features they had reported **(I)**; and
- the **ratio** of relevant features to irrelevant, a standardised measure of *discrimination*between the two, calculated as the difference between the number of relevant andirrelevant features over the total number of features (that is, [R-I]/[R+I]). A positivescore on this measure showed a balance in favour of relevant features; a negativescore, a balance in favour of irrelevant; a score of zero would indicate no overalldiscrimination between the two.

Conceptual responses were scored in terms of the number of justifications a child hadgiven *for relevant features* only at each of three levels:

- **Level 0** justifications were those where the child had given either no response or noresponse that was pertinent;
- **Level 1** justifications were pertinent but essentially rote in character and provided noreal evidence of insight into why attention to a feature might matter(for example, "driveway, because a car might come out"); and

- **Level 2** justifications were those that did provide signs of such insight (for example,"If a car reversed out and you didn't see it, cos it was in a driveway, it could knock youdown").

3.8 RESULTS AND DISCUSSION

The effects of training and age on children's roadside search performance at different stages of testing are described below. Section 3.8.1 examines pre-test scores on the six measures defined in 3.7, and details evidence of knock-on effects from previous training in safe place finding. Section 3.8.2 looks at change in the trained and control samples pre-test to posttest 1 and post-test 1 to post-test 2, and presents evidence of clear benefits being derived from computer-based training in roadside search. It also describes data that indicate a possible causal relationship between conceptual advance and change in information pickup. Finally, Section 3.8.3 compares the data from children in the high accident and socially mixed areas, which suggest the presence of an indirect but important positive effect of training on children's verbal skills.

3.8.1 Pre-Test Scores

The first point to note about the pre-test data was that the **ratio** scores obtained from thissample of children were high by comparison to those reported in previous research. In thepresent study, the average across age groups and conditions was +.86, with a relativelynarrow range of variation, against an average of +.37 obtained under similar testingconditions (that is, a number of roadside locations plus an explicit road-crossing focus) inthe survey studies reported by Tolmie *et al*. (1998). This difference appears to beattributable primarily to a much lower incidence of reporting of irrelevant features **(I)**,although the number of relevant features **(R)** reported was also slightly lower than before.There was one notable difference in the roadside testing procedure employed in thepresent study, however: the inclusion of explicit questions asking children to explain whythe features they reported were important. It is possible that these conceptual questions ledchildren to reflect more fully on what constituted an adequate response and that thisresulted in more focused reporting of features than had been the case before.

In order to check on this, the number of relevant and irrelevant features reported bychildren at the first two locations on the pre-test traffic trails was compared to the numberreported at the last two locations. The assumption underlying this comparison was thatany additional reflection provoked by the conceptual questions would have had a gradualrather than an immediate effect. There was some sign that this was the case: reporting ofrelevant features increased between the beginning and the end of the pre-test for both thetrained and the control samples (5.99 vs 6.76 for the trained children; 2.96 vs 5.59 for thecontrol children). There was, however, no corresponding decline in reporting of irrelevantfeatures, which was low from the outset (0.38 vs 0.36 for the training children; 0.47 vs0.49 for the control children). Thus the evidence for the conceptual questions having aneffect on children's responses is not entirely clear-cut, and with regard to the low incidenceof irrelevant features this explanation only holds if the effect is assumed to have beenimmediate. Irrespective of the exact reason, though, it was still plain that the **I** and thusthe **ratio** scores had turned out to be relatively insensitive measures in the context of thisstudy. They are therefore excluded from further consideration in what follows.

These measures aside, there were clear effects attributable to both age *and* whether or not children had previously undertaken safe places training on the pre-test scores. For instance, as can be seen in Table 3.2, children in the training group (that is, those who had previously undertaken the safe places training) reported significantly more relevant **(R)** features in the roadside search pre-test than did the controls ($F(1, 217)=21.06$, $p<.001$). Moreover, in spite of a significant main effect of age (F (2,217)=16.06, p<.001), the scores obtained by 8- and 10-year-old control children were still not notably better than those obtained even from 6-year-olds in the training group. Similarly, in terms of providing insightful justifications of why reported features were important **(Level 2)**, children in the training group again did significantly better than controls before training in roadside search had even begun (F(1,217)=54.20, p<.001). Performance again improved with age (F(2,217)=13.58, p<.001) but, in this case, the gap between those who had and had not previously undertaken safe places training now widened as it did so (F(2,217)=9.05, p<.001). This indicates that previous training had conferred a particular advantage on older children. At the same time, however, 6-year-olds who had received safe places training still outperformed untrained 10-year-olds.

In addition to these differences, the trained children also gave significantly fewerinadequate justifications **(Level 0)** than the controls (F(1,217)=6.09, p<.02), although theeffect was less marked, and these tended to fall away with age in any case (F(2,217)=3.43,p<.05). The only exception to this pattern was amongst the 6-year-olds, where the trainedsample did worse than the controls, creating a significant age x condition interaction(F(2,217)=4.76, p<.01). With regard to basic justifications **(Level 1)**, the scores for trainedchildren were roughly equal to those of the controls, and the only significant effect wasthat of age group (F(2,217)=6.92, p<.002), reflecting an increase in the number ofresponses of this type between the 6-year-olds and the 8-year-olds in particular.

Table 3.2: Mean roadside search pre-test scores by age and experimental condition (standard deviations in parentheses)

	R	Level 0	Level 1	Level 2
TRAINED				
6-year-olds (n=41)	13.24	1.44	5.02	1.46
	(7.40)	*(1.76)*	*(2.85)*	*(1.48)*
8-year-olds (n=55)	19.51	0.42	6.89	2.76
	(10.55)	*(0.85)*	*(3.83)*	*(2.28)*
10-year-olds (n=42)	24.55	0.31	6.73	5.14
	(13.45)	*(0.75)*	*(3.15)*	*(3.99)*
Overall	19.18	0.69	6.29	3.10
	(11.55)	*(1.27)*	*(3.44)*	*(3.09)*
CONTROL				
6-year-olds (n=30)	9.53	1.10	4.53	0.50
	(5.06)	*(1.30)*	*(3.01)*	*(1.17)*
8-year-olds (n=29)	13.00	1.29	5.89	0.93
	(6.87)	*(1.76)*	*(3.18)*	*(1.12)*
10-year-olds	16.70	1.11	6.52	0.93

(n=27)	*(8.45)*	*(1.34)*	*(2.22)*	*(1.36)*
Overall	12.95	1.16	5.61	0.78
	(7.40)	*(1.46)*	*(2.94)*	*(1.22)*

Overall, then, a systematic pattern emerged, with children who had previously undertakensafe places training generally outperforming the control children on the roadside searchpre-test. Most notable was that the safe places-trained children started off at a considerablyhigher level than the controls in two key areas of performance: the pick-up of relevantfeatures; and the ability to explain features' relevance in insightful terms. Thus there isclear evidence of a knock-on effect from the previous training in safe place finding.

Some of these advantages are not altogether surprising, since there was a certain degree ofbuilt-in overlap between safe places training and roadside search. As regards the reportingof relevant features, for instance, safe places training was aimed at improving awareness ofthe static features of traffic environments that might pose a danger when crossing the road,so it is reasonable that trained children should be more likely than controls to report these.However, the conceptual carry-over is more striking, since it implies that safe placestraining had helped at least some of the children to acquire a more general framework forthinking explicitly about traffic hazards, which they were able to import into the roadsidesearch task. The low incidence of inadequate justifications amongst the older trainedchildren is also consistent with this, suggesting that the previous training helped them inparticular to attune rapidly to the demands of the new task and what it required them tothink and talk about. All these findings are thus consistent with the hypothesis that safeplaces training did indeed produce cumulative effects, improving children's performance onkey aspects of roadside search even before training in the latter skill had begun.

3.8.2 Change From Pre-Test to Post-Test 1, and Post-Test 1 to Post-Test 2

Examination of changes in performance across the three stages of testing[1] revealed that trained children continued to improve in the key areas where they already held an advantage at pre-test. Thus with regard to reporting of relevant features **(R)**, all age groups in the trained sample improved significantly from pre-test to post-test 1 ($F(1,124)=6.94$, $p<.01$). With the sole exception of the oldest age group, there were also further significant gains from post-test 1 to post-test 2 ($F(1,108)=4.39$, $p<.05$). These trends are illustrated in Figure 3.1. In percentage terms, pick-up of relevant features increased between pre-test and post-test 1 by 34 per cent for the 6-7-year-olds, by 51 per cent for the 8-9-year-olds, and by 14 per cent for the 10-11-year-olds. The flattening off of the 10-11-year-olds' increase to meet the 8-9 year-old mean at post-test 2 suggests the older two age groups reached ceiling level performance. For the youngest age group, the cumulative effects of training raised pick-up to a level above that of untrained 10-year-olds, although they failed to close the gap on older trained children.

Figure 3.1: Number of relevant features reported (R) at different stages of testing (trained children)

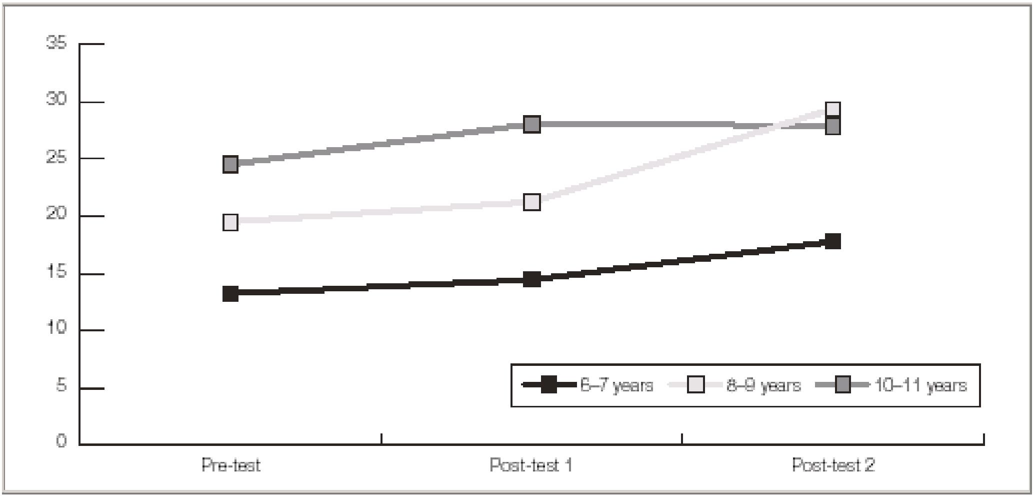
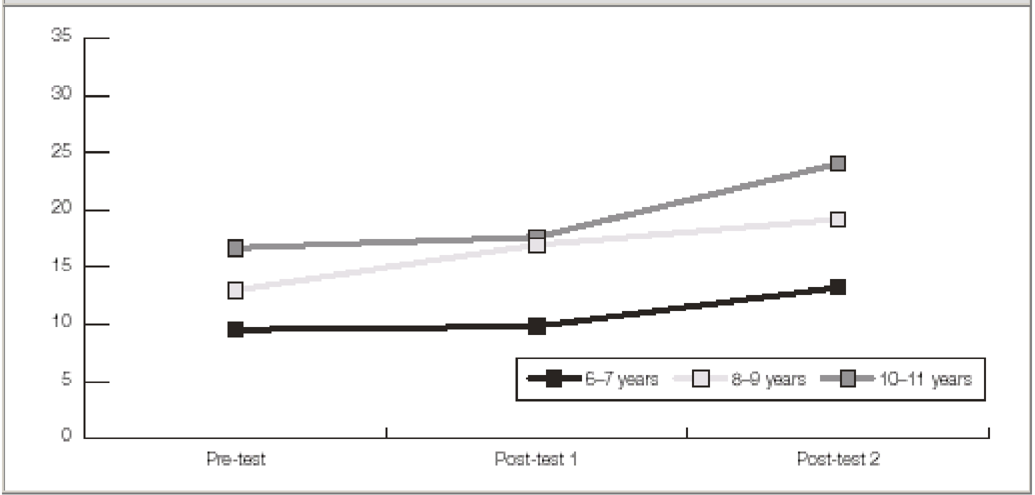


Figure 3.2: Number of relevant features reported (R) at different stages of testing (control children)



One important point to note here is that approximately half of the trained sample who took part in post-test 2 had not been trained on roadside search itself (although they had been trained in gap timing), and yet there was no significant difference between the two halves of the sample in the pick-up of relevant features. That this was the case, and that reporting of relevant features was even better here than at post-test 1, indicates a clear influence of gap timing training on this aspect of roadside search. Given that the effectiveness of training in gap timing (see Chapter 4) depended on children learning to pay close attention to traffic movements, however, this outcome is perhaps not entirely surprising.

In contrast to the trained children, the control sample showed no significant improvement in reporting of relevant features pre-test to post-test 1 (see Figure 3.2). An apparently more marked trend towards improvement between post-test 1 and post-test 2 was also nonsignificant because of the high variance surrounding the means. In any case, these shifts only brought the average level of performance of the control children to that shown by the trained children at *pre-test* (see Table 3.2).

As far as higher level justifications of reported features **(Level 2)** are concerned, the trained children (see Figure 3.3) improved significantly from pre-test to post-test 1 ($F(1,124)=17.06$, P<.001), whilst the control children (see Figure 3.4) again showed no significant improvement from pre-test right through to post-test 2, despite the scores for the older children going up marginally. Amongst the trained children, the 6-7-year-olds showed a 30 per cent increase pre-test to post-test 1, 8-9-year-olds a 46 per cent increase, and 10-11-year-olds a 24 per cent increase. The absolute frequency of these responses was admittedly still not especially high: one every eighth relevant feature on average amongst the youngest children, rising to one every fourth relevant feature amongst the oldest age group. However, they were sufficiently prevalent to suggest the emergence of a wellelaborated, broad conceptual grasp, particularly among the older trained children.

