Training children in safe use of designated crossings (No.34)

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Front Cover

Road Safety Research Report No. 34

Training children in safe use of designated crossings

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Executive summary

Despite the intention that they should increase pedestrian safety, designated crossings (that is, marked out points for road crossing such as stand-alone signal-controlled crossings, zebras, and junction lights with a pedestrian phase) are known to be problematic in character (Carsten, Sherborne & Rothengatter, 1998). Bly, Dix & Stephenson (1999), comparing child pedestrian injury events in Great Britain, France and the Netherlands, found that children in Britain face a higher risk when using designated crossings. The most recent figures (2001) on pedestrian casualties for the UK bear out this point, with cases at all levels of severity tending to be more common at designated crossing sites than within 50 metres of them. Whilst the precise reasons for this are unclear, it may be the result of children in Britain also making less use of such crossings, and thus having a poorer grasp of what behaviours are appropriate at these points and why. It would therefore be valuable to ascertain what children do understand about designated crossings, and to attempt to ameliorate any gaps via educational intervention, especially since there has been little previous

work of this kind. Indeed, at present, none of the practical pedestrian training schemes for children in use in the UK address safe use of designated crossings.

Task analysis reveals that safe use of designated crossings is highly complex, involving between 14 and 19 distinct behaviours (depending on crossing type), deployed in three separate phases (preparation to use, looking immediately prior to crossing, and execution). In addition, integration of these elements into a co-ordinated sequence that can be used at different sites almost certainly depends on a conceptual understanding of the specific reasons for engaging in each of them. Given this complexity, it would perhaps be unsurprising if children's road-crossing performance at designated crossings were poor. It also raises questions, though, about what forms of educational intervention would be helpful. Practical training methods (that is, where children make actual crossing decisions and related judgements under supervised and structured conditions, and receive feedback on the adequacy of those decisions and judgements) have been shown to be effective in improving pedestrian skills in children as young as 5 years (Thomson & Whelan, 1997). Moreover, the emphasis these methods place on learning via the shaping of behaviour in context is particularly suited to the complexity of designated crossings.

However, in this instance carrying out training of this kind at the roadside might well be problematic because of a conflict between the need for diverse experiences to build up flexible skills, and the geographical distances likely to be involved in visiting a range of sites. There is therefore a strong case for developing computer-based training materials for building up designated crossing skills, in view of their capacity to capture diversity in a more manageable way. Materials of this form have already been demonstrated to be effective in improving generic pedestrian skills in primary age children, when used as a focus for decision-making informed by discussion, amongst small groups of children working under the guidance of an adult trainer (Tolmie, Thomson & Foot, 2000; Tolmie, Thomson, Foot, Whelan, Sarvary & Morrison, 2002).

The main objectives of the present project were therefore:

- to develop software for computer-supported training of primary age children in safe use of the main types of designated pedestrian crossings (pelicans/puffins/toucans, zebras, and junction traffic lights with pedestrian phases); and
- to evaluate the effectiveness of this training by implementing it with samples of children aged 6, 8 and 10 years, pre-testing these children at the roadside to establish their baseline capabilities, post-testing them to measure changes in performance, and comparing these changes with those exhibited over the same period by untrained control samples of the same age, and with the performance of adults

The training software developed during the first stage of the project was designed for use by groups of three children working with an adult trainer. It consisted of four sets of simulated traffic problems presented on a standard PC, one set to be used in each of four training sessions. Each set took the form of a route (for example, between home and school) which children had to help an on-screen character to navigate, traversing as they did so a mixture of four to five designated crossings, starting with basic instances of each, and then moving on to variations on these. All instances were based on photographs of real sites, to ensure that training related to crossing features that children could reasonably be expected to encounter in real life. A high degree of flexibility was built into the software, so that children could make the character move and look wherever they wished. The intention was that feedback on these actions from the software itself and from the trainer would assist children towards enacting appropriate behaviours (as defined by task analyses) in the right sequence, and discussing the underlying reasons for these. In this way, they would build up a generalised conceptual grasp of what each type of crossing requires.

Evaluation of the effectiveness of training using the software was carried out via an implementation of the full programme with children aged between 5 and 10 years in two locations, West Dunbartonshire and Gateshead. Within each location, approximately 30 children from each of three age groups, 5-6-, 7-8- and 9-10-year-olds, worked through four training sessions over a four to five-week period at the rate of roughly one session per week. Training took place within schools, with children being taught in groups of three by project researchers. The effectiveness of this training was established via individual pre- and post tests, conducted at the roadside, on children’s use of pelicans, zebras and junction traffic lights with a pedestrian phase. These tests focused on four instances of each crossing type, children being asked in each case to ’take the researcher across at the crossing’, during which the latter noted whether the specific actions that would form part of an ideal crossing strategy were performed. Children were also asked a series of questions designed to tap into key areas of conceptual understanding for each crossing type. At both pre- and post-test, crossing behaviour and conceptual grasp amongst children in the trained sample were compared to that exhibited by matched controls (approximately 15 in each age group in each location) who had received no training. Data was also collected from a sample of adults, using the same procedures, as a means of establishing how far trained children had progressed towards the normal developmental end point.

Analyses showed that at pre-test, whilst there were clear progressions with age in the extent to which children showed appropriate behaviours on each crossing type, even amongst the oldest group performance was at far from ceiling levels. On stand-alone signal-controlled crossings and junctions in particular, use of effective looking strategies (a crucial element) was very poor amongst 6- and 8-year-olds, and was still comparatively low amongst 10- year-olds. Adult performance, though far from ideal, was notably better. Conceptual grasp broadly reflected these trends, and conceptual and behavioural performance were found to be only weakly correlated. At post-test, around two months after training, the picture had altered substantially, with significant improvements on pre-test performance being found in all areas, including looking behaviours, and for all age groups, with these improvements being significantly greater amongst the trained children, especially as regards perceptual strategies and conceptual understanding. More importantly, not only did behavioural performance and conceptual grasp both improve, in two out of the three crossing types they became more highly correlated, suggesting that understanding and action had become more co-ordinated as a result of training, a central requirement for flexible deployment of what had been learnt, and for future learning.

All in all, the results of the evaluation are very positive, and serve to confirm the potential for computer-based training of children in safe use of designated crossings, provided this training follows the appropriate format. Whilst training by no means brought children to ceiling levels of performance, the improvements they exhibited were based solely on two hours activity and were robust enough to show up two months later. At the same time, there is obviously some scope for extending the impact of the training programme. Some minor modifications to the software itself were identified as desirable on the basis of the evaluation, and have since been enacted. Refinements in the issues that should be emphasised by trainers have also been identified. One other possibility that may be worth exploring would be combining the computer-based sessions with supervised roadside deployment, given that the latter would seem to have a contributory role to play going by the modest but nevertheless measurable behavioural improvements shown by the control sample simply as a result of being tested twice. Finally, since there were signs that the training worked best when it was able to build on a certain amount of prior conceptual understanding, it is recommended that the programme be targeted particularly at children in the later primary school years who have already been through more generic training in pedestrian skills. This is also the age group that stands in most need of training in use of designated crossings, since they are likely to have to encounter them unsupervised after the transition to secondary school.

1. Background and objectives

1.1 Background

Despite the intention that they should increase pedestrian safety, designated crossings (that is, marked out points for road crossing such as stand-alone signal-controlled crossings, zebras, and junction traffic lights with a pedestrian phase) are known to be problematic in character (Carsten, Sherborne & Rothengatter, 1998). Bly, Dix & Stephenson (1999), comparing child pedestrian injury events in Great Britain, France and the Netherlands, found that, relative to their peers, children in Britain appeared to face a higher overall risk of collision with a vehicle when using designated crossings. This pattern was by no means uniform, the level of heightened risk being found to vary with crossing type: for stand-alone signal-controlled crossings, for instance, there was actually a lower risk in Britain than in France and the Netherlands, though this was the only category where this was the case. Moreover, it is probably attributable in part to the fact that in a sizeable percentage of the injury cases examined by Bly *et al*., traffic calming and designated crossing measures had been installed *after*the injury event, giving rise to false associations between collisions and site characteristics. Nevertheless, the most recent figures for pedestrian casualties in the UK (that is for 2001) bear out the association between designated crossings and increased risk. For zebras, injuries at all levels of severity were more frequent at the crossing site than within 50 metres of it; for pelicans, the same was true for killed and slightly injured; and for light-controlled junctions, it was true for seriously injured. Thus, especially given the ’officially’ sanctioned nature of designated crossings and the aura of safety they carry in the minds of parents and teachers, the possibility that there might be a genuine problem underlying these findings merits closer examination. In particular, Bly *et al*. also report that children in Britain characteristically make less use of designated crossings than children in France and the Netherlands, which may mean that they have a poorer understanding of what behaviours are appropriate at these points and why, resulting in an increase in risk. It would therefore be valuable to ascertain what children in the primary age range in particular do in fact understand about designated crossings, and to attempt to ameliorate any gaps in their understanding via educational intervention.

Curiously, despite the official character of designated crossings, there has been almost no previous educational work aimed at investigating or promoting their safe use by children. This may be because the infrastructure of designated crossing sites is assumed to make their use self-evident, it being concluded that they therefore naturally give rise to safer patterns of pedestrian-traffic interaction. Even if this were so only for adults, it would, for instance, enable parents to provide guidance to their children without need for further intervention, and would also lead drivers to regulate their behaviour at such sites more automatically to the presence of pedestrians, both adult and child. However, even cursory analysis reveals that appropriate use of designated crossings is in fact a highly complex matter, involving a number of distinct behaviours, deployed in three separate phases (preparation to use, looking immediately prior to crossing, and execution). Moreover, these different elements must be integrated into a co-ordinated sequence that can be modified as specific circumstances vary. Skilled use therefore almost certainly depends on some form of conceptual understanding of the reasons for engaging in each behaviour, and hence when it is needed and when it is not. Such complexity may be invisible to experienced pedestrians, for whom the behaviours are well-practiced and thus semi-automated, and yet still present a bewildering set of demands for the novice. It should perhaps be noted that the same point may apply to engineering measures more generally: these might often not be as behaviourally transparent as they are assumed to be by those who are familiar with their design.