Figure 3.3: Number of insightful justifications (Level 2) at different stages of testing (trained children)

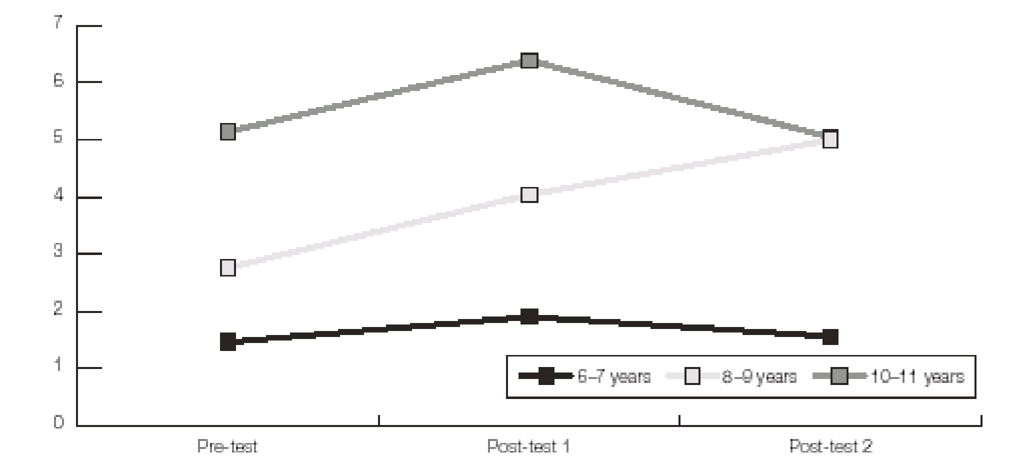
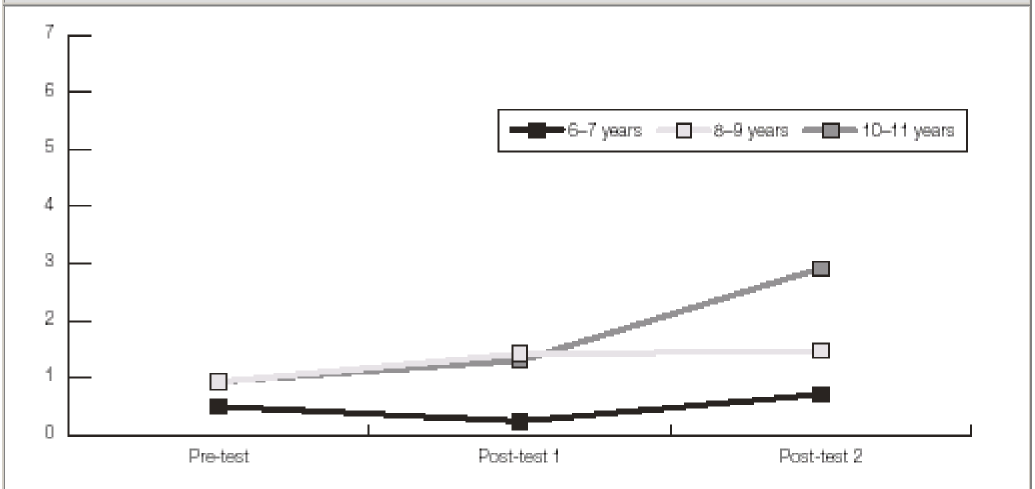


Figure 3.4: Number of insightful justifications (Level 2) at different stages of testing (control children)



The pattern for post-test 1 to post-test 2 appeared to undermine this picture to someextent, however, with the trained 6-7 and 10-11-year-olds tending to fall back towards thelevel of their pre-test scores, suggesting any gains made previously were not robust. Thescores of the 8-9-year-olds, in contrast, continued to go up ($F(2,108)= 3.19$, $p<.05$). Closeranalysis revealed that this pattern was in fact largely attributable to the substitution of halfthe trained sample at post-test 2. In all three age groups, the children who came into thesample at this stage performed at a lower level than their counterparts from the mixed areahad done at post-test 1 (2.77 at post-test 1 vs. 2.30 at post-test 2 for 6-7-year-olds; 3.29 vs.2.90 for 8-9-year-olds; 6.56 vs. 5.28 for 10-11-year-olds). In comparison, the performanceof those who had been part of the original sample either remained more nearly at the samelevel (0.79 vs. 0.75 for the 6-7-year-olds[2]; 6.28 vs. 5.80 for the 10-11-year-olds), or wentup (4.87 vs. 6.33 for the 8-9-year-olds). These differences were sufficient to open up asignificant effect of sample at post-test 2, albeit in interaction with age group since theprecise pattern varied according to this ($F(2,117)=6.20$, $p<.005$). The implication of theseresults is that, whereas training in gap timing improved performance on pick-up of relevantfeatures, *conceptual* gains for roadside search depended more specifically on roadside searchtraining. Where children had received this training, their advances were typically morerobust or even on an upward trend.

This point is significant, because there are signs in the pattern of correlation amongsttrained children between **Level 2** justifications and pick-up of relevant features **(R)** thatconceptual grasp may play an important role in the honing of pick-up skills. For 6-7-yearolds,this correlation was moderately positive and increased marginally from pre-test topost-test 1, as scores on both increased (r=+.34 at pre-test; +.37 at post-test 1). For 8-9-year-olds, the correlation started at a similar level, but increased more strongly pre-test topost-test 1 (r=+.40 at pre-test; +.64 at post-test 1). For 10-11-year-olds, on the otherhand, the correlation started high and declined, despite the general increase in scores onboth measures (r=+.80 at pre-test; +.57 at post-test 1)[3].

Figure 3.5 shows these correlation coefficients plotted against the actual mean score on R obtained by the relevant age group at the corresponding point of testing. What seems apparent from this is that there was a more-or-less linear increase in R with increasing strength of correlation - but only up to the point (post-test 1) at which the 10-11 yearolds achieved ceiling on pick-up of relevant features, where it fell off again. One interpretation of these data is that conceptual growth initially helps drive improved information pick-up by signalling what to look for and where, but that this relationship weakens at high levels of performance, when information pick-up is more practiced and automated. Sternberg (1985) describes similar patterns of relationship between understanding and performance in other areas of functioning. This does not necessarily mean that improved performance cannot occur in the absence of conceptual growth (as with the effects of gap timing training on pick-up of relevant features), but it might prove less consistent and less robust under these circumstances. It also does not imply that conceptual grasp about roadside search becomes redundant once high levels of performance have been achieved, since it might still be important under less familiar conditions where automated pick-up has not been developed.

Figure 3.5: Correlation between Level 2 justifications and pick-up of relevant features in different levels of performance

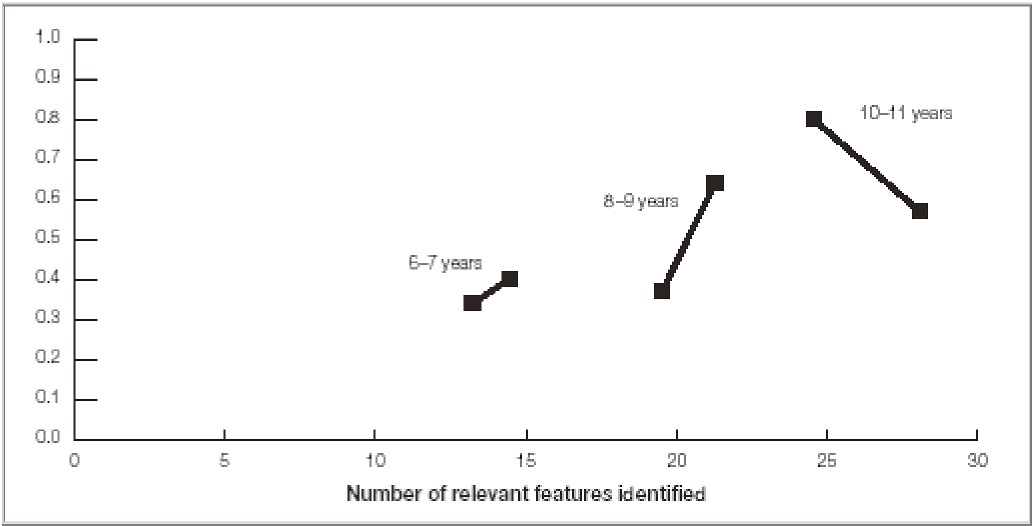


Table 3.3: Mean scores on Level 0 and Level 1 justifications at pre-test, post-test 1 and post-test 2 by age and experimental condition						
	Trained			**Control**		
	6-7 years	**8-9 years**	**10-11 years**	**6-7 years**	**8-9 years**	**10-11 years**
Level 0						
Pre-test	1.44	0.42	0.31	1.10	1.29	1.11
Post-test 1	0.72	0.50	0.17	0.38	0.50	0.78
Post-test 2	0.75	0.46	0.37	0.78	1.14	1.00
Level 1						
Pre-test	5.02	6.89	6.73	4.53	5.89	6.52
Post-test 1	5.82	7.11	8.56	5.24	7.00	7.22
Post-test 2	8.36	8.66	9.30	6.79	8.05	8.07

The pattern of data on the remaining measures (see Table 3.3) was in general less revealing. As far as inadequate justifications **(Level 0)** were concerned, trained children improved significantly (that is, showed a drop in the frequency of these) pre-test to post-test 1 ($F(1,124)=6.02$, $p<.02$). This was especially true for the 6-7-year-olds ($F(2,124)=3.85$, $p<.05$). There was no further decline from post-test 1 to post-test 2, but the incidence of such responses was already very low. Basic justifications **(Level 1)** increased pre-test to posttest 1 ($F(1,124)=7.18$, $p<.01$), and again post-test 1 to post-test 2 ($F(1,108)=9.93$, $p<.005$).

The control children, however, showed much the same pattern of change. Thus theyimproved significantly on **Level 0** pre-test to post-test 1 ($F(1,75)=19.35$, $p<.001$), in factto a rather greater extent than the trained children, though they had started at a higher(that is, worse) level at pre-test. They then fell back again from post-test 1 to post-test 2($F(1,46)=4.28$, $p<.05$), although a different sample of children was involved here, who hadnot been tested on roadside search before (though they had been pre- and post-tested ongap timing). In common with the trained children, the controls improved on **Level 1** bothpre-test to post-test 1 and post-test 1 to post-test 2, though in neither case did the increasequite achieve statistical significance.

All in all, the data suggest that for these measures testing in itself, particularly whenrepeated, acted to sensitise children to some extent to the types of response required,shifting them away from inadequate justifications towards those which were moreacceptable. It is important to note, however, that this only promoted a very basic level ofunderstanding since, as already outlined, there was no improvement in Level 2 responsesamongst the control children. The gains attributable to this effect are minor in comparisonto the advances brought about by training detailed above.

3.8.3 Comparison of Children From High Accident and Socially-Mixed Areas

Analyses of the relative performance of children from the high accident and sociallymixedareas at pre-test, post-test 1 and post-test 2 were carried out to establish that thelack of significant difference between areas which had been found for safe places obtainedfor roadside search. In general, this was the case, with the few differences which wereidentified typically being explicable in terms of sample changes rather than school area.

However, these analyses did throw up one finding of considerable potential interest.The start point for this was the observation that, amongst the *trained* children, 6-7-yearoldsfrom the high accident area were discovered to have performed worse on **Level 0** and**Level 2** justifications at pre-test than the equivalent children from the mixed area (forLevel 0, 2.32 vs. 0.68; $F(2,132)=8.33$, $p<.001$; for Level 2, 0.63 vs. 2.18; $F(1,132)=5.44$,$p<.05$). This difference was maintained for **Level 2** justifications across post-test 1 andpost-test 2 (at post-test 1, 0.79 vs. 2.77; $F(2,123)=4.38$, $p<.02$; at post-test 2, 0.75 vs. 2.30;$F(2,117)=6.20$, $p<.005$).

It should be emphasised that this difference only applied to the youngest children; ifanything, older children from the high accident area did better than those from the mixedarea, though the change of mixed area sample for post-test 2 has to be taken into accounthere. It is plausible to attribute this effect to a lack of familiarity with explainingthemselves to strangers on the part of younger children from the cultural backgroundassociated with lower SES communities. Past research indicates that children from suchbackgrounds are likely to be uncertain about or to lack knowledge of the appropriatelanguage to use under these circumstances, and to perform poorly as a result (see forexample, Tizard, Hughes, Carmichael & Pinkerton, 1983).

What was striking, however, was that for the *control* children, those from the high accidentarea of *all* ages did worse on **Level 2**, especially at post-test 1 ($F(1,75)=5.79$, $p<.02$) andpost-test 2 ($F(1,47)=10.87$, $p<.005$), where they increasingly lagged behind children fromthe mixed area. This suggests that the same verbal effect as noted for the trained childrenwas operating here, but spread over all three age groups and interacting with test stage tosome extent.

Two important points follow from this. First of all, the occurrence of the verbal effect overall age groups in the control sample, but its restriction to 6-7-year-olds for the trainedsample, would indicate that training had had a positive effect on the verbal skills of olderchildren from the high accident area. If so, this would be an indirect benefit of no smallconsequence. Secondly, the fact that the differences amongst the controls became moreevident at successive stages of testing indicates that children from the mixed area learntsomething of what was required from repeated testing, even if only to a limited extent,whereas children from the high accident area did not (remember that at post-test 2 themajority of the control children had already been pre- and post-tested on gap timing).This might be because the available signals were too implicit to decode unless the modeof communication was already familiar. However, it underlines the inference that it was*training* that improved the verbal skills of children from the high accident area, not testing.

3.9 CONCLUSIONS

Reviewing the evidence from the evaluation work against the aims laid out in Section 3.2, a number of conclusions can be drawn. First of all, it is clear that the computer-based training in roadside search had a positive impact on both children's pick-up of relevant features at the roadside, and their understanding of why attention to these is important. These improvements were found to be robust over a period of eight months for all three age groups involved in training. Testing on its own appeared to lead to some advance amongst the control children, but this was minor in comparison.

It is also clear that training did, as hypothesised, generate cumulative effects across skills.Thus, previous training on safe place finding led the trained sample to start from a higherinitial position than the controls on both the pick-up of relevant features *and* the ability toprovide insightful explanations of those features' relevance. Moreover, this was true for allage groups, including the 6-year-olds, despite the fact that for these children, safe placestraining appeared to make little impact on safe places finding itself. Similarly, whenchildren subsequently underwent training on gap timing, this apparently left them betterable still to identify traffic-relevant features. In this case the benefits did not extend toimproving their conceptual grasp, however. As far as the latter was concerned, thisappeared to depend rather more specifically on receiving the roadside search training, asignificant point given the evidence that, at lower levels of pick-up of relevant features,improved conceptual grasp may play a role in driving performance upwards.

It is important, finally, not to lose sight of the secondary benefit of training in terms of theboost it gave to the verbal skills of at least some older children. Given that this effect wastied specifically to training rather than to testing, it is hard not to conclude that it wasattributable to the non-directive, child-led dialogue emphasised in our training procedure.This outcome is especially interesting since peer-based interaction has often been claimedto have exactly this impact, although to date there has been little hard evidence to backthat claim up.

[1] Note: for the statistical analysis of change in children's performance, separate tests were conducted pre-test to post-test 1 and post-test 1 to post-test 2. This was because the rate of attrition, and the change in the trained sample between post-test 1 and post-test 2 (see 3.3 above) meant that an analysis across all three stages of testing would have had to drop data from a large number of effectively incomplete cases. Similarly, in view of the differences between them which were apparent at pre-test, separate analyses were conducted for the trained and control samples in order to obtain a clear picture of which changes within condition were significant, without these being obscured by higher-order interaction effects.

[2] The lower level of performance of the East End 6-7-year-olds on this measure in comparison to those in the West End, even in the substitute training sample, will be returned to in Section 3.8.3.

[3] The correlations between Level 2 justifications and pick-up of relevant features at post-test 2 are excluded from consideration here, since the substitution of half the trained sample rendered their status uncertain.

CHAPTER 4:
Skill three - Gap timing

4.1 RATIONALE

A crucial aspect of pedestrian skill, especially on busy roads, is the ability to assess when a gap of sufficient size has opened up between vehicles to enable a safe crossing to be made. This skill, perhaps more than any other, requires the integration of complex judgements about:

- the distances and speeds of vehicles (often approaching from more than one direction);
- the time that these vehicles will take to reach the intended crossing point (the *time available*); and
- the time that the pedestrian would need to cross the road in question given its width and the intended speed of movement (the *time required*).

Once such judgements have been made, the pedestrian then has to compare the time available with the time required in order to determine whether crossing is possible or not. If the time available is equal to or less than the time required, then safe crossing is not possible. If the time available is greater than the time required, then crossing is possible in principle, although a skilled pedestrian would undoubtedly leave a safety margin to allow for estimation errors. Having decided it is safe to cross, a further judgement is required about when to initiate the crossing. In general, the pedestrian needs to decide fairly quickly whether to accept the gap or not, because even large gaps will rapidly shrink if too much time is wasted deciding whether to go or not. This is especially important in the case of smaller gaps, where the pedestrian needs to minimise their 'starting delay' (Lee, Young & McLaughlin, 1984) so as to maximise the gap's effective size. Where gaps are very large, this would obviously not matter as much, although it is probably always desirable to make the effective gap as large as possible by crossing promptly.

A final point is that these various judgements cannot be made instantly. To achieve a safe crossing it is therefore necessary to look ahead for upcoming gaps well in advance of their arrival so that preparations for accepting those that are big enough can be initiated in a timely fashion. In other words, anticipation and forward planning are crucial elements whenever a pedestrian ventures on to busier roads. Note too, that attention should be focused on the gaps *between* vehicles, rather than on the vehicles themselves. The importance of gaps tends to elude inexperienced child pedestrians whose attention is often drawn to less important features (Tolmie *et al.*, 1998).