Given the complexity of designated crossings, it would be unsurprising if children's road crossing performance at these sites were in fact poor, although it remains of course to be ascertained that this is the case. If it is poor, however, this complexity also raises questions about the forms of educational intervention that may be helpful. Informational measures of any kind are highly unlikely to be effective, since, as with any complex skill, acquisition of the necessary behavioural co-ordination would depend primarily on the actual execution of the behaviours in question and their adjustment in the light of resulting feedback. A more plausible approach would thus be to use practical training methods, where children actively make crossing decisions and related judgements under supervised and structured conditions, and receive feedback on the adequacy of those decisions and judgements in iterative cycles. Such methods have been shown to be effective in improving pedestrian skills in children as young as 5 years (Thomson & Whelan, 1997), and the emphasis they place on learning via the shaping of behaviour in context seems particularly well-suited to the complexity of designated crossings. At present, though, none of the practical training schemes in use in the UK address safe use of crossings.

The use of practical training methods to teach safe use of designated crossings is not entirely straightforward, however. First of all, in the absence of any previous systematic analysis, a precise specification of what constitutes an ideally safe pattern of behaviour for each type of crossing is required, in order to determine the objectives of training. These specifications are also crucial for the development of measures of children's baseline performance in the absence of training, and any improvement they show following training. Secondly, as noted above, flexible deployment of these behaviour patterns, whatever their character, is likely to depend on a conceptual understanding of why each element is being performed. Training in behavioural procedures alone will therefore not suffice: space must be found within the training programme to promote conceptual grasp alongside behavioural adjustment. Thirdly, a minimum requirement for building up this conceptual grasp will be the availability of a sufficiently diverse range of experiences to encourage explicit comparison and generalisation (see Karmiloff-Smith, 1992). Carrying out training at the roadside (the natural context, and the one employed in most previous work on practical training) might well be problematic, therefore, simply because of the distances involved in visiting a range of sites of the appropriate kind.

The last point suggests that there is a strong case for utilising computer-based training materials to help promote the development of designated crossing skills, in view of their capacity to capture diverse experiences in a more manageable way. This approach may also, however, have additional advantages for building up conceptual grasp, since it more readily allows the creation of well-structured and supported spaces for discussion around behavioural procedures, ensuring that explicit comparison and generalisation actually occur.

Consistent with this, computer-based training materials have already been demonstrated to be effective in improving both the behavioural and conceptual aspects of generic pedestrian skills amongst primary age children, *provided* they are used as a focus for decision-making informed by discussion, amongst small groups of children working under the guidance of an adult trainer (Tolmie, Thomson & Foot, 2000; Tolmie, Thomson, Foot, Whelan, Sarvary & Morrison, 2002). In particular, Tolmie *et al*. (2000) showed that optimal behavioural and conceptual growth depended on this combination of adult guidance and peer collaboration, central to which was a gradual shift, as training progressed, from an adult-child mode of interaction to a child-child mode. Thus, learning was greatest when the trainer initially took a proactive role, leading children towards appropriate actions, offering explanations and encouraging discussion, and then retreated into the background, as children themselves took over the role of making suggestions, offering explanations, and comparing different experiences (see Tolmie *et al*., 2000, 2002, for more detailed discussion). Tolmie *et al.* (2002) refined this approach by developing computer-based tasks for the training of four pedestrian skills in which resources were provided to assist adult guidance and deliberate spaces were created for child discussion across series of problems of gradually increasing difficulty. Training using these materials produced across-the-board improvements in the roadside behaviour and conceptual grasp of 6- to 11-year-olds which were robust at delayed post-tests three to eight months later.

An extension of the methods used by Tolmie *et al.* (2000, 2002) would thus appear to be particularly appropriate for training children in the safe use of designated crossings. At the same time, previous computer-based training materials have focused more on unitary judgements and behaviours, such as deciding when it is safe to cross a road; and have used schematic simulations to provide the context for these judgements, with much of the direct feedback on children's decisions provided by the software itself. The need to co-ordinate a *sequence* of behaviours and to deal with fairly exact exemplars of physical infrastructure as part of training in designated crossings poses a greater challenge for the design of comparable resources. In particular, on-screen representations of crossing sites would have to be less schematic, and yet not so detailed as to be too 'busy' and therefore counterproductive (see Tolmie, Thomson, Foot, McLaren & Whelan, 1998, on the benefits of schematic over video images of traffic environments in the design of simulations). A second point is that there is also a need to allow children undergoing training to exercise much greater flexibility of action than has been the case in previous resources, so that they can explore the potential role of various behaviours. This makes it correspondingly harder to program the software itself to provide feedback, since it means allowance would have to be made for a very wide range of options. The function of the trainer in generating feedback is likely to become more central, therefore. For this reason, it would be more appropriate to use researchers as trainers in the first instance (rather than parent volunteers, as in Tolmie *et al*., 2002), in order to establish the key elements of trainer input empirically, as opposed to making a priori decisions on these. As a counterweight to this, it would be desirable to carry out evaluation of the effects of training across different locations, in order to demonstrate stability of outcome, and that this did not depend on individual researchers' skills. As in Tolmie *et al.* (2002), this evaluation would necessarily include testing of children in real contexts, in order to confirm the transfer of learning from computer to roadside.