Mature pedestrians, of course, have perfected these gap timing skills to a high degree, missing relatively few safe opportunities to cross whilst always rejecting gaps that are too small or else 'tight fits' (Lee *et al.*, 1984). They also know how to maximise a gap's effective size by minimising their starting delay. This enables safe crossings to be made in conditions where crossing opportunities arise relatively infrequently. In more extreme circumstances, mature road users may even tackle a crossing in two stages, treating the crown of the road as a 'safe refuge' between the approach of vehicles on the near and far sides of the road. Decisions to treat crossings in this fashion are of a very high order of skill, based not just upon judgements of traffic speeds and road width, but also personal visibility and a recognition that traffic would have the ability to steer a wide enough berth behind and in front of the standing position without having to swerve.

Clearly these are not strategies for immature or inexperienced pedestrians, and there is absolutely no advocacy in the intervention programme that children should be trained in these complex and potentially dangerous manoeuvres. Nonetheless, there are elements involved that can be suitably addressed in a training programme aimed at young children. For example, children do have to learn how to judge if a gap between vehicles is large enough to cross through: without this ability, they would be unable to cross even moderately busy streets. All pedestrians eventually acquire the ability to do this, although they would appear to do so mainly through informal learning on real roads. A preferable approach would be to find a means of improving these skills in a safer and more controlled manner where no harm would come to learners if they made errors.

Previous research in this field has concentrated on roadside activities, with training taking place either at the roadside itself or using roadside simulations. For example, Young & Lee (1987) set up a 'pretend' road parallel and immediately adjacent to a real road of the same width. The children's task was to observe the traffic moving on the real road and then, when they thought it safe, to cross the adjacent pretend road as if the traffic were on it. This gave children the opportunity to practice making real traffic judgements, but no harm came to them if they made mistakes. In fact, any mistakes they did make provided feedback and therefore helped promote learning. Children as young as 5 years of age made significantly improved judgements on the basis of this intervention. For example, their *crossing times* became more consistent (providing them with a better index of the time *required* to cross the road); they had fewer *missed opportunities* (that is, they rejected fewer large gaps that were safe to pass through); made fewer tight fits (that is, accepted fewer gaps that were dangerously small); and had shorter *starting delays* (that is, did not squander a gap by delaying stepping into it once they had decided to accept it). Their judgements also became more consistent. Similar results have been reported by other researchers using comparable roadside tasks (for example, van Schagen, 1988; Demetre *et al.*, 1993).

One of the goals of the current project was to see if similar outcomes could be achieved using a computer-simulated roadside environment rather than the real roadside as the focus of training, and by replacing the children's own movements with movements undertaken by on-screen characters. This approach would, of course, give rise to potentially serious problems. Firstly, the traffic speeds, gap sizes, road widths and pedestrian movements would not correspond to those occurring at the roadside, but would be substantially scaled down. Secondly, there would be no motor element in children's learning, since they would be co-ordinating the activity of on-screen characters, not their own movement. Such lack of correspondence between the training context and the actual context for which the children were being prepared might be felt to undermine the likelihood of children generalising from one to the other.

Whether the simulation would lead to improved roadside judgements is, of course, an empirical question that cannot be answered in advance. The advantages of being able to train children on a simulation rather than at the roadside are, in this case, so great that the effort of evaluating the simulation seems justified. Moreover, there are reasons to be optimistic about what might be achieved. Firstly, although there are substantial differences in the absolutes sizes, distances and speeds of objects and characters represented in the simulation relative to the roadside, nevertheless the procedural and conceptual principles underlying the decisions that children need to make are common to both. Secondly, a previous study (albeit carried out on a more modest scale) found positive signs that such judgements were transferring from a computer context to the roadside (Tolmie *et al.*, 1998). In this work, computer-based training of 6-year-olds (on roadside search) was found not just to improve information pick-up at the roadside, but also led to reductions in accepted gap size and starting delays on a kerbside task similar to that employed by Demetre *et al.* (1993). This represents a substantial degree of generalisation and encouraged us to undertake the present, more extensive study.

4.2 AIMS

- *to teach children how to identify traffic gaps that are sufficiently large to permit safe crossing, and to differentiate these from gaps that are too small;*
- *to teach children to anticipate the arrival of gaps by looking ahead;*
- *to teach children to focus on time rather than distance or speed per se when making judgements about the safety of traffic gaps; and*
- *to teach children how factors such as road width and personal mobility characteristics (for example, damaged ankle or heavy shopping bags) influence the time required to cross and therefore the size of gaps that can be safely accepted.*

It also aimed to:

- *assess the impact of training on children's roadside judgements and conceptual understanding of why the judgements are required;*
- *establish whether training on previous skills in the programme contributed to the acquisition of gap timing skills; and*
- *examine the relative impact of training on children aged, 7, 9 and 11 years at the start of training.*

4.3 Participants

A total of 129 children undertook training in gap timing. Of these, 59 came from the original training sample in the high accident area, all of whom had received training previously in safe place location and roadside search. The remainder were children from the substitute school in the socially mixed area (see Sections 1.8 and 3.3 above) who had not received any training previously. Since roadside testing was in this case a lengthy procedure (see Section 4.5 below), it was decided to carry this out with a representative, randomly selected two-thirds of the training sample, in order to ensure completion within the time available. Thus pre- and post-test data were collected from 94 children - 26 7-year-olds, 32 9-year-olds and 36 11-year-olds. Due to absence and illness there was some attrition in the numbers of these children available at the delayed post-test.

Complete pre- and post-test data were also obtained from a control sample of 49 children of matched age and background - 15 7-year-olds, 18 9-year-olds and 16 11-year-olds. The control sample for post-test 2 (n=46) was a different group of children of similarly matched age profile and background to those who participated in the pre-test and post-test 1. As before, this was to control for any general maturational improvements taking place over the period, and to minimise contamination caused by undertaking previous testing. The majority of control children had been pre- and post-tested in perception of intentions. This means that, as before, most control children undertook three test sessions. The age profile of the children in the trained and control samples who underwent testing is presented in Table 4.1.

Pre-testing, training (where relevant) and post-testing took place in autumn 1999. Post-test 2 was carried out in spring 2000, after pre-testing, training and post-testing on perception of intentions.

Table 4.1: Mean ages of trained and control children at the start of pre-testing			
TRAINED SAMPLE			
Year group	**Participants**	**Mean age**	**Range**

P3	26	7 years 1 month	13 months
P5	32	9 years 2 months	14 months
P7	36	11 years 2 months	12 months
CONTROL SAMPLE			
Year group	**Participants**	**Mean age**	**Range**
P3	29	7 years 2 months	13 months
P5	34	9 years 1 month	15 months
P7	32	11 years 1 month	13 months

4.4 INTERVENTION: SOFTWARE DESIGN AND TRAINING

As in earlier interventions, children in the training group undertook four training sessions at weekly intervals, working in small groups of three (occasionally two or four) under the guidance of an adult trainer. Each training session illustrated different aspects of traffic movement, road features and pedestrian characteristics, in order to draw explicit attention to factors which impact upon the time *available* for crossing; the time *required* to cross; and the judgements that a careful pedestrian should make as a result. The complexity of the information presented and the judgements that were required was also increased across the four training sessions. The main objectives were to get children to focus on gaps rather than vehicles; to anticipate the arrival of gaps by looking ahead; to assess gap size in terms of time available and time required for crossing; and to maximise the effective gap size by minimising starting delays. There was also a subsidiary objective of encouraging children to become aware of how different sets of circumstances can influence the degree of safety or risk associated with their crossing decisions.

The basic task presented by the software remained constant across the training sessions. This was to decide the exact point in time at which various members (sometimes two or three together) of a range of on-screen characters (some familiar from past training) should cross through a continuous flow of traffic. No unsafe locations were used: children always viewed the traffic flow from a safe position offering good visibility in all directions.

All action was shown from an elevated viewpoint, as in roadside search, but in this case no worm's-eye view was made available. Unlike the roadside search software, the animation of traffic movements ran on a continually repeating loop. However, whilst the movement sequence was looped, the vehicles actually depicted on each cycle varied so that it was almost impossible to spot the cyclical nature of the presentation. Three or four gaps of varying type (that is, near-near, near-far, far-near or far-far) of sufficient size for crossing were contained in each loop. The motion of the character(s) as they proceeded to the crossing location served to provide information on their walking speed, which could be used to judge how long they would actually need to get across the road. Children made their responses simply by pressing a 'go' button at the point when they thought there was enough time available for the character(s) to cross. There was also a pause facility to enable comparisons to be made between gaps, and to permit discussion of key points in relation to these.

Each training session required decisions to be made on between eight and nine crossings. These were strung together into a story to provide a rationale for the crossing activity (for example, two children who live on opposite sides of the road meeting to go to play in an adjacent park; one of them having a fall and having to be helped home; and the friend then coming back to collect the bicycle that was left behind in the park). Sessions were not, however, organised around routes in the same way as the safe places and roadside search software.

The material for the four training sessions was arranged to progress both within and across session from relatively straightforward decisions integrating consistent features of the traffic environment to more complex decisions involving varying features. Thus the sessions involved:

Session 1: standard road width, constant traffic speed and normal walk speed; and

Session 2: standard road width, constant traffic speed and variable walk speed (occasioned by a child falling from a bicycle and limping across the road with a sore ankle, helped by a friend; or pushing a pram);

Session 3: variable road width, variable traffic speed (some vehicles accelerating or decelerating) and variable walk speed; and

Session 4: variety of new scenes involving variable road width, traffic speed, walk speed.

The software thus began by introducing children to the kinds of decision making required when crossing busy roads (Session 1); then gradually introduced the idea that the time *required* for crossing may vary (Session 2); as does the time *available* for crossing (Session 3). It also illustrated some of the factors that are responsible for such variation. Session 4 presented examples of everything that had been covered in earlier sessions and arranged scenarios where the different variables co-varied. Appendix 3 contains (static) illustrations of some of the traffic scenes used in the software.

During training, discussion amongst the children and adult trainer revolved around the features and events in the scenarios that should affect the crossing decisions children were being asked to make. As in safe places and roadside search, trainers used prompts and questions to draw children's attention to key points. In particular, they aimed to encourage children to look for and anticipate gaps; take into consideration the factors affecting available and required gap size; focus on variables affecting temporal judgements, such as the speed/distance of approaching vehicles, road widths, factors affecting normal walking speed, and so on. Trainers attempted to get the children to explicitly use such information when formulating decisions about when to cross. Emphasis was also placed upon the idea that gaps are more important than individual vehicles, and that gaps are time slots which may or may not permit a safe crossing.

Feedback on children's decisions was provided, as before, via a combination of software reaction and discussion initiated by the trainer about this reaction. Unlike the safe places and roadside search software, however, the computer provided both positive and negative feedback. Thus, when children had correctly identified a safe gap for the on-screen character to cross and had pressed the 'go' button soon enough in that gap for the character(s) to get across without a tight fit, they were shown crossing the road (positive feedback). If, on the other hand, the timing was incorrect so that the pedestrian(s) could not get across safely, the characters would still attempt to cross but would turn into ghosts. There would be an accompanying loud screeching of brakes and the action would freeze. Thus, the children received a fairly dramatic, but non-lurid, illustration of what might well have happened had someone really tried to cross the road in the manner they had decided was safe. It also promoted discussion as to *why* the decision was wrong.

Finally, it should be emphasised that children were continuously alerted to the danger of actually attempting crossings of this kind on real roads. Trainers were expected to emphasise this from time to time throughout training. At the end of each training session, a warning message was also displayed on-screen for trainers to read out. It read: "REMEMBER CHILDREN doing these exercises on the computer does NOT mean that you can cross REAL roads by yourself". Documentation sent to children's parents also emphasised that the training was not intended to prepare children for independent travel and that they should continue to accompany them at all times in accordance with government guidelines.

4.5 PRE- AND POST- TESTS

Testing was conducted at the roadside on an individual basis with all children in the test samples. Different locations were used for each school, although they were kept as similar as possible. The same four tasks were employed at each test phase (pre-test, post-test 1 and post-test 2). These were as described below. Each child completed the tasks in the same sequence on a single journey out of school. Testing took in the region of 45 minutes per child, including walking time.

Estimated crossing time. On a quiet road similar in width to the one used for the accepted gap task, children were asked to make five separate estimates of the time it would take them to cross at normal walking speed. They were asked to do this by mentally visualising themselves crossing, signalling the start and point of arrival to the experimenter on each occasion. The experimenter used a stopwatch to time the mental crossing. Since time required is always based on such mental estimates, it was important to assess how accurately - and consistently - children of different ages would judge their required crossing times.

Actual crossing time. On the same stretch of quiet road, and under close supervision by the researcher, children were asked to cross the road at normal walking speed on five separate occasions. The time taken, from the moment they stepped forward till the moment they stepped on to the kerb on the other side, was recorded by stopwatch. This measure was used to gauge the accuracy of children's estimated crossing times. These data were also used in calculating whether children had made a tight fit or missed an opportunity to cross (see Section 4.6).

Accepted gap task. Roads of identical width to the roads used in calculating 'crossing times' were used, except that these roads were considerably busier in terms of traffic flow. Children stood at the kerbside with a clear view of traffic in both directions and with no parked vehicles in the immediate vicinity. They were asked to watch the flow of traffic and indicate, by a hand signal, as soon as they thought the road was safe enough to start crossing. Ten trials of this type were recorded, or as many as could be conducted within a 20-minute period. A continuous video-recording was made of the passage of all vehicles and of the children's signals. This was used to derive a number of measures used for analysis (see Section 4.6).

Conceptual understanding. As with safe places and roadside search, measures were also taken of children's conceptual understanding. However, unlike the previous studies these were not derived from the justifications children gave for each of their decisions. Instead, a short interview was held with each child after all the roadside judgements had been made. This interview was essentially open-ended, but began with a framing question at the outset: "If you were on a busy road, with cars going past all the time, how would you decide when you could cross safely? What would you look out for?" Probing was employed to follow up children's answers and obtain as full a response as possible.

4.6 SCORING

Performance measures were derived from the data described above as follows:

Estimated and actual crossing times. Medians of the five estimated and five actual crossing times were calculated separately. A measure of fit was also calculated (median actual time minus median estimated time). A score of zero on this measure would indicate that the child's estimated crossing time was very accurate (because it matched the actual crossing time); positive and negative scores would represent under- and over-estimates of the time required respectively. A measure of each child's consistency in making these judgements was also derived from the variability amongst their scores. These measures provide an index of children's ability to judge the time required to cross a particular road.

Accepted gap task. As already described, video-recordings were made of the traffic movement and child's signals throughout each test session. These were used to derive five separate performance measures, corresponding to those used in previous studies of gap timing (see for example, Demetre *et al.*, 1993).

- *Accepted gap size*: the temporal size of any gap nominated by the child as safe. Its size was defined from the moment a vehicle passed the projected crossing point until the same point was passed by the next approaching vehicle.
- *Effective gap size*: since pedestrians usually delay stepping into a gap, there is normally a mismatch between the true size of the gap (defined by the time between two vehicles passing the projected crossing point) and the *actual size* of the gap (defined by the time that remains between actually stepping out and the next vehicle arriving). We refer to the latter as the *effective gap*.
- *Starting delay*: this corresponds to the time the pedestrian takes after a vehicle has passed before stepping into the ensuing gap. A pedestrian can exploit the full size of the gap by stepping out smartly once the lead vehicle has passed, thereby maximising the gap's effective size. Alternatively, a pedestrian could squander a perfectly safe gap by procrastinating before stepping out, thereby reducing the size of the useable part of the gap (and possibly making it unsafe).
- *Missed opportunities*: a missed opportunity was defined as a gap more than twice as long as the time needed by the child to cross the road. The time needed was based on the median over five trials that the child had taken to walk across a road of the same width (see Section 4.5, 'actual crossing times').
- *Tight fits*: the definition of a tight fit varied according to whether the approaching vehicle was in the near lane, far lane, or middle lane (in the case of the three-lane dual carriageway used at one of the schools). Where the next approaching vehicle was in the near lane, a tight fit was deemed to have occurred where the effective gap was less than the child's actual crossing time (that is, the car passed at or before the child would have reached the far kerb). In the case of a vehicle approaching in the far lane, a tight fit occurred where the effective gap was less than 1.5 times the actual crossing time. In the case of the middle lane of the three-lane dual carriageway, a tight fit occurred where the effective gap size was less than 1.25 times the actual crossing time. Tight fits do not always correspond to the child being knocked down, but rather represent 'close calls'. The definitions applied here are also slightly more conservative than employed by previous researchers, in that slightly larger gaps are considered to be tight fits. This is because of the degree of risk associated with such judgements.

For accepted gap size, effective gap size, and starting delay, median scores across trials were derived for each child. Means and standard deviations for conditions and age groups were based upon the median scores of individual children. For missed opportunities and tight fits, the number of instances were simply totalled across trials.

Conceptual understanding. Transcripts of the street interviews were used to score children's responses according to whether they made any reference to: a) the need to focus on gaps in the traffic flow; b) the concept of time *available* for crossing; c) the concept of time *required* for crossing; and d) the need to anticipate opportunities to cross. Mention of each idea attracted one point, therefore the marking scale was on a range of 0 to 4. Scores allocated by two independent raters on a randomly selected 10 per cent of the sample found a 77 per cent agreement rate.

4.7 RESULTS

4.7.1 Cumulative effects of previous training on pre-test

Performance

In order to establish if previous training on safe places and roadside search had a knock-on effect on children's gap timing skills, we compared trained children's pre-test performance on gap timing with that of the controls. However, because a new training school had been recruited in the West End, and children in that school had obviously not undertaken the previous training modules, only children from the East End trained sample (N=44) were included in this analysis.

Two-way ANOVAs with group (trained, control) and age (7-, 9-, 11-year-olds) as factors were undertaken for each of the principal measures described in Section 4.6. Main effects of group were found on three measures: *accepted gap size* ($F(1, 87)=5.26$, $p<.05$); *effective gap size* ($F(1, 87)=6.60$, $p<.02$) and *tight fits* ($F(1,87)=12.51$, $p<.001$). In each case, these differences favoured the children who had previously undergone training. The gaps that trained children were prepared to accept were significantly larger than those accepted by controls (20.8 seconds vs. 17.8 seconds); the effective gap size was larger (18 seconds vs. 15 seconds), showing that they were leaving themselves more time to get across the road; and they made significantly fewer tight fits (.57 vs. 1.76). This latter finding is particularly encouraging. Although the overall level of tight fits was quite low, control children nevertheless made three times as many as trained children. Bearing in mind that a tight fit only needs to be made once to end a child's life, this advantage is of considerable importance.

No significant differences were found for starting delay, missed opportunities or the conceptual measure, although the last showed a non-significant advantage for the two older age groups in the trained sample. Surprisingly, the only main effect of age was on starting delay ($F(2, 87)=3.97$, $p<.05$), which was due to the fact that younger children delayed longer before stepping into accepted gaps. This also gave rise to an age by group interaction ($F(2, 87)=3.47$, $p<.05$), with effective gap size being correspondingly larger in the 9- and 11-year-old trained children. However, this age effect was absent in the controls.

Taken as a whole, these results show that children who had taken part in previous phases of training performed more safely at pre-test than did control children. There seems no other possible explanation but that the previous training had primed children to make more cautious, and perhaps more skilful, judgements from the outset. This advantage is particularly noteworthy in view of the fact that there were few age effects in the pre-test data: that is, older children did not start from a noticeably stronger position than younger children. That previous training should have a stronger effect on performance than age indicates, firstly, that even the oldest children still had a lot to learn with regard to this skill; and secondly, that the cumulative training effect must be relatively powerful if it can over-ride the normally dominating effect of age.

4.7.2 Effect of training on actual and estimated crossing times

Measures of actual crossing time were calculated, as they were required in order to derive both 'missed opportunities' and 'tight fits'. In addition, however, it is important that pedestrians are able to *estimate* their crossing time accurately, since otherwise they would be unable to determine whether the time required for crossing is greater than the time available. Without this information, safe gaps in the traffic flow could not be accurately detected and crossing in such circumstances would involve considerable risk. Young children would be particularly vulnerable if there were any tendency to *underestimate* their actual crossing times. These aspects of children's performance were therefore of some importance.

Actual and estimated crossing times are shown in Table 4.2 and Figure 4.1. It can be seen that, at pre-test, children took around 6.5 seconds on average to cross the road. However, crossing time decreased significantly in the trained group from 6.4 seconds at pre-test to 5.8 seconds in post-test 2 ($F(2, 132)=6.179$, $p<.001$). In the control group, there was no such decrease. Training thus caused children to cross the road somewhat faster. It seems likely that, as training progressed and confidence was raised, children may have crossed more decisively, appreciating from training that actual crossing involves firm action.

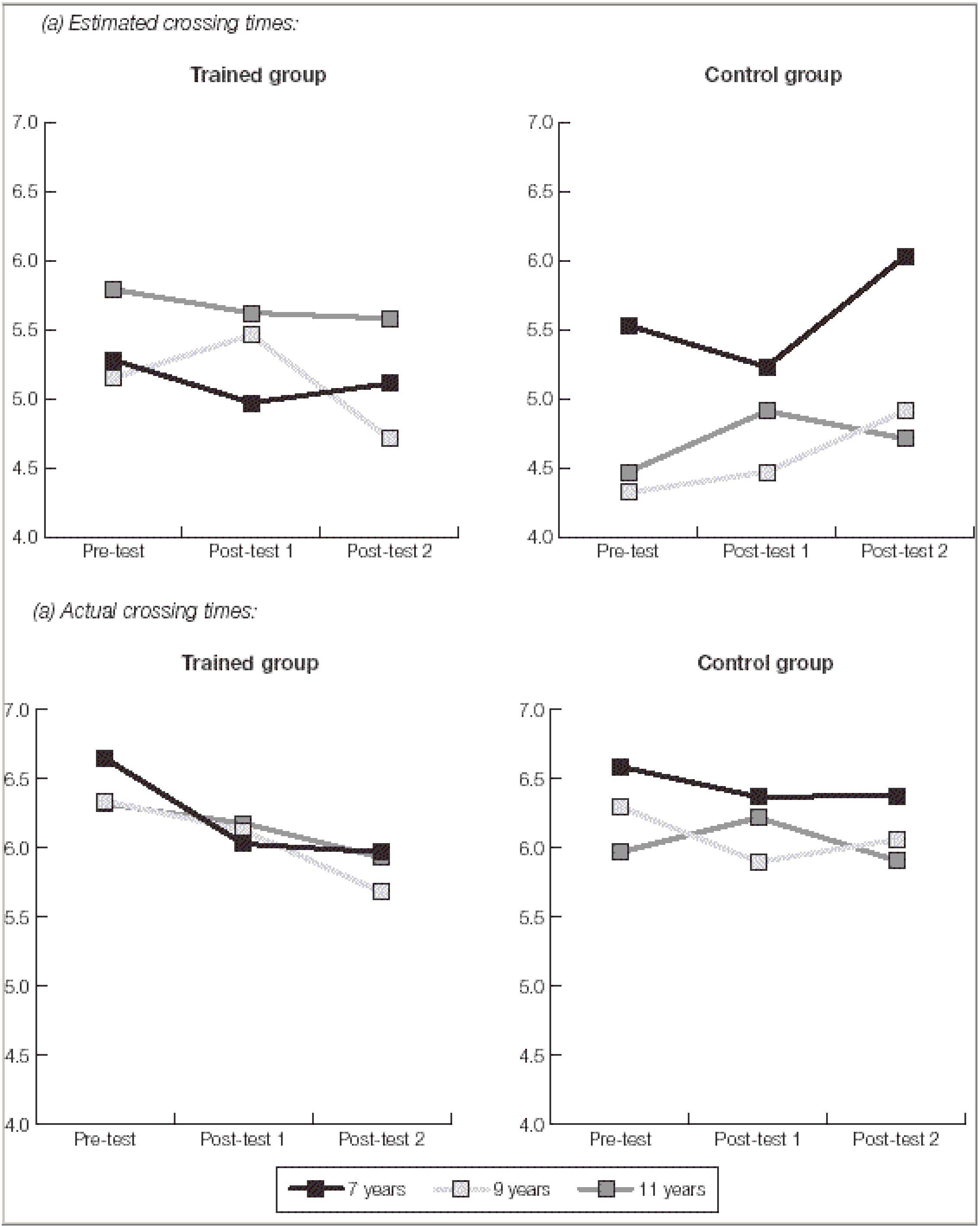
The data on estimated crossing times show that children have a marked tendency to underestimate the time required to cross. At pre-test, this tendency was in the region of 1-1.5 seconds. Estimated crossing times did not change significantly at post-test in either group. However, since *actual* crossing time decreased in the trained group, this means there was now a better fit between estimated and actual crossing time than there had been at pre-test. This improvement in fit is much to be welcomed, because children who underestimate crossing time necessarily overestimate the time available for crossing. Since this would clearly put the child at risk in a real crossing situation, reducing the mismatch is important.

Table 4.2: Crossing times (in seconds) for selected roadways (standard deviations in parentheses)

	Estimated			Actual		
	7 years	9 years	11 years	7 years	9 years	11 years
TRAINED	(n=26)	(n=32)	(n=36)	(n=26)	(n=32)	(n=36)
Pre-test	5.28	5.15	5.79	6.65	6.34	6.32
	(3.19)	(2.18)	(2.38)	(1.65)	(1.74)	(1.49)
Post-test 1	4.97	5.46	5.62	6.03	6.13	6.18
	(1.79)	(2.11)	(2.43)	(1.04)	(1.49)	(1.53)
Post-test 2	5.11	4.17	5.58	5.97	5.68	5.93
	(2.00)	(2.07)	(2.81)	(1.36)	(1.34)	(1.60)

CONTROL	(n=15-29)	(n=18-34)	(n=16-32)	(n=15)	(n=16)	(n=16)
Pre-test	5.53	4.32	4.47	6.59	6.30	5.97
	(3.89)	(1.78)	(1.28)	(1.72)	(1.01)	(1.30)
Post-test 1	5.23	4.74	5.54	6.37	5.90	6.22
	(2.55)	(1.26)	(1.97)	(1.63)	(1.12)	(1.63)
Post-test 2	6.03	4.91	4.71	6.38	6.06	5.91
	(1.48)	(1.73)	(1.61)	(1.49)	(1.73)	(1.32)

Figure 4.1: Mean estimated and actual crossing times (in seconds) for trained and control children as a function of test-phase



4.7.3 Effect of training on accepted gaps, effective gaps and starting delays

As argued earlier, a measure of pedestrian skill in relatively busy traffic is the extent to which the individual can identify gaps that are safe to pass through whilst rejecting those that are too small. Mature road users show considerable skill in this, rejecting few gaps that are safe and, at the same time, accepting few that are dangerous (Lee *et al.*, 1984; Young & Lee, 1987). They are also skilful at exploiting relatively small gaps, which they do by minimising 'starting delay' - that is, the time between the point at which the leading car passes their crossing position and the point at which they step out. Reducing starting delay exploits the full size of the gap, making it possible to accept smaller gaps than would otherwise be the case. This is useful in busier traffic, where long gaps might not often arise spontaneously.

Since young children show little ability in dealing with gaps, the major aim of training was to improve this aspect of their judgement and decision-making. In this section, we consider the effect of training on the size of the gaps they deemed acceptable; the size of their starting delays; and the effect this had on the size of the remaining gap (that is, the gap's 'effective size' at the time they accepted it). The effect of training on tight fits and missed opportunities is explored in the next section.

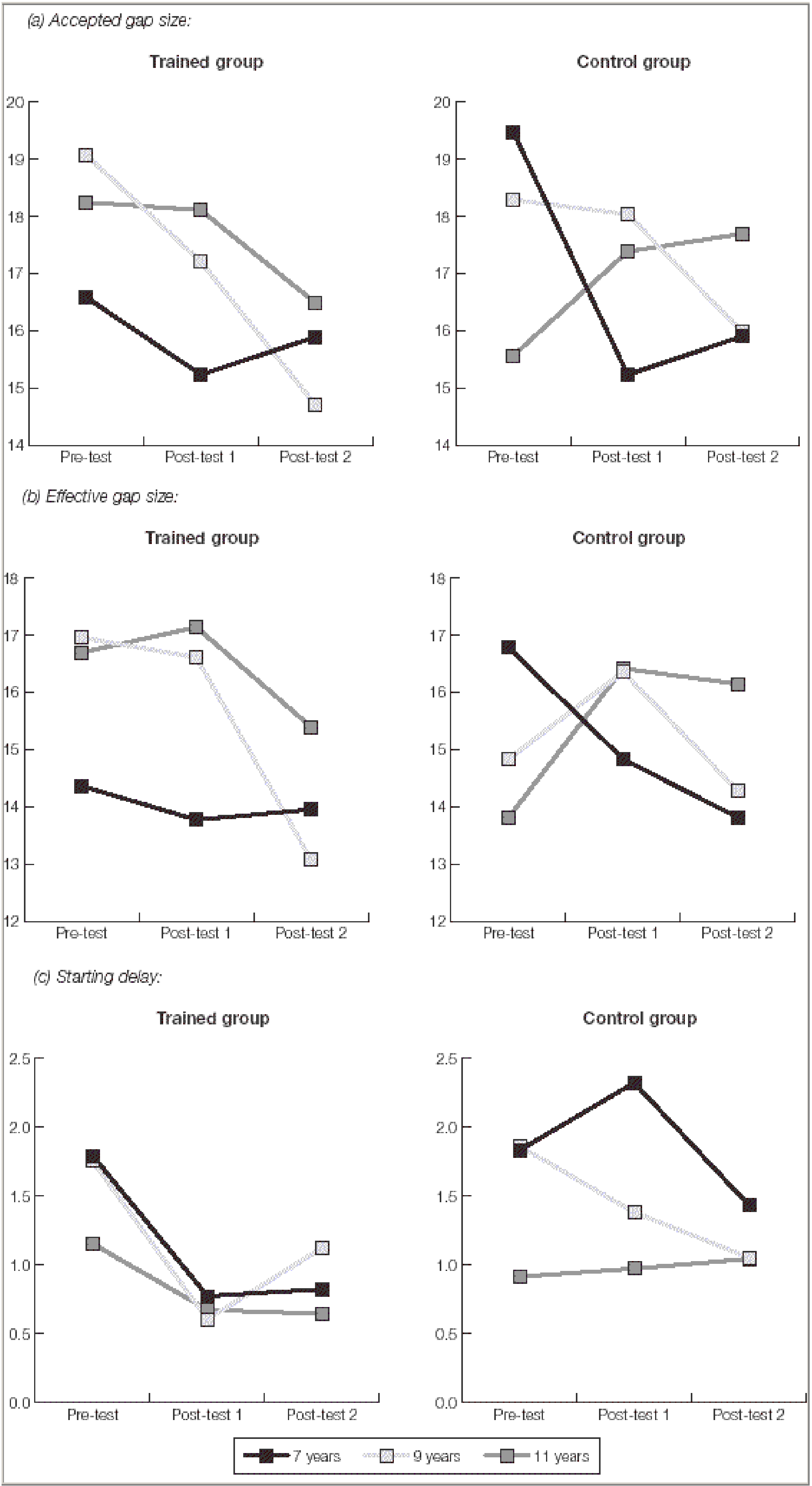
Table 4.3: Accepted gap sizes, effective gap sizes and starting delay (in seconds) for trained and untrained children as a function of age and test-phase (standard in parentheses)

	TRAINED			CONTROL		
	7 years	**9 years**	**11 years**	**7 years**	**9 years**	**11 years**
(a) Accepted gap sizes						
Pre-test	16.58	19.06	18.24	19.47	18.28	15.56
	(5.28)	(7.36)	(4.31)	(7.17)	(7.63)	(2.83)
Post-test 1	15.23	17.20	18.10	15.23	18.03	17.38
	(4.73)	(4.29)	(5.45)	(10.59)	(4.34)	(3.79)
Post-test 2	15.89	14.70	16.48	15.90	15.97	17.69
	(5.47)	(4.65)	(3.88)	(3.10)	(4.53)	(4.29)
(b) Effective gap sizes						
Pre-test	14.36	16.95	16.69	16.77	14.83	13.81
	(4.52)	(6.38)	(4.10)	(6.74)	(4.75)	(2.88)
Post-test 1	13.77	16.60	17.13	12.59	16.35	16.41
	(4.23)	(4.17)	(5.16)	(7.95)	(3.89)	(3.47)
Post-test 2	13.95	13.08	15.39	13.30	14.28	16.14
	(5.00)	(4.38)	(3.55)	(3.28)	(4.33)	(3.64)
(c) Starting delay						
Pre-test	1.79	1.75	1.15	1.83	1.86	0.91
	(1.28)	(1.33)	(0.69)	(1.57)	(2.51)	(0.45)
Post-test 1	0.77	0.60	0.67	2.32	1.38	0.97
	(0.94)	(0.63)	(0.71)	(3.21)	(1.29)	(0.46)
Post-test 2	0.82	1.12	0.64	1.43	1.05	1.04
	(0.90)	(0.63)	(0.74)	(1.19)	(0.51)	(0.75)

The data on accepted gap size, effective gap size, and starting delay are summarised in Table 4.3 for each age group as a function of training and test-phase. The trends are also plotted in Figure 4.2.