1.2 Objectives of the project

The objectives of the present project were therefore as follows:

- to conduct a task analysis of each of the three main types of designated pedestrian crossing, *pelicans*(and the newer variants of these, *puffins*and *toucans*), *zebra s*, and *junction traffic lights with a pedestrian phase*; and on this basis to develop detailed specifications of crossing strategies or safe patterns of behaviour for each type, together with the conceptual rationale underlying the elements of these strategies;
- taking use of these strategies and an understanding of their purpose as the goal of learning, to develop software for computer-supported practical training of primary age children in safe use of these types of designated crossing, utilising as far as possible the design principles employed for the training

software described by Tolmie *et al*. (2002);

- to establish, by means of roadside testing on each of the three crossing types, the baseline performance and conceptual grasp, relative to adults, of children aged 6, 8 and 10 years from two different geographical locations; and
- to evaluate the effectiveness of the computer-supported training in designated crossings by implementing it with the same samples of children, post-testing them to measure changes in performance and conceptual grasp, and comparing these changes with those exhibited over the same period by untrained control samples of the same age and background.

2. Strategies for designated crossings

2.1 Development of the crossing strategies

2.1.1 Preliminary considerations

Given the range and diverse nature of designated crossings, it was felt that a number of key considerations should guide the process of strategy development. These can be summarised as follows.

- *The strategies should be as internally consistent as possible* . It was considered crucial that elements introduced into any one crossing strategy (for example, stand-alone signal controlled crossing) should not conflict with elements introduced into another (for example, zebras). As far as possible, the different strategies should be underlain by *a common generic structure* so that each individual strategy would be an extension (or abbreviation) of the others. Strategies would thus complement rather than conflict with each other.
- *Each strategy would focus on a clearly specified set of actions together with the order in which these should ideally be executed* . Acquisition would therefore involve learning to behave correctly in actual or simulated traffic environments. It would not involve verbal learning or memorisation of rules, nor would ability to recite the strategy serve as evidence of competence.
- *Strategies should embrace some degree of flexibility. They should not consist of rigid rules* . This follows in part from the degree of variation to be found even within a single crossing category (for example, stand-alone signal-controlled crossing), and the consequent need to acquire adaptable behavioural strategies. However, it also reflects children’s well-documented tendency to apply rules in an excessively intransigent and literal manner. At the same time it would be necessary to avoid vagueness since this too gives rise to inappropriate application of taught elements (cf. the Green Cross Code). Finding an appropriate balance between these considerations would be an important goal of strategy development. It would also play a key role in developing training methods.
- *Children should not be taught strategies in isolation from other aspects of traffic decision-making* . In particular, attention should be paid to issues such as *why* and *when* designated crossings should be used. Training would therefore have to include aspects of route planning: it could not be restricted to the purely ’mechanical’ aspects of crossing, as if designated crossings were structures that simply ’popped up’ from time to time.

Finally, whilst the strategies would focus on a series of decision/action steps and their correct sequencing, it was recognised that training would also have to focus on *children’s conceptual understanding of the purpose*underlying each of the elements being taught, as the central means of promoting flexible behaviour. In devising the strategies, thought would therefore need to be given at the outset to the conceptual issues arising from each proposed element and how these might be addressed during training.

2.1.2 Task analyses and derivation of strategies

Following discussion with Department for Transport (DfT) Road Safety Division, engineering experts at DfT and other road safety professionals, it was decided that strategies should be developed for three classes of designated crossing. These would encompass most of the structures children would likely meet and, between them, would lay an appropriate foundation for dealing with any other variations that might be encountered. The focus would be on the following broad classes:

- pelicans, puffins and toucans (that is, stand-alone, light-controlled crossings, respectively without sensors for detecting pedestrian and vehicle presence; with sensors; and jointly for pedestrians and other non-vehicular road users, typically cyclists);
- zebras (that is, non-light controlled crossings); and
- light-controlled junctions with a pedestrian-called phase.

Strategies for use of each of these three classes of crossing were devised on the basis of task analyses of the logical sequence of actions required at each type of site to execute a crossing in an ideally safe fashion. The conduct of these analyses was assisted by technical documentation provided by DfT on the infrastructure of each class of crossing and its intended operation (see Appendix 1 for a listing). It was recognised that the results of these analyses would probably not reflect the actions typically carried out by *adults*when making use of designated crossings, since they are likely to have arrived at workable behavioural shortcuts on the basis of experience and a rich knowledge of cues to likely driver behaviours. The inclusion of an adult sample for purposes of comparison in later testing would of course serve to establish how far this was actually the case. The key point, however, was that it was imperative to train children in strategies which were maximally safe, since they would inevitably lack the experience to perform at adult levels of adaptation to circumstances. In other words, they need to acquire strategies that could be applied with a measure of flexibility (for example, taking into account differences in the location of the pedestrian signal between pelicans and puffins - on the far side and near side respectively), but which avoid taking unnecessary risks under all conditions.