Statistical analysis with age (7-, 9-, 11-year-olds) and test-phase (retest, post-test 1, post-test 2) as factors was conducted by means of two-way ANOVA, separately for the trained and control groups. For the trained group, there were significant main effects of test-phase on *accepted gaps* (F (2,130) = 5.61, p<.005); *effective gaps* (F(2,130) = 4.61; p<0.01); and *starting delay* (F (2, 130)=31.44, P<.001). All three measures decreased in size as a result of training. For effective gaps, there was also a marginally significant main effect of age (F (2, 65)=3.17, p<.05). There were no other significant trends in the trained sample.

Figure 4.2: Mean accepted and effective gap sizes, and starting delay (in seconds) across pre-test, post-test 1, and post-test 2

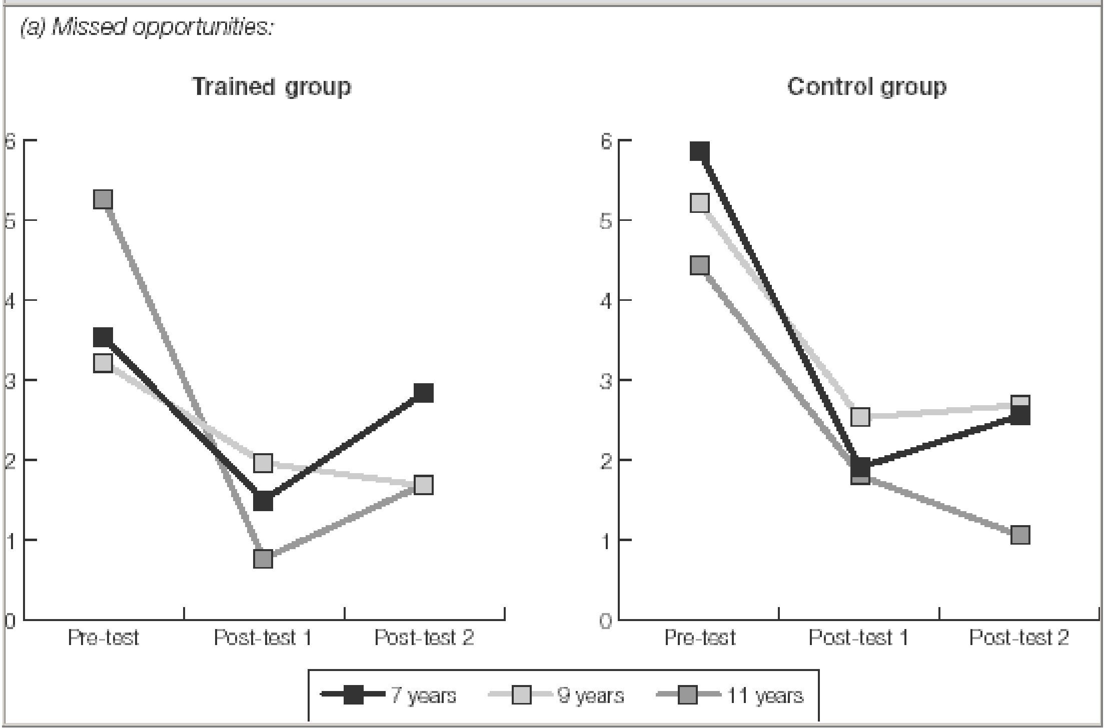


(a) Accepted gap size:
Trained group
Control group
20
19
18
17
16
15
14
Pre-test
Post-test 1
Post-test 2
(b) Effective gap size:
Trained group
Control group
18
17
16
15
14
13
12
Pre-test
Post-test 1
Post-test 2
(c) Starting delay:
Trained group
Control group
2.5
2.0
1.5
1.0
0.5
0.0
Pre-test
Post-test 1
Post-test 2
7 years
9 years
11 years

In control children, almost all these effects were absent. For *effective gaps*, there was a significant interaction between age and test-phase ($F(2, 78)=2.78$, $p<.05$). This is due to the fact that, among the 7-year-olds, effective gaps became shorter in the post-tests whereas, in older children, they became longer. All other main effects and interactions were non-significant.

These results show that training reduced the overall size of the gaps that children were prepared to accept from an average of 18.4 seconds at pre-test to 15.8 seconds at post-test 2. Some concern might be raised that there is an element of risk involved in reducing accepted gap size in this way. However, it should be noted that these are still quite long gaps, certainly by comparison to what would routinely be accepted by adults. Moreover, because children's starting delays also reduced from an average of 1.5 seconds before training to 0.83 seconds at post-test 2, the reduction in accepted gap size was to some extent offset by the fact that the children were also becoming more adept at using the gaps in a safe way. Children's crossing times also became significantly smaller following training, so less time was required for crossing - again, allowing children to accept smaller gaps. Accepted gap size therefore did not reduce simply because children were learning to 'go sooner' in a rote fashion. Rather, they were becoming more attuned to the gaps, and were learning how to make the most of them. In control children, by contrast, these trends were almost entirely absent.

Figure 4.3: Mean number of missed opportunities and tight fits across pre-test, post-test 1, and post-test 2



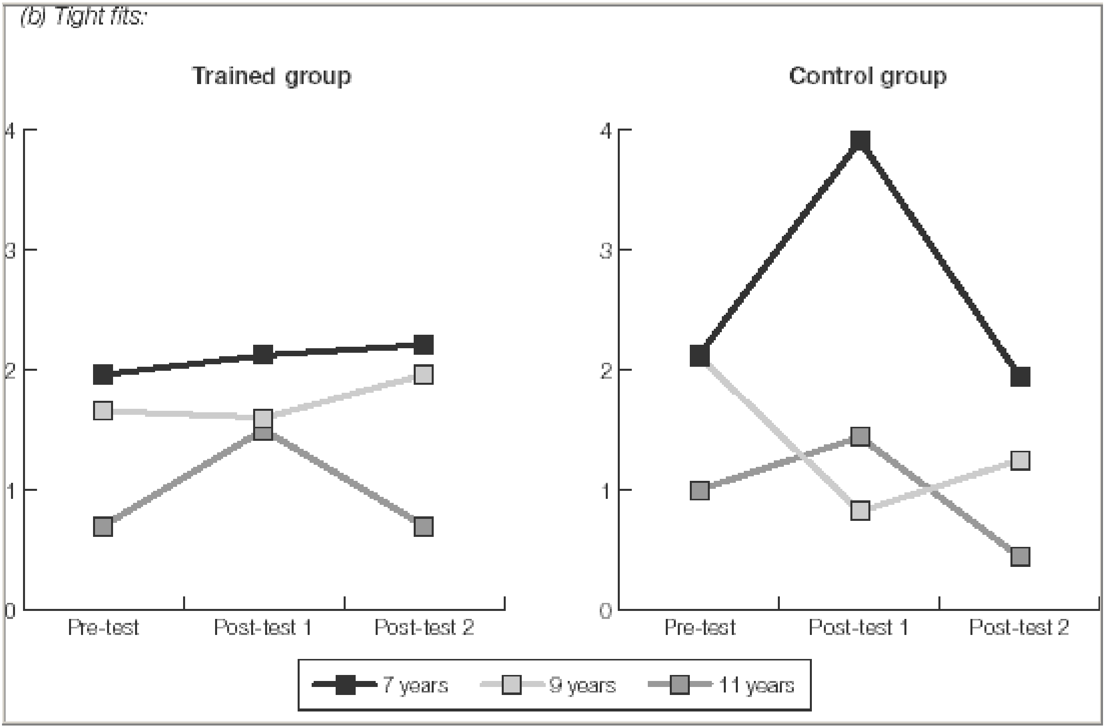


Table 4.4: Mean number of missed opportunities and tight fits for trained and untrained children as a function of age and test-phase (standard deviations in parentheses)						
	TRAINED (n=1936)			**CONTROL (n=1118)**		
	7 years	**9 years**	**11 years**	**7 years**	**9 years**	**11 years**
(a) Missed opportunities						
Pre-test	3.54	3.22	5.28	5.87	5.22	4.44
	(3.34)	(3.37)	(5.02)	(7.21)	(5.80)	(4.53)
Post-test 1	1.50	1.97	0.77	1.91	2.53	1.81
	(1.79)	(2.95)	(1.13)	(3.67)	(2.06)	(1.33)
Post-test 2	2.84	1.68	1.70	2.56	2.69	1.06
	(4.49)	(2.15)	(2.00)	(2.80)	(3.05)	(1.34)
(b) Tight fits						
Pre-test	1.96	1.66	0.70	2.13	2.11	1.00
	(2.16)	(2.10)	(0.98)	(1.96)	(2.22)	(1.46)
Post-test 1	2.12	1.60	1.50	3.91	0.82	1.44
	(1.68)	(1.59)	(1.50)	(2.84)	(1.47)	(1.90)

Post-test 2	2.21	1.96	0.70	1.94	1.25	0.44
	(1.93)	(2.09)	(0.88)	(1.81)	(2.26)	(0.73)

4.7.4 Effect of training on missed opportunities and tight fits

Data on these measures are presented in Table 4.4 and Figure 4.3. Analysis took the same form as previously, with separate analyses being carried out for the trained and control samples. For missed opportunities in the trained sample, there was a significant main effect of test phase ($F(2, 130)=14.83$, $p<.001$) together with a significant age by test-phase interaction ($F(4, 130)=2.67$, $p<.05$). The main effect shows that children missed many fewer opportunities to cross after training than before. The interaction seems to be due to the fact that the rank order of the three age groups changed across the three test-phases. However, there was no indication that these changes in rank order favoured the older children, as might have been expected. The age factor itself was not significant. For tight fits, there was no effect of test-phase but there was a significant main effect of age ($F(2, 65)=3.89$, $p<.05$). Figure 4.3 shows this is because older children made fewer tight fits than younger children across all test-phases.

For the controls, there was also a significant decrease in the number of missed opportunities, giving rise to a main effect of test-phase ($F(2, 78)=17.17$, $p<.001$). There was no effect of age and no interaction. For tight fits, there was a main effect of age ($F(2, 39)=6.57$, $p<.005$) and a significant age by test-phase interaction. As with the trained group, the age effect is due to the fact that older children generally made fewer tight fits than younger children. Figure 4.3 shows the interaction is caused by the fact that, in post-test 1, the 7-year-old control children actually made *more* tight fits than at pre-test. However, this trend was reversed at post-test 2.

4.7.5 Effect of training on conceptual measures

As with safe places and roadside search, the training procedure was designed to provoke debate and reflection among the children with the aim of improving their conceptual understanding of the factors that must be considered when making decisions about crossing roads on which there is relatively busy traffic flow. In order to assess such understanding, children were briefly interviewed at the end of each test-phase and were asked to indicate the factors they would need to consider in deciding if it was safe to cross the road. A higher level of conceptual understanding was assumed if children showed awareness of the role played by four factors: traffic gaps; time available for crossing; time required for crossing; and the need for anticipation and forward planning. Points were awarded as a function of the number of these factors that were mentioned, so that the highest possible score would be four. However, since the interview was open-ended and non-prescriptive, the children did not know how many factors were considered important or how many points were available. This made it relatively unlikely that children would achieve a maximum score, because they did not know when their response would be 'complete'. This procedure was followed to determine what children would report spontaneously, the notion being that spontaneously-reported factors would have relatively greater psychological import. The procedure also reduced the likelihood of bias and practice effects.

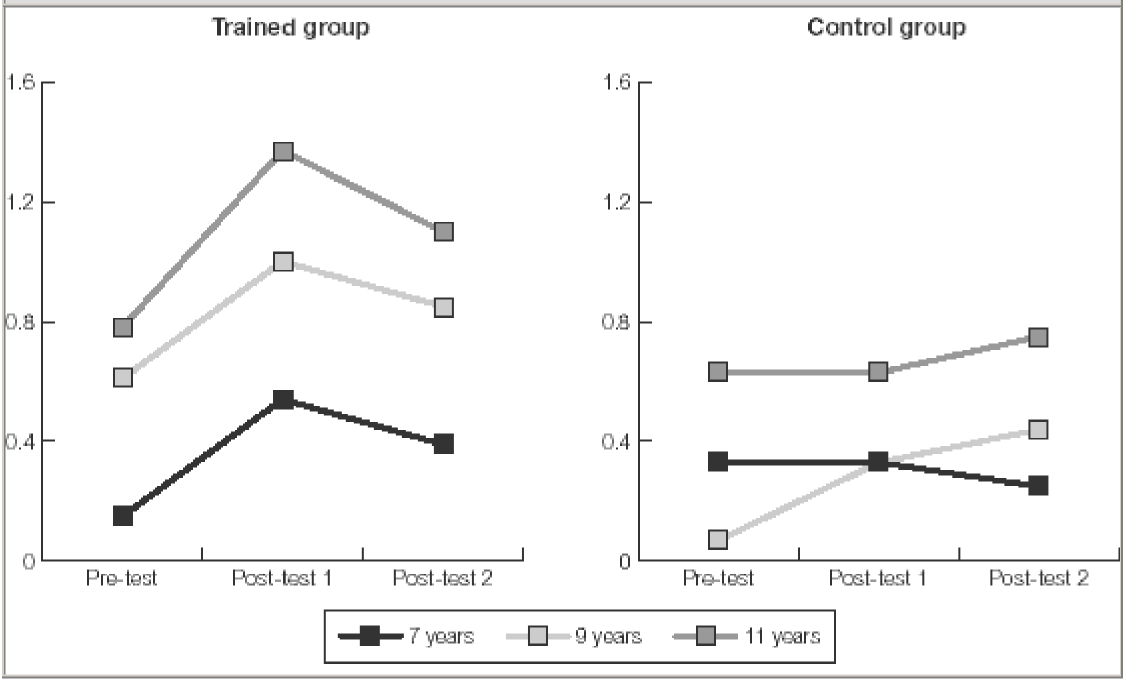
Mean scores for trained and control children as a function of age and test-phase are presented in Table 4.5 and illustrated graphically in Figure 4.4. Analysis for the trained sample revealed a significant effect of age group ($F(2,65) = 9.86$; $p<0.001$), with 11-year-olds (mean = 0.87) scoring higher than 9-year-olds (mean = 0.56) and 9-year-olds, in turn, scoring higher than 7-year-olds (mean = 0.33). There was also a significant effect of test-phase ($F(2,130) = 9.99$; $p<0.001$), with post-test 1 (mean = 0.70) and post-test 2 (mean = 0.63) producing higher scores than at pre-test (mean = 0.43). There was no interaction between age group and test-phase, confirming, as Figure 4.4 indicates, that the three age groups produced very similar trends, with children of all ages increasing their scores from pre-test to post-test 1 and then slipping back a little at post-test 2. The controls showed generally flatter trends, with no significant effect of either age group or test-phase.

Table 4.5: Conceptual scores for trained and control children as a function of age and test-phase

	TRAINED			CONTROL		
	7 years	9 years	11 years	7 yeears	9 years	11 years
Pre-test	0.15	0.61	0.78	0.33	0.07	0.63
	(0.37)	(0.83)	(0.90)	(0.82)	(0.26)	(0.72)
Post-test 1	0.54	1.00	1.37	0.33	0.33	0.63
	(0.78)	(0.95)	(0.89)	(0.65)	(0.59)	(0.72)
Post-test 2	0.39	0.85	1.10	0.25	0.44	0.75
	(0.70)	(0.73)	(0.85)	(0.45)	(0.73)	(0.68)

These results are very encouraging and entirely consistent with expectations. Trained children, operating at roughly the same level as the controls at pre-test, produced twice as many conceptual responses as the controls at post-test 1. Despite some slippage, the effect was largely maintained at post-test 2, showing the continuing positive effect of training on conceptual understanding.

Figure 4.4: Conceptual scores for trained and control children as a function of age and test-phase



4.8 CONCLUSIONS

The overall pattern of results shows that children did derive benefit from training. This is especially interesting in view of the fact that the distances, velocities, road widths, and pedestrian movement characteristics portrayed on the computer are very different to those that pertain in the real world. In spite of these all being scaled down, children's improved roadside judgements show that they achieved a considerable amount of generalisation from one context to the other. The fact that training also improved children's conceptual understanding of the issues involved may well have proved important in this. Certainly, trained children were better able to articulate the factors that demand attention when making crossing decisions than were control children. Knowing more explicitly what it is they were trying to achieve would surely give trained children an added advantage, especially where the underlying elements of the task and test context are changed, as they were at the roadside.

The main effect of training seems to be that it made children cross the road more efficiently whilst at the same time maintaining a fair degree of caution. Thus, although children were prepared to accept somewhat smaller traffic gaps after training, these gaps were still around 15 seconds. By contrast, in a recent study, Pitcairn & Edlmann (2000) found that 7-year-olds accepted gaps with a mean size of 8.5 seconds. Even allowing for the possibility that the road used in that study was somewhat narrower (children's crossing times were also somewhat quicker), children in the present study clearly adopted a more cautious approach. This is confirmed by the fact that, although there were reductions in the size of accepted gaps (and correspondingly, the number of missed opportunities), there was no corresponding increase in the number of tight fits. The children were therefore not simply learning that they should 'go sooner' in a rote fashion in order to reduce the number of wasted crossing opportunities. Instead, it seems they were learning to utilise gaps better, so that shorter gaps could be accepted without any concomitant risk of increasing the number of tight fits. This is supported by the observed decrease in starting delays, which allowed children to maximise the effective size of the smaller gaps they were now prepared to accept; and their shorter crossing times, which reduced the amount of time that they needed in the first place. Finally, examination of Tables 4.2, 4.3 and 4.4 shows that children's judgements also became somewhat more consistent following training, as shown by the generally smaller standard deviations at post-test. These results all point towards increased strategic efficiency in trained children, without these gains being obtained at the expense of caution.

In the control group, almost all of these trends were absent, with one exception: number of missed opportunities decreased in control children to about the same extent as in the trained group. It is not quite clear why this happened. Partly, it may reflect the fact that we used a somewhat more cautious definition of what constitutes a missed opportunity than have previous authors. Generally, a missed opportunity has been defined as any gap greater than 1.5 times the child's total crossing time (Lee *et al.*, 1984; Young & Lee, 1987; Demetre *et al.*, 1993; Pitcairn & Edlmann, 2000). However, where the next approaching car is in the far lane, this means that the child would have reached the far kerb rather a short time before the vehicle would pass. For this reason, we decided to use the more conservative definition of 2 times total crossing time. This would be a good fit for far-side vehicles, although somewhat generous in the case of vehicles in the near-side lane. It also means that gaps would have to be very long indeed to be classified as missed opportunities. For this reason, it is possible that even untrained children would realise that some of these very long gaps could safely be passed through.

However, the fact that this reduction was not matched by changes in any of the other measures shows that the reduction in missed opportunities by the controls was not part of a more general improvement in roadside traffic judgements. Indeed, at post-test 1 there was a worrying *increase* in tight fits among the 7-year-old group - although the trend disappeared at post-test 2. Interestingly, Pitcairn & Edlmann undertook a discriminant function analysis of their data to determine which measures most successfully discriminated between adult and child pedestrians. They found that starting delay was the factor with by far the greatest discriminating power, followed by mean accepted gap size and mean number of safe crossings (defined as number of crossings minus number of tight fits). Missed opportunities, by contrast, had little discriminating power. These results are interesting, because the variables found to be most important in their study are just the ones on which trained children showed most improvement relative to controls in the present study. This suggests that that the training programme may have succeeded in promoting learning in very much the right areas.

Taken together, these results demonstrate important benefits derived from computer-based training in gap timing. Through training, children of all ages appear to have gained both in their expertise in judging safe gaps in traffic; in their more general understanding of the ways in which traffic movements and speeds have to be taken into account; how gaps have to be anticipated; and how the time available for crossing has to be related to the time required to cross. Whilst not systematically evaluated, children also had the opportunity to learn how other factors would influence crossing, such as changes in crossing speed brought about by injury or encumbrances.

CHAPTER 5:
Skill four - Perception of intentions

5.1 RATIONALE

To make sense of events in the traffic environment, children need to develop not only their own awareness of relevant cues and traffic movements, but also an appreciation of other road users' intentions. To the extent that young children's cognitions are dominated by concrete and external cues, then we should expect their understanding of others' intentions to be relatively poor (Durkin, 1995).

Research evidence is, however, somewhat conflicting on this point. Astington (1986) has shown that children's comprehension of the language of intention (for example: 'plans to...', 'means to...', intends to...) is limited at the age of 5, developing strongly in middle childhood. Yet evidence from theory of mind studies suggests that children earlier than 4 years of age are capable of attributing mental properties and plans to others (cf. Leekam, 1993). Even toddlers' language makes frequent reference to intentionality on the part of themselves and others (Dunn, 1988; Wells, 1985), suggesting that they have some practical awareness of the relevance of intentionality to everyday behaviour (Durkin, 1995). Even so, linguistic usage of intentional themes does not imply that young children necessarily have the same grasp of intentionality as adults (Astington, 1986). Young children may use verbal routines to excuse their actions (for example, "I didn't mean to do it") without necessarily understanding fully the meaning of the concepts they express.

In a traffic environment, the process of judging intentions is complicated further by 'invisible' adults using their vehicles as agents to express their intentions. In other words, children at the roadside do not on the whole perceive other road users' intentions directly, but rather indirectly through signalling devices on their vehicles and through characteristics of the vehicles' movements. A pedestrian may be fairly confident that a cyclist holding out his left hand means to turn left immediately. However, whilst a car's flashing left indicator may, and usually does, reveal a similar intention by the driver, it can represent an uncancelled signal or herald an early intention to turn much further down the roadway.

The inherent ambiguity of road signals for most road users means that a driver may give a perfectly correct signal for the intended manoeuvre, but it is by no means always obvious to other road users what action is intended. Equally a driver may give an apparently unambiguous signal and then act in a way which is unexpected by other road users. Adults are relatively experienced in making probabilistic assessments of what drivers are most likely to mean by their signals, but even they are caught out periodically. For children, with much less roadside experience, drivers' signals in different traffic and road configurations must present a bewildering array of possibilities, about which judgements are very difficult for them to make.

Surprisingly, no previous research appears to have addressed the issue of how well attuned children are to signalling conventions, or how easy they find it to assess what other road users' intentions are likely to be in different traffic situations. Thus, while the aim of the fourth stage of the study was to improve children's ability to identify the intentions of other road users, the baseline data gathered at pre-test will also provide for the first time an assessment of how competent children of different ages in fact are at making intentionality judgements.

5.2 AIMS

The fourth skill, then, was concerned with children's perception of other road users' (specifically drivers') intentions. The aims of this stage of the study were:

- *to assess children's ability to anticipate drivers' intentions when provided with different kinds of cues, both conventional and informal (for example, signals, changes in vehicle's speed of movement, lane positioning, etc.);*
- *to assess age-related differences in sensitivity to such cues in children aged 7, 9 and 11 years;*
- *to improve children's sensitivity to the visual and auditory cues that reflect drivers' intentions;*
- *to enhance children's understanding that, in many situations, a driver's signals may be ambiguous or express intentions other than those which at first seem most obvious;*
- *to investigate the extent to which children's judgements of drivers' intentions can be improved through such training; and*
- *to examine the relative impact of training on children aged 7, 9 and 11 years at the start of training.*

5.3 PARTICIPANTS

One hundred and thirty children, balanced for gender, undertook the training programme. Of these, complete pre-test and post-test data were available for 122 children aged 7 years (n=37), 9 years (n=39) and 11 years (n=46). Approximately half the sample (that is, all children in the East End, high accident sample) had undertaken the three previous interventions on safe places, roadside search and gap timing; the remainder (all from the West End, socially mixed sample) had undertaken the earlier gap timing intervention. Sixty-one children from matched schools served as controls: of these, 60 children provided complete sets of pre-test and post-test data. The age profile of children at the time of pretesting is shown in Table 5.1.

Table 5.1: Mean ages of trained and control children at the start of pre-testing			
TRAINED SAMPLE			
Year group	**Participants**	**Mean age**	**Range**
P3	37	7 years 5 months	12 months
P5	39	9 years 5 months	14 months
CONTROL SAMPLE			
Year group	**Participants**	**Mean age**	**Range**
P3	20	7 years 5 months	13 months
P5	20	9 years 4 months	21 months
P7	20	11 years 6 months	10 months

5.4 INTERVENTION: SOFTWARE DESIGN AND TRAINING

Devising a task suitable for training (or indeed testing) children's ability to predict other road users' intentions poses serious difficulties, especially if roadside training methods are favoured. In the first place, a sufficiently wide range of scenarios has to be available at scheduled training (or testing) times. To find such scenarios conveniently in the vicinity of the children's schools would be no easy matter. Moreover, since children cannot all be taken to the roadside at the same time, some way would have to be found of ensuring that the scenarios presenting themselves at different times were roughly comparable. Finally, the task would have to convey cues about the future actions or manoeuvres on the part of drivers well *before* drivers' actually executed those actions. Continuous traffic movement on a real road would not satisfy these conditions because, by the time a suitable driver signalling an intention had been identified and the child asked to make a judgement about that driver's intentions, the manoeuvre would, in most cases, have been completed. This shows the problems that can arise in using the roadside as the context for training even if, on other grounds, the roadside would represent the preferred training context. It also illustrates particularly well the potential that simulations offer for overcoming such problems.

As in the earlier interventions, children were trained in groups of three (occasionally two or four) under the guidance of an adult trainer. Four sessions were held at approximately weekly intervals. In Sessions 1 to 3, children were presented with 10 scenarios to be solved: in Session 4, this was reduced to 8. Most of the trials involved situations in which crossing would be unsafe given the intentions of the depicted drivers. In a few cases, crossing would have been safe. These variations were introduced primarily to ensure that children did not learn to judge the situations as safe or unsafe on a purely rote basis.

Each training session emphasized a different set of potential hazards, and the problems were arranged in a roughly hierarchical progression from relatively simple judgements (involving one or two intentional signals) to more complex sets of signals sometimes involving more than one vehicle. The principal themes dealt with during each session were as follows:

Session 1 focused on indicating and turning to right and left at a variety of distances and directions relative to the on-screen character.

Session 2 focused on reversing, pulling away, three-point turns, U-turns and vehicles emerging from driveways.

Session 3 focused on drivers' intentions at traffic lights, zebra crossings and when overtaking.

Session 4 drew from manoeuvres of all types in Sessions 1, 2 and 3, weaving them into more complex arrangements with different road scenes and more vehicles.

The software was constructed within the same general framework as used previously. Thus, the action was viewed from the same elevated viewpoint as in roadside search and gap timing. Each scenario showed an on-screen character walk along the pavement to a choice point where s/he wished to cross the road. At the same time, a traffic scenario involving moving vehicles would develop. This might involve a car approaching with an indicator light flashing; a driver leaving his house, getting into a parked vehicle, and starting his engine; an approaching vehicle decelerating and taking up position on the crown of the road; and so on. At some point in the sequence, and always before any manoeuvre was actually carried out, the computer screen would freeze and the children were asked to guess what was about to happen next. The format was similar to that used in the popular television programme *A Question of Sport*, and was regarded by the children as fun.

Within any given scenario, cues would be available to help children decide what the driver's intentions might be. These consisted both of conventional signals (for example, indicator lights flashing; reversing lights illuminated; traffic lights in front of an approaching vehicle set at red) and other cues that experienced road users routinely use in anticipating a driver's likely intentions (for example, vehicle decelerating on the approach to a zebra crossing; moving from the crown of the road to the near-side lane). Usually, several cues would be provided simultaneously, as they normally would be in the real world. Sometimes, cues which might be expected were missing, again as they might be in the real world. For example, a vehicle might take up position on the crown of the road and start to slow down as a street on the other side of the road was approached, but the driver would fail to signal explicitly his/her intention of turning right. Sometimes, cues would be ambiguous. For example, a driver approaching a street on the left would signal his/her intention to turn left. However, his/her intention was, in fact, to turn into a driveway on the other side of the side street - s/he had signalled early. Finally, drivers sometimes made risky manoeuvres. For example, a driver approaching traffic lights that were changing to red would accelerate, providing a cue that s/he intended to beat the lights. Thus, training was aimed at more than just informing children of the conventional signals that drivers *should* use on the road. It showed how such signals might occasionally be missing, thereby creating ambiguous situations; and alerted children to other cues that are generally available to help determine what a driver intended to do. Finally, both visual *and* auditory cues were routinely provided. Examples of the latter would be an engine starting (for example, after a driver had entered a parked car), or the sound of acceleration (for example, as a vehicle prepared to overtake).

Each time the on-screen action froze, the trainer initiated a discussion around three issues: (1) What is most likely to happen next? What range of intentions might the driver have? What manoeuvres are possible in this particular situation? (2) What are the indicative cues? Are any cues that might be expected missing? (3) Would it be safe for the on-screen character to cross? If not, why not? When would it be safe for him/her to cross? As before, discussion between the children was considered paramount, with the trainer intervening only when necessary to help keep the dialogue going in productive ways, or to make suggestions when the children got stuck. At all times, children were encouraged to make their reasoning as explicit as possible and to justify any proposed actions both to each other and the trainer. Over the course of the intervention the trainer sought to drop into the background, letting the children take over the task as far as possible.

Once children had arrived at a joint decision as to what was likely to happen next, they were permitted to decide if this allowed the on-screen character to cross safely. If they deemed it safe to do so, they could make him/her cross by clicking a 'GO' button on the screen. If they thought it would be unsafe, they clicked a 'DON'T GO' button. The action then resumed, allowing the children to see what the driver actually did, and what the consequences would have been for the character. If the children had guessed the ensuing action correctly and also judged that it was safe to cross, the character would wait until approaching vehicle(s) had completed their manoeuvres and would then cross. If the children had made a mistake and it was not safe to go, then the ghost figure (first seen in the gap timing intervention) would step into the street and the vehicle would cut across him/her. As before, this was to provide children with feedback in a relatively non-lurid fashion about what the consequences of making an error might be. Where children had made an error, the trainer would reopen discussion and try to get children to reconsider the cues that they had previously missed. It was possible to replay and rehearse any trial as frequently as children or trainer wished before moving on to a new one.