2.2 Detailed outlines of the crossing strategies

The behavioural/decision-making elements for each of the three strategies are specified in Tables 2.1 to 2.3 overleaf, together with the corresponding conceptual issues it was felt would need addressing. Each element consists of a fairly distinct action whose presence or absence would be relatively easy to detect during training and testing. Whilst the strategies look quite long (consisting of between 14 and 19 elements), in practice some of these are alternatives while others go together to form natural sub-groups (for example, Elements 5-8 of the pelican/puffin/toucan strategy). While *memorising*19 elements would certainly prove complex for most of the children, we anticipated that learning the elements *behaviourally*would pose much less difficulty. The results of teaching other strategies (for example, crossing near parked cars in Thomson & Whelan, 1997) were consistent with this view. This is, of course, one reason why practical training is superior to rule-based learning.

It was stressed earlier that the strategies should be as consistent as possible and share a common structure so that they would extend or abbreviate each other rather than being completely independent. Examination of the strategies will show that they do indeed have many elements in common and few points of conflict.

Where a conflict is unavoidably present, this is flagged as a conceptual issue to be addressed in training. For example, in the pelican/puffin/toucan strategy children are encouraged to listen for the auditory signal that accompanies the Green Man. However, at a signal-controlled pedestrian phase at a junctions this signal is not always present. The divergence is therefore stressed as a point for discussion between trainer and children when the latter strategy is being taught. In this way, provision was made for addressing potentially confusing messages in the different strategies.

Table 2.1

Crossing strategy for pelicans, puffins and toucans	
Desired behavioural elements	Conceptual issues
1. Approaches crossing at moderate walking speed. Looks for and locates pedestrian request button (on the post to left or right of the crossing).	Child must understand possible locations of request button, what it looks like, etc.
2. Looks at pedestrian light to see if man is RED, GREEN or FLASHING GREEN/BLANK (near-side or far-side).	Child must understand what these signals mean for the pedestrian. Also what the implications are for drivers. Especially important to understand the potential ambiguity of FLASHING GREEN - what the corresponding flashing amber is supposed to mean to drivers (but also what drivers may take it to mean in practice).
3. IF FLASHING GREEN/BLANK... Does not attempt to cross, but goes to 5.	Child must understand why you cannot take a chance by hurrying across on flashing green/blank. Relates to the reduced time available before the light switches to red, but also relates back to the ambiguous message that flashing amber signals to drivers.
4. IF GREEN... Moves to position at 7, then goes to 9.	No conceptual issues, other than those addressed at 7.
5. IF RED or FLASHING GREEN/BLANK... Takes up position by the request button.	Child must understand the need to be adjacent to the request button not only so that they can press it, but also to signal to drivers an intention to cross, allowing drivers to anticipate the light change.
6. Presses request button and ensures that 'WAIT' light comes on (or checks that this has been done and the light is illuminated).	Need to stress that light may not come on (sometimes broken). In this case, press button again and wait. Also child should be aware that if 'WAIT' light is already illuminated (because request button has been pushed by someone else) there is no need to push the button again.

7. Stands on pavement close to (but not on) the kerb, with the crossing directly ahead.	Child must understand that this puts space between them and passing traffic - especially large wing mirrors on buses, etc. Child also needs to know that the defining characteristics of the crossing can vary (barriers, studs, white markings, etc.) - and that with toucans, at a minority of sites the pedestrian crossing may be distinct from the crossing for bikes (marked with a bike symbol).
8. Remains still and alert whilst waiting for Red Man to turn to Green Man. Listens for auditory signal.	Child needs to understand why standing still and not wandering around is important (because of the signal it sends to drivers about intention to cross, and because of the need to register a presence on the sensors where these are present). Also needs to be attuned to the time s/he is likely to have to wait. Since children are impatient, priming them for waits of a realistic duration will be important (the training software will be able to do this).
9. When light turns green and auditory signal sounds, looks RIGHT to check that vehicles are stopping. If there is more than one lane, ensures that the lead vehicle in each lane is stopping. When all salient vehicles have stopped...	Auditory signal needs to be explained. Importance of focusing on LEAD VEHICLES needs to be understood (the importance is that, if the lead vehicle has stopped, all subsequent vehicles must also stop. Child doesn’t need to wait until every vehicle in the approaching queue has reached a steady state - just the lead vehicles, which control the movements of all other vehicles). If there is more than one lane in each direction, the importance of looking for partially obscured vehicles approaching in the outer lanes will be stressed. The training routes will contain examples with different numbers of lanes, so that children will gain experience of these different types and how to deal with them. Child also must be able to judge when distant vehicles are so far away that crossing can be completed before they arrive.
10. Looks LEFT to ensure that vehicles are stopping. If there is more than one lane, ensures that the lead vehicle in each lane is stopping. When all salient vehicles have stopped...	Same issues.
11. Looks RIGHT again to double check leading vehicle(s) are stationary.	Same issues.
12. Looks at pedestrian light to check it is still showing Green Man.	The child must understand the need to check that steps 9-11 have not taken them so long that the static Green Man signal has changed.
13. If all leading vehicles are stationary, then steps out promptly, and walks smartly across the road.	Child needs to understand importance of not dawdling, as well as importance of not running.