5.5 PRE- AND POST-TESTS

All children were individually pre-tested during the two weeks before the start of training. After training was completed (four weeks), children were retested (post-test). No delayed post-test (post-test 2) was included for perception of intentions due to time constraints. Control children undertook the same set of pre- and post-tests, but without receiving training in the interim period.

As discussed in Section 5.4, roadside testing of children's perception of intentions is much more difficult than was the case with the three preceding skills. This is partly due to the difficulty of finding suitable roadside events just when they are needed and partly the difficulty of controlling the unfolding of the events themselves. To overcome this problem, two kinds of pre- and post-test task were devised, one at the roadside and one on the computer. The roadside test involved two staged events, both involving a vehicle parked outside the school. In the first event, the driver started the engine and turned on the reversing lights (which faced towards the child). In the second, the engine started and the offside indicator flashed. In both cases, the child witnessed the event from a distance of about five metres.

The computer-simulated test presented six scenarios in which the action was viewed from the same elevated position as during the training sessions. The view encapsulated a road environment depicting a main street, traffic lights, a zebra crossing and several junctions with side-roads. Each test trial presented the first part of a vehicle manoeuvre, accompanied by explicit cues as to what the manoeuvre would be. However, the manoeuvre was never executed because the road scene froze at a strategic point before this occurred. The cues included conventional signals (for example, reversing lights, brake lights, indicator lights) and other cues (for example, acceleration/deceleration, positional changes on the road), accompanied by appropriate auditory cues. The signals were precursors to actions such as: reversing; turning right/left; pulling in/moving out from the kerb; stopping at/speeding through traffic lights or zebra crossings; and overtaking. However, children never obtained feedback by witnessing the ensuing action.

Judgements about drivers' prospective actions and intentions depend essentially on two skill elements: first, an appreciation of the options for action that are available to the driver in that particular situation; second, sensitivity to the cues signalling what the action is likely to be. In a specific traffic environment, this means that children must learn what options drivers have from the range of manoeuvres that are possible; what information about intended action is conveyed by the driver's explicit signalling; and what information is conveyed by other features of the vehicle's movement. Children's assessment of these elements then leads to a global judgement about the potential safety or danger of crossing the road.

These elements of awareness were distilled into three fundamental questions used for both simulation and roadside trials. In each case, they were posed at a point after the vehicle's action had been signalled but *before* it was executed. The questions were:

1. What do you think the car is going to do next? (awareness of options)
2. How can you tell? (sensitivity to cues)
3. Would it be safe to cross right now? Why?

For Question 2, children were encouraged to make as many points as they could, until they ran out of ideas.

5.6 DATA CODING AND ANALYSIS

Children's responses were recorded verbatim on audio-tape and were coded subsequently. For Question 1 (***What do you think the car is going to do next?***), children received a score of 1 if they gave the correct response, or a response deemed reasonable given the information presented (for example, *"The car is going to reverse"*). They received extra points for any additional information they were able to provide (for example, *"The car is going to reverse and then pull away forwards"*). For Question 2 (***"How can you tell?"***), children received 1 point for each cue they correctly identified. After each response, children were prompted by being asked, "Anything else?", until they had nothing further to report. For Question 3 (***"Would it be safe to cross right now? Why?"***), children again received 1 point for a correct response, together with further points for each reasonable justification of the decision. There was thus no fixed upper limit to the number of points children could attain on each question.

5.7 RESULTS

5.7.1 Effect of training on performance

Table 5.2 presents children's scores as a function of test (pre-test, post-test), group (trained, control) and age (7-, 9-, 11-year-olds). Since the questions were designed to tap into three distinct elements of skill, the data are presented separately for each element. This is because of the possibility that training might affect each element in a different way. For example, it is possible that training might improve children's understanding of the likely actions of the vehicle (Question 1), yet fail to improve their understanding of how this should in turn affect their own crossing decisions (Question 3). For this reason, the data have been analysed separately in what follows.

Table 5.2: Mean total score for each question as a function of age, training and test-phase (standard deviations in parentheses)

		TRAINED			CONTROL		
		Q1	**Q2**	**Q3**	**Q1**	**Q2**	**Q3**
Pre-test	**7 years**	**4.9**	**7**	**8.4**	**4.6**	**5.6**	**8.4**
		(1.9)	(2.7)	(2.0)	(1.9)	(1.9)	(2.3)
	9 years	**5.7**	**9.1**	**10.7**	**6.5**	**9.2**	**9.3**
		(1.8)	(2.3)	(2.7)	(1.6)	(2.5)	(2.2)
	11 years	**6**	**9.4**	**10.9**	**6**	**9.6**	**10.6**
		(1.2)	(2.6)	(2.3)	(1.5)	(2.5)	(2.2)
Post-test	**7 years**	**7.9**	**11.3**	**11.6**	**6.3**	**7.2**	**9.6**
		(2.3)	(3.5)	(2.2)	(1.8)	(2.2)	(1.4)
	9 years	**9.3**	**13.2**	**13.4**	**7.2**	**9.8**	**9.8**
		(2.3)	(3.1)	(2.8)	(1.8)	(2.7)	(2.2)
	11 years	**10**	**14.5**	**14.5**	**8.3**	**11.5**	**11.4**

		(2.2)	(3.6)	(2.5)	(1.3)	(3.0)	(2.7)
Q.1 What will the car do next? Q.2 How can you tell? Q.3 Would it be safe to cross? Why?							

The trends are most easily seen in Figures 5.1 to 5.3, which plot the performance of trained and control groups separately for each question. It can be seen that, in all three age groups, training led to substantial improvements in performance. The effect is not limited to one or two skill elements: rather, improvement seems to have taken place right across the board. Without even differentiating between the different age groups, trained children showed an overall improvement of 65 per cent on Questions 1 and 2 and a 32 per cent improvement on Question 3. Control children also showed some improvement but at a much more modest level. Thus on Question 1 (concerning what the vehicle is likely to do), controls showed an improvement of 28 per cent. However, the information they were able to use in making this judgement (Question 2) improved by only 17 per cent. Finally, the safety of the crossing decision they made on the basis of these judgements (Question 3) scarcely improved at all (8 per cent).

These trends were analysed separately for each of the three questions using three-way ANOVA with age (7-, 9-, 11-year-olds), test-phase (pre, post) and group (trained, control) as factors. For Question 1 (What will the car do next?), there were significant main effects of age (F (2, 124)=56.55, p<.001), test phase (F (1, 124)=182.94, p<.001) and group (F (1, 124)=11.24, p<.001). There was also a significant interaction between group and test-phase (F (1, 124)=28.90, p<.001) and smaller interaction between age and test-phase (F (2, 124)=4.35, p<.02). These results indicate an extremely reliable difference in pre-versus post-test performance. The main effect of group and the interaction between group and test-phase show that this improvement was far more marked in the trained children, as the descriptive data show. The interaction between age and test-phase shows that older children benefited from training somewhat more than younger children - though Figure 5.1 shows that this effect was quite small.

For Question 2 (How can you tell?), similar trends were obtained. There were main effects of age (F (2, 124)=23.83, p<.001), test phase (F (1, 124)=120.49, p<.001) and group (F (1, 124)=19.05, p<.001). There was also a significant interaction between test-phase and group (F (1, 124)=40.23, p<.001). Figure 5.2 shows that these trends emerged because post-test performance in the trained group substantially surpassed performance in the pre-test whereas, in the control group, this effect was very small. There was no age by test-phase interaction for Question 2 showing that children of all ages improved to about the same extent as a result of training.

For Question 3 (Would it be safe to cross?), there were again main effects of age (F (2, 124)=15.41, p<.001), group (F (1, 124)=26.86, p<.001) and test-phase (F (1, 124)=60.79, p<.001). There was also an interaction between test-phase and experimental group (F (1, 124)=21.04, p<.001). Again, Figure 5.3 shows that this is because the improvement at post-test is almost entirely limited to the trained group.

Looking at the results overall, the pattern is clear: the impact of training was considerable, with substantial improvements occurring across all three age groups. There was no strong evidence of older children benefiting disproportionately relative to younger children: all three age groups appear to have improved to about the same extent. Moreover, the positive impact of training extended across all three skill elements: a broader appreciation of the manoeuvres a vehicle is likely to make; sensitivity to a wider range of cues signalling what the manoeuvre is likely to be; and an increased likelihood of making a correct judgement as to whether or not the road is safe to cross. By contrast, control children improved only to a very small degree and these improvements had almost no impact on the decisions they made about whether it would be safe to cross. The small improvements seen in this group probably result from an exposure effect; that is, they represent the impact of asking children a series of focused questions at pre-test which alerted them to thinking about the issues involved. Such small improvements on the basis of limited exposure to the task are, of course, welcome. The improvements seen in the trained group, however, are of a quite different order.

Figure 5.1: Responses to Question 1 (What will the car do next?)

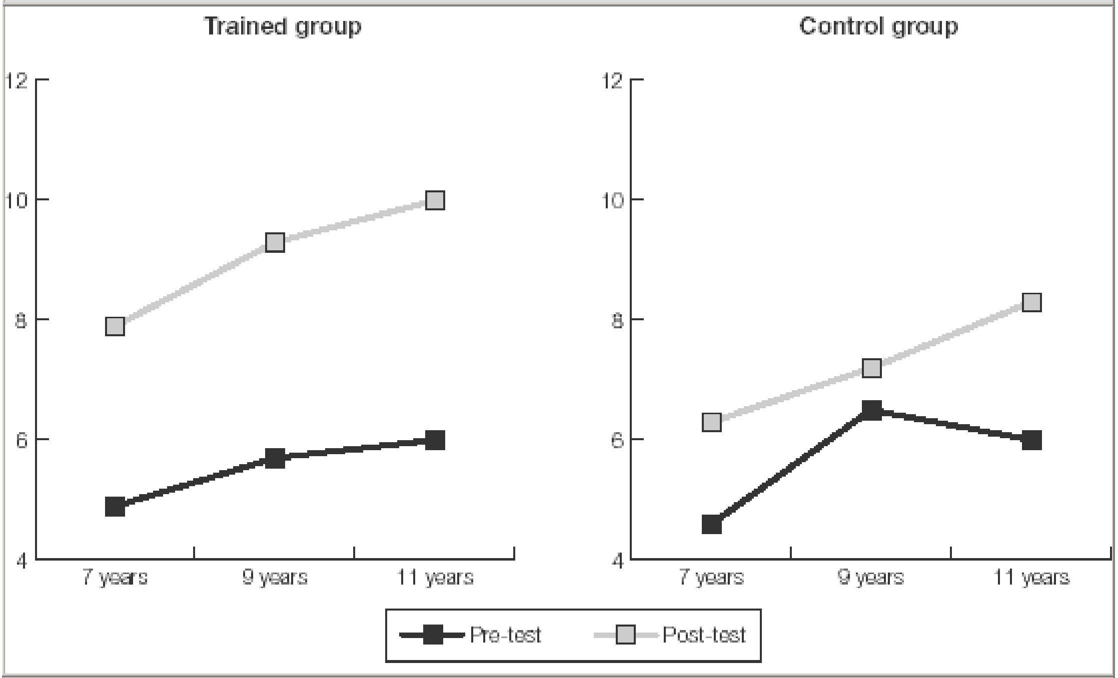


Figure 5.2: Responses to Question 2 (How can you tell?)

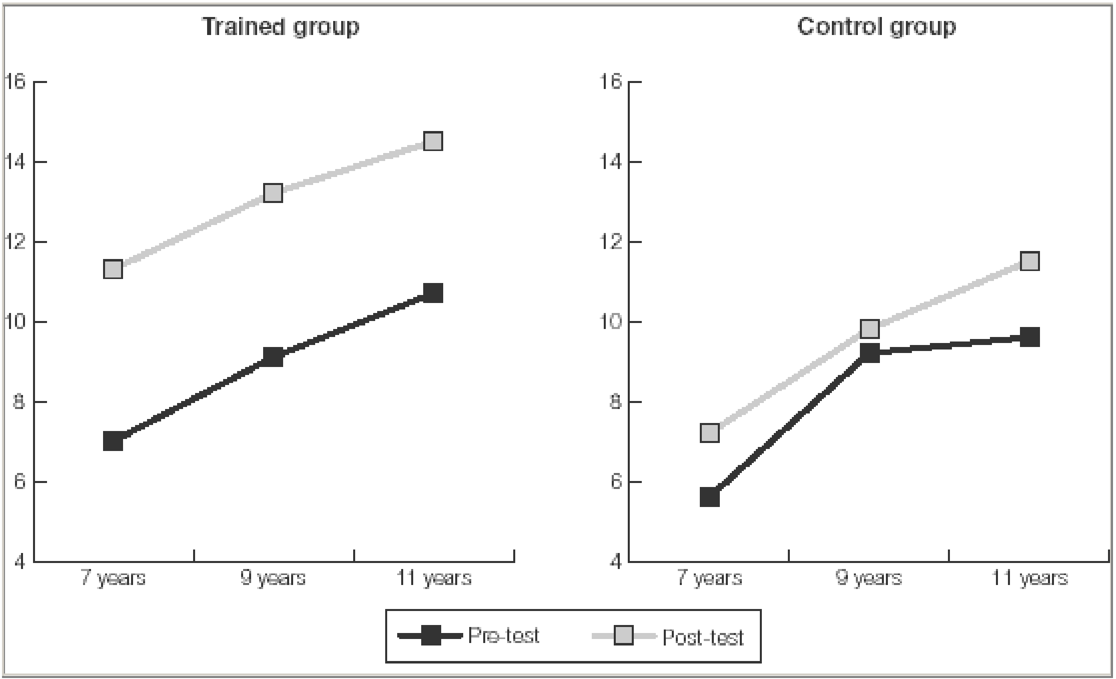


Figure 5.3: Responses to Question 3 (Would it be safe to cross?)

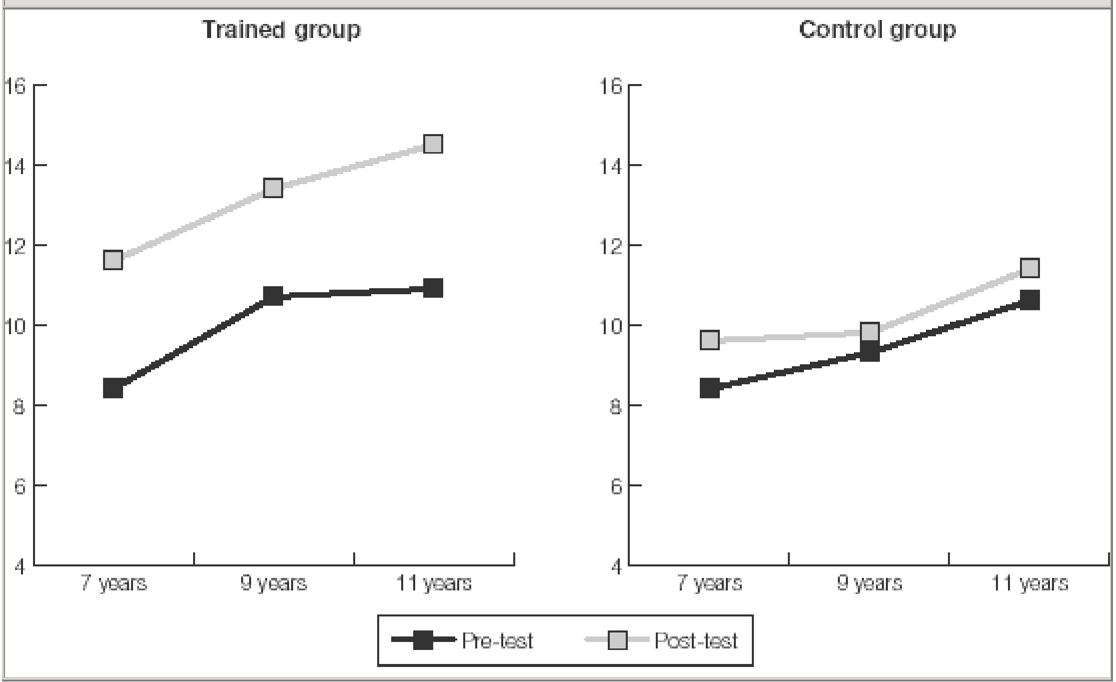


Table 5.3: Mean total score across all three questions as a function of age, group and test-phase-roadside trials only

	TRAINED			CONTROL		
	7 years	9 years	11 years	7 years	9 years	11 years

Pre-test	**4.4**	**5.9**	**6**	**4.9**	**6**	**6.5**
	(1.9)	(2.4)	(1.6)	(2.2)	(1.7)	(1.8)
Post-test	**6**	**7.4**	**8**	**5.2**	**6.1**	**7**
	(2.0)	(2.2)	(1.7)	(2.0)	(1.4)	(1.6)

5.7.2 Effect of training on roadside performance

The previous analysis is based on performance across the two roadside and six computer assessments. The small number of roadside trials is, of course, due to the difficulty of finding (or indeed contriving) roadside scenarios that tap into this particular set of skills. For this reason, we had no option but to include a sizeable number of computer scenarios in the assessment procedure. However, it is possible to do a partial analysis exclusively on the roadside data in order to ensure that the pattern of results reported in Section 5.7.1 is not limited to the computer elements of the task. This would offer reassurance concerning the generalisability of the results.

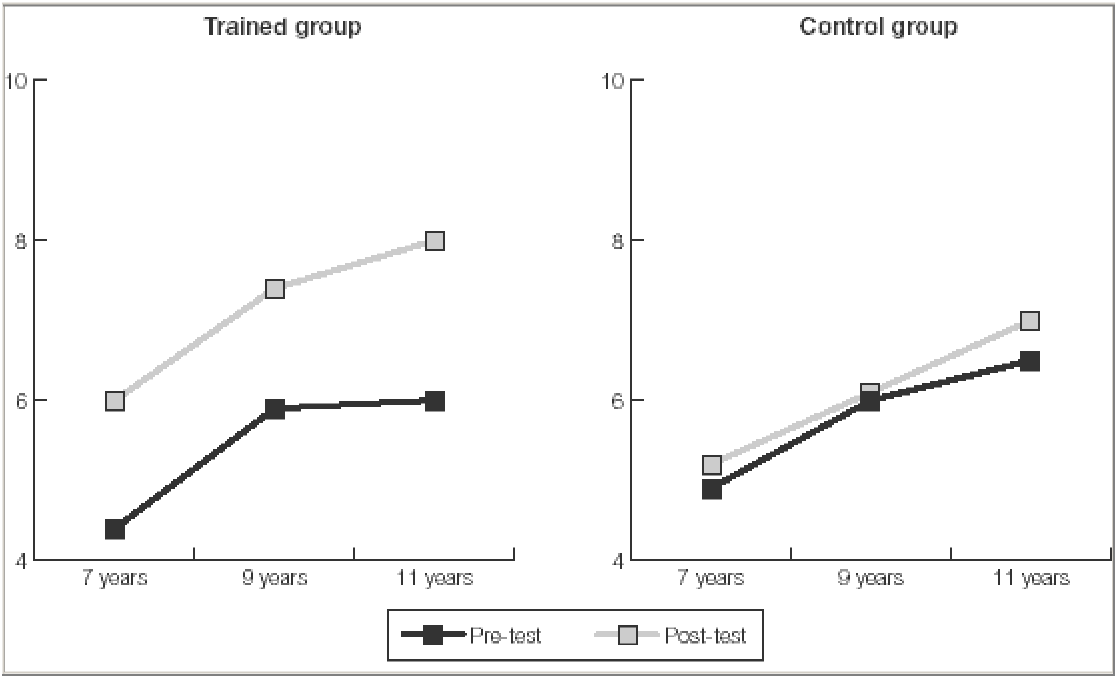
Since only two assessments were made at the roadside, it was decided to compute the data across all three questions, rather than separately as in Section 5.7.1. This would then provide six data points for each child instead of two, increasing the reliability of the data. Table 5.3 and Figure 5.4 present the resulting scores as a function of age, group and test-phase.

It can be seen that the results of the roadside trials closely mirror those obtained from the trials as a whole. Substantial improvements were found in the trained group, with improvements of 37 per cent, 26 per cent and 33 per cent in the 7-, 9- and 11-year-olds respectively. In the control group, by contrast, improvements were minimal (6 per cent, 2 per cent and 7 per cent in each age group respectively. These trends were confirmed by means of three-way ANOVA with age (7, 9, 11), group (trained, control), test-phase (pretest, post-test) as factors. There were significant main effects of age ($F(2, 164)=17.55$, $p<.001$) and test-phase ($F(1, 164)=26.13$, $p<.001$). There was also a significant group by test-phase interaction ($F(1, 164)=13.02$, $p<.001$). Figure 5.4 shows this is because there was no difference between trained and control children at pre-test whereas, at post-test, a substantial difference in performance had emerged. There was no interaction between age and test-phase, showing that the trends applied equally to all three age groups.

5.7.3 Cumulative effects of training

In Chapters 2, 3 and 4 we found evidence of cumulative effects of training as shown, for example, by the priming effect that training on one skill can have on the pre-test performance of a skill introduced subsequently. This effect was particularly clear in the case of roadside search (see Chapter 3), where children who had previously undertaken safe places training started off at a significantly higher level of performance in the pre-test than control children. Since children undertaking training in Skill 4 had all undertaken previous training (in gap timing, in the case of the West End sample; in all three preceding skills, in the case of the East End sample), any cumulative effects on perception of intentions should be revealed in children's pre-test performances.

Figure 5.4: Mean total score across all three questions as a function of age, group and test-phase-roadside trials only



In fact, Table 5.2 and Figures 5.1-5.3 show no evidence of such cumulative effects. Visual inspection reveals that the trained and control groups started off from almost exactly the same baseline levels of performance. Although priming effects were apparent between some of the skills previously taught, this clearly has not carried through to the present skill. We consider possible reasons for this in Section 5.8.

5.8 CONCLUSIONS

The outcomes that emerge from this part of the study offer a highly consistent pattern:

- children of 7, 9 and 11 years can be trained to become more conceptually aware of drivers' intentions: that is, they develop a broader appreciation of drivers' manoeuvring options, and they show greater sensitivity to the cues signalling which possible manoeuvre is most likely in the circumstances;
- they can also be trained to appreciate that drivers' signals do not always match up to their actions and that care must be exercised in interpreting likely actions from those signals. They also become more adept at using information other than conventional signals in clarifying drivers' intentions;
- the preceding improvements also improve the accuracy of children's decisions about whether or not it would be safe to cross the road; and
- training appeared to have much the same effect on all three age groups, with younger children showing much the same proportional improvement as older children.

The latter result is particularly noteworthy, given the widely-held view that children's grasp of intentionality in others is relatively poor. Our data are more consistent with the conclusion of Leekam (1993) that, by the age of 7, children are quite capable of attributing plans and intentions to others and are able to deploy these attributions when making judgements about other people's actions. At the beginning of the present study we anticipated that training on the perception of intentions might best be postponed until children are rather older. The results do not, in fact, warrant this cautious conclusion. It seems that children as young as 7 years would derive benefit from such training. We do not, of course, know how children younger than 7 years would fare.

Finally, we found no evidence that any of the previous training had a cumulative effect on children's learning of Skill 4. This may seem surprising given that, by this phase of the programme, half the children had received training on all three preceding skills. The explanation would seem to lie in the fact that perception of intentions taps into a new and rather different set of processes than the preceding skills. Not only did each of the earlier skills build on each other in clearly defined ways, some of the items deliberately encapsulated material previously dealt with in the preceding skill. By contrast, perception of intentions represents rather a new departure. Its placing as the last skill to be introduced had more to do with the complexity of the problem, and our concern that it might prove too much for younger children, than with a strong conviction that it built explicitly on training undertaken previously. In practice, the concern that younger children might have difficulty in acquiring this set of competences seems ill-founded. However, it does not appear to be the case that the preceding training had any great influence on children's skill acquisition. In that sense, training on perception of intentions does not seem to depend on any of the previous training phases having previously been undertaken.

CHAPTER 6:
Overall conclusions and recommendations

Taken together, the data from the four stages of the evaluation study present highly consistent evidence that the computer-based training programme was a considerable success. The key points to emerge, along with our recommendations for future implementation and use based on these, are laid out below.

- Computer-based training was effective in substantially improving both roadside behaviour and children's conceptual understanding of the traffic environment, producing robust change in all four of the skills dealt with, and in all three age groups. The coupling of behavioural with conceptual change is particularly significant, given the strong support that exists (including that apparent here) for the notion that conceptual grasp is central to the generalisation of behaviour and to the integration of component skills.
- The sole exception to this pattern of advance occurred with the youngest children, the 6-year-olds, on safe places, a slightly surprising outcome given previous evidence of the effectiveness of *roadside* training in safe place location with this age group. However, even here the picture was not wholly negative. There were clear signs that safe places training produced knock-on benefits for the roadside search performance of the 6-year-olds, leaving them more advanced at pre-test, relative to controls, on both direction of attention and understanding of why it should be so directed. This, plus the success of the training with this age group on the remaining three skills, suggests that younger children simply take longer to grasp the connection between the computer simulations and the roadside, rather than that safe places training on the computer is ineffective for them. If this is true, then the initial block of training might apparently work less well whatever skill was involved. It may be important therefore to use more than one run-through of the first block of training with this age group, and to ensure that it takes place in conjunction with roadside training, in order to prime the connection between the two.
- The broad pattern of success described above underlines the point that none of the four skills was too difficult for younger children to grasp, or too easy for older children to show improvement. All age groups progressed to about the same extent for the most part. Thus concerns that perception of intentions would require a level of insight beyond the capacity of younger children (7-year-olds by the time this point in the training programme was reached) proved unfounded. Similarly, the possibility that older children would already be performing at so advanced a level on safe place location that this would leave training redundant was not borne out in practice. This point is important because it puts the pedestrian skill level of 10-11-year-olds in perspective: they may appear proficient in comparison to 6-year-olds, but they plainly have some progress still to make, progress that the computer-based training was capable of engendering. There is, then, no age within the primary school range at which use of any section of the training software would be inappropriate, nor any age at which any section would be especially recommended: it is effective throughout.
- Not only are all sections of the training programme appropriate for all age groups, but there are clear benefits to be gained from children working through the whole package, as is apparent from the cumulative effects reported in the preceding chapters. These were admittedly not entirely uniform in character. Safe places training had positive effects on both behaviour and concepts relating to roadside search, and roadside search training had effects of a similar kind on safe places. For gap timing performance, on the other hand, the effects of previous training were limited to behaviour alone, as were the effects of gap timing training on roadside search. Perception of intentions was yet more of an outlier, with

little or no sign of any boost in performance resulting from previous training, or of training here affecting gap timing skills. This is not entirely surprising: the first three skills interrelate well, and build on each other in clear-cut ways, whereas perception of intentions is more obviously discrete. However, this should not lead to any playing down of the cumulative effects that were obtained. These produced one of the first ever reports of *improvements* at delayed post-test. It is also, in fact, important that the cumulative effects were not more uniform, since this makes it clear that the different components of the training programme are *complementary*, not interchangeable. Both points evidence the value of running the whole programme of training, and in the order employed here, although the use of separate sections would not be without benefit, provided the caveat about the youngest age groups noted above is taken on board.

- There are some other caveats to be noted. Firstly, and most obviously, despite the substantial improvements achieved, the computer-based training programme did not promote anything resembling adult levels of pedestrian skill. It is important, therefore, that it is thought of as assisting children to become more effective - and because of the conceptual advances, more autonomous - *learners*, who it should be recommended are still kept under parental supervision.
- Secondly, whatever its benefits, it would probably be inappropriate to see the computer-based training programme as a solely stand-alone resource. It is difficult to compare its effectiveness to that of roadside training on present data, but our general recommendation would be that it should be used in conjunction with it, rather than as a substitute. This is because roadside training necessarily provides more opportunity for judgements and feedback of directly appropriate form than simulations could ever do, and gaining this experience may, as already indicated, be important to establishing the message of computer-based training in children's minds. At the same time, however, the software plainly offers genuine added value, allowing convenient and effective supplementation of roadside training, and permitting some skills (notably perception of intentions) to be tackled which could not really be addressed at the roadside because of the difficulty of setting up the right conditions.
- There is, moreover, no obvious limitation to its applicability. The two areas from which the evaluation sample was chosen were selected to make this as representative as possible, and to allow the inclusion of a high accident area of the type within which subsequent implementation might be seen as most appropriate, rather than to facilitate formal comparison. As far as legitimate comparison could be made, though (no comparison was possible for gap timing and perception of intentions because the data here were confounded by the change in the West End training sample), there was no evidence of children from one area doing systematically better than the other. Indeed, if anything, there were signs that the training served in itself to equalise the performance of children from different backgrounds, if the evidence of the improvement in the verbal skills of children from the high accident area is reliable.This subsidiary benefit is of no little significance in its own right, and again suggests that there is no scientific reason to restrict implementation to any particular subset of the primary school population.
- Finally, the apparent dependency of the improvement in verbal skills on the child-centred dialogue that took place during training underscores a broader point about the importance of not divorcing the software from the training procedure within which it was employed. There is no reason at all to suppose that putting children in front of the training software on their own would have any benefit whatsoever. On the contrary, the evidence of both past research and the present study is that the success of computer-based training depends on the involvement of *trained adults* capable of setting up the forms of adult-child and child-child

dialogue that promote discussion and learning. It is crucial that any training programme utilising the software is implemented within this framework. However, helping parent volunteers to perform appropriately was not something that was difficult to achieve, because the required interactional style is similar to that naturally used by adults in informal learning situations, and it was well-supported by the designed-in usability of the software. Thus people from very ordinary backgrounds are capable of promoting effective interaction within the training sessions. They need direction in the first instance, though, to bring out this capability, and to emphasise the fact that the trainer's role is not the same as that of a teacher in a formal classroom, which is frequently what they initially suppose it to be.

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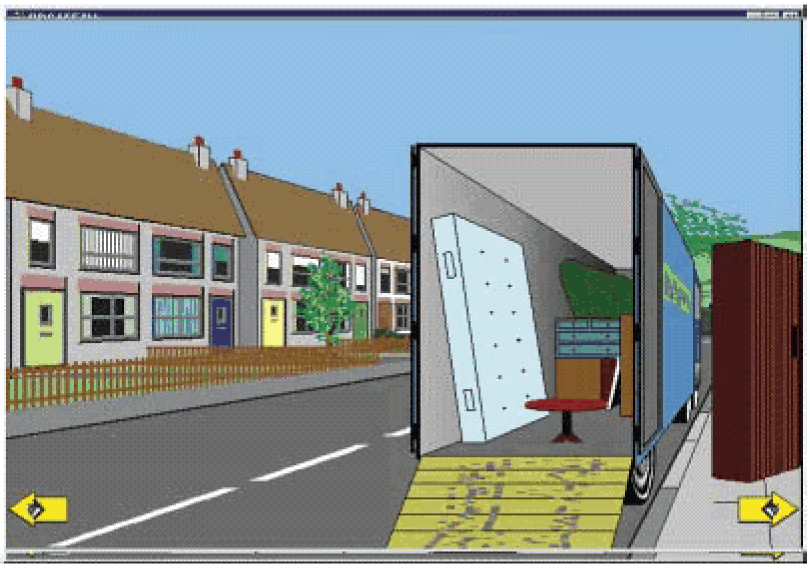
APPENDIX 1 - Safe places


RDSAFETY
Options

APPENDIX 2- Roadside search



APPENDIX 3 -Gap timing

APPENDIX 4 - Perception of intentions

Contents

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