14. Keeps looking and listening to ensure traffic remains stationary.	Child must be aware of need to keep looking and listening to check for possible mistakes or impatience from drivers.
15. Remains between road studs or white lines at all times.	Child needs to understand that the middle of the crossing is always safest, as it maximises distance from vehicles approaching from both directions. Also that the function of the crossing is to create a temporary safe haven (that is, only when the Green Man is illuminated). During this time, they will only have priority if they remain within the crossing.
16. Mounts far pavement midway between studs, white lines, barriers.	Child needs to understand that priority is restricted to the crossing itself and that significant risk adheres to abandoning it before the far kerb is reached.
17. Moves to inside of pavement before continuing journey.	Needs to understand that this places child away from traffic, and avoids obstructing other users of the crossing.
18. If Green Man starts flashing/ signal goes blank whilst on crossing, continues to walk smartly to far kerb. Monitors traffic carefully to ensure it remains stationary.	The significance of flashing green again, and what this means about changing priorities.
19.If Green Man flashes/signal goes blank BEFORE starting on crossing, goes to 6.	As 18.

Table 2.2

Crossing strategy for zebra crossings	
Desired behavioural elements	Conceptual issues
1. Approaches crossing at moderate walking speed.	Child must not rush up to the crossing or behave precipitately because zebras often involve negotiation between pedestrians and drivers which takes time.
2. Takes up position at the crossing (defined by road markings, kerbside barriers, road studs, etc, directly ahead).	Child must understand importance of positioning well within the crossing. Must also understand that positioning signals child’s intentions to drivers.
3. Stands on pavement close to (but not on) the kerb.	Child must understand that this puts space between them and passing traffic - especially large wing mirrors on buses, etc.

4. Looks RIGHT to check for approaching vehicles. Ensures that vehicles are stopping. If there is more than one lane, checks that the lead vehicle in each lane is stopping.	Child must understand importance of looking for signs that vehicles are slowing down (signals their intention to stop). Importance of focusing on LEAD VEHICLES (because, if the lead vehicle has stopped, all subsequent vehicles must also stop). Child doesn't need to wait for every vehicle in the approaching queue to reach a steady state - just the lead vehicles. If there is more than one lane in each direction, the importance of looking for partially obscured vehicles approaching in the outer lanes also needs to be understood. Child also must be able to judge when distant vehicles are so far away that crossing can be completed before they arrive.
5. Looks LEFT to check for approaching vehicles, and that vehicles are stopping. If there is more than one lane, checks that the lead vehicle in each lane is stopping.	Child must understand importance of looking for approaching vehicles in BOTH directions. Otherwise same issues as 4.
6.Looks RIGHT, and engages eye contact with the leading driver(s).	Child must understand importance of making eye contact with the nearest leading driver(s), as a signal confirming that the child's intention to cross, and that driver has seen them and intends to stop.
7. Continues looking RIGHT until all salient traffic has stopped.	Child must understand importance of waiting to confirm that vehicles have actually stopped before crossing, and that there has been no misinterpretation of cues.
8. Looks LEFT to confirm all salient traffic is stopping.	Same issues as 7.
9. Looks RIGHT again to double check leading vehicle(s) are stationary.	Child must understand the need to check that step 8 has not taken them so long that the lead driver(s) on the right has changed their mind about waiting.
10.If all leading vehicles are stationary, then steps out promptly, and walks smartly across the road.	Child must understand importance of not dawdling, as well as importance of not running.
11. Keeps looking and listening to ensure traffic remains stationary.	Child must be aware of need to keep looking and listening to check for possible mistakes or impatience from drivers.
12. Remains on crossing area at all times.	Child must understand that the middle of the crossing is always safest, as it maximises distance from vehicles approaching from both directions. Also that the function of the crossing is to create a temporary safe haven. During crossing, they will only have priority if they remain on the crossing.

13. Mounts far pavement midway between studs, barriers.	Child must understand that priority is restricted to the crossing itself and that significant risk adheres to abandoning it before the far kerb is reached.
14. Moves to inside of pavement before continuing journey.	Child must understand that this places child away from traffic, and avoids obstructing other users of the crossing.

Table 2.3.

Crossing strategy for junctions with pedestrian-called phase	
Desired behavioural elements	Conceptual issues
1. Approaches crossing at moderate walking speed. Looks for and locates pedestrian request button (on the post to left or right of the crossing defined by kerbside barriers, road studs, white lines).	Child must understand possible locations of request button, what it looks like, etc.
2. Looks at pedestrian light to see if man is RED, GREEN or BLANK.	Child must understand what these signals mean for the pedestrian. Also what the implications are for drivers. It may be important for the child to be aware that there is no FLASHING GREEN phase on these signals.
3. IF GREEN... Moves to position at 6, then goes to 8.	No conceptual issues, other than those addressed at 6.
4. IF RED or BLANK... Takes up position by the request button.	Child must understand the need to be adjacent to the request button so that they can press it.
5. Presses request button and ensures that ’WAIT’ light comes on (or checks that this has been done and the light is illuminated).	May need to stress that light may not come on (sometimes broken). In this case, press button again and wait. Also child should be aware that if ’WAIT’ light is already illuminated (because request button has been pushed by someone else) there is no need to push the button again.
6. Stands on pavement close to (but not on) the kerb, with the crossing directly ahead.	Child must understand that this puts space between them and passing traffic - especially large wing mirrors on buses, etc. Child also needs to know that the defining characteristics of the crossing can vary (barriers, studs, white markings, etc.).

7. Remains still and alert whilst waiting for Red Man to turn to Green Man.	Child needs to understand why standing still and not wandering around is important (because of the signal it sends to drivers about intention to cross). Also needs to be attuned to the time s/he is likely to have to wait. Since children are impatient, priming them for waits of a realistic duration will be important.
8. When light turns green, looks at all roads in sequence beginning with the RIGHTMOST (which may be behind). Continues round anticlockwise to check that vehicles are stopping. If there is more than one lane, ensures that the lead vehicle in each lane is stopping.	Importance of sequence of looking needs to be explained, that is start with traffic that is nearest to point of crossing and then move round. Child needs in particular to understand that the nearest traffic to the point of crossing may be behind them. Importance of focusing on LEAD VEHICLES also needs to be understood (the importance is that, if the lead vehicle has stopped, all subsequent vehicles must also stop. Child doesn't need to wait until every vehicle in the approaching queue has reached a steady state - just the lead vehicles, which control the movements of all other vehicles). If there is more than one lane in each direction, the importance of looking for partially obscured vehicles in the outer lanes is stressed.
9. Keeps looking round in sequence until all salient traffic has stopped.	The child needs to be aware that vehicles in the distance which are still moving are NOT relevant to the task, even where these are the effective lead vehicle, since the crossing would be completed before these arrived at the crossing. Otherwise same issues as 8.
10. Looks round in sequence again to double check leading vehicle(s) are stationary.	Same issues as 8.
11. Looks at pedestrian light to check it is still showing Green Man.	The child must understand the need to check that steps 8-10 have not taken them so long that the Green Man signal has changed.
12. If all leading vehicles are stationary, then steps out promptly, and walks smartly across the road.	Child must understand importance of not dawdling, as well as importance of not running.
13. Keeps looking and listening to ensure traffic remains stationary.	Child must be aware of need to keep looking and listening to check for possible mistakes or impatience from drivers.
14. Remains between road studs or white lines at all times.	Child needs to understand that the middle of the crossing is always safest, as it maximises distance from vehicles approaching from both directions. Also that the function of the crossing is to create a temporary safe haven (that is, only when the Green Man is illuminated). During this time, they will only have priority if they remain within the crossing.

15. Mounts far pavement midway between studs, white lines, barriers.	Child needs to understand that priority is restricted to the crossing itself and that significant risk adheres to abandoning it before the far kerb is reached.
16. Moves to inside of pavement before continuing journey.	Needs to understand that this places child away from traffic, and avoids obstructing other users of the crossing.
17. If Green Man changes to Blank or Red Man whilst crossing, continues to walk smartly to far kerb. Monitors traffic carefully to ensure it remains stationary.	The child needs to be aware that, provided they continue straight across, they will have time to complete the crossing before the traffic begins moving.
18. If Green Man changes to Blank or Red Man BEFORE starting on crossing, goes to 5.	Child must understand that you cannot take a chance by hurrying across at this point.

3. Software design

3.1 Overview of content and intended use

The development of the computer-based materials for training children in the use of designated crossings was informed both by the crossing strategies for pelicans/puffins/ toucans, zebras and junction traffic lights outlined in Section 2.2, and by the design principles employed in the training software described in Tolmie *et al.* (2002) (see Section 1.1). The intention was to produce a resource that would function as far as possible in the same manner as the earlier software, but with content aimed at promoting acquisition of the crossing strategies, together with a grasp of their conceptual foundations. Given the success that had been achieved previously by blending support for adult guidance and peer collaboration, this entailed once again developing software for use by small groups of children (ideally three) working with an adult trainer. Similarly, this software had to include explicit support for trainer guidance on key points, whilst employing a task structure which enabled children to take the lead in decision-making and provided space for child-child discussion.

As noted in Section 1.1, there were, however, aspects of designated crossing training which necessitated a departure from strict equivalence with the design of the earlier software. First of all, there was a need to ensure strict accuracy of representation of the infrastructure of the different crossing types, and of likely variations within these, so that children gained experience with the precise configurations they might be expected to encounter. This meant that schematic animations, at least of the crossing sites themselves, would no longer be suitable. Secondly, it was important in this instance that the software allowed children to explore in flexible fashion all the possible behaviours relating to the preparatory, looking, and execution phases of crossing use, and the sequential relationship between these.

In consequence, it was no longer appropriate to structure the problems children had to deal with so that they were focused on a single decision. At the same time, since having a clear decision or choice to make is crucial to children taking a lead, this meant that the trainer would have to help organise children’s approach to the problems into manageable steps (for example by asking them "What’s the *first*thing

Kirstie needs to do?"). Since a much greater range of behavioural options would be available to children, the trainers would also need to play a major role in providing feedback on their responses, as it would not be feasible to program the software to allow for all of these. A third consideration was the need to include within the task an element of route planning and discussion of when and why designated crossings should be used. Logically, this meant that, rather than having routes and decision points automatically programmed, as in the earlier software, training sessions would need to commence with a more general objective, and a series of decisions about the best route to take, and how designated crossing sites fitted into this route. At the same time, it was important to constrain route choices sufficiently to avoid too great a diversity of experience on the part of different groups of children undergoing training.

Dealing with each of these points meant that the training software that emerged from the development process had a distinctly different ’feel’ to that developed by Tolmie *et al.* (2002), although bearing structural similarities to it. Thus, as for each of the four generic skills addressed by Tolmie *et al.*, the software consisted of four sets of simulated traffic problems, built in MacromediaÂ® DirectorÂ® and presented on a standard PC, one set to be used in each of four training sessions. All the problems were located within the same imaginary neighbourhood. Each set took the form of a general travel objective faced by an on-screen character (for example, Jimmy going from his home to school, and Su-Ming going from school to the supermarket). The task of children being trained was to select the route they thought was most appropriate to meet this objective from an on-screen overview of the simulated environment, and then help the character to navigate it safely. All permissible routes for each objective entailed the character traversing the same mixture of four to five designated crossings, including, across the four problem sets, pelicans, puffins, toucans, zebras, and junction traffic lights with a pedestrian phase. Since the goal of the training was to develop children’s ability to use designated crossings, the simulated environment included sufficient examples of these to enable routes to be planned using only such crossings, although, in the real world, routes would include crossing at both these and other suitable places.

Once the route for a given objective had been selected, the character’s progress along the paved sections of it was shown automatically via schematic animations from a bird’s eye perspective. When they arrived at each designated crossing point, however, the view switched to that at roadside level. All instances of the different crossings shown at these points were based on photographs of real sites, with the cartoon-style on-screen character superimposed on these. Photographic views to right and left were available by clicking the mouse on icons at the bottom of the screen. At each crossing point, children were required to determine what things the character needed to do (for example, move to an appropriate position, press a request button, check the pedestrian light, look for traffic, etc.) and in what sequence, both preparatory to, and whilst making the crossing. A high degree of flexibility was built-in to the software at these points, so that children could make the character move and look wherever they wished - and even press the request button on a call signal - simply by clicking a mouse. There were, however, some constraints on what the character would do, depending on what actions had already been performed, as a means of providing feedback on the appropriate sequence. For instance, the character would not be allowed to proceed to the next crossing if children had failed to get him or her to check traffic movements correctly before crossing; the entire sequence would have to be repeated. Other behaviours that fell short of the ideal were allowed (for example not moving straight across the crossing, or failing to continue looking whilst crossing), but feedback on the inappropriateness of these was still to be provided by the trainer.

The trainer's role in general throughout the training sessions was to encourage children to discuss and agree the steps the character needed to take, and to prompt them to consider any issues to which they had failed to give due consideration. The principal software tools available to support them in this were the ability to pause and replay sequences, so that alternative possibilities could be considered, and the provision of as far as possible all the salient visual and auditory cues within the portrayed environment that would be present in reality (for example, traffic and pedestrian light changes, the timing of these, vehicle movements, etc.). All of these could be used to help draw children's attention to issues they needed to consider. Thus trainer and software feedback taken *together*were aimed at helping children not only to enact appropriate behaviours in the right sequence, but also to discuss the underlying reasons for these, and so build up a generalised conceptual grasp of what each type of crossing requires.

The sequence in which the travel objectives and routes were presented across the four training sessions was also designed to encourage children to gradually build up generalised understanding of the strategies appropriate to each type of designated crossing. This was done by presenting them initially with basic instances of each type, and then with variations in these and in the circumstances surrounding use (for example, the lights changing whilst the character was halfway across). Thus each route included a different combination of crossing types and introduced added complexities or points for discussion as the program proceeded. For example, the first crossing on the first route was a zebra crossing. This introduced first of all the need to be standing in the correct place on the pavement before making a crossing. Only when Jimmy was standing in the correct place could he be made to look to either side along the road. It then introduced the idea of the need to look both right and left and then again to the right. This was done by showing a car approaching and stopping only when Jimmy looked right for a second time. If a crossing was attempted without making Jimmy do this then the car was seen (and heard) to drive fast onto the crossing almost knocking him over. As reinforcement, a similar scenario but in a different setting was used on the second route, but on the third route, with Kirstie, children were introduced to the idea that cars do not always stop, even when you do things in the correct order. In this case, a car approached as Kirstie looked left and drove straight across the crossing without slowing down. Children were thus being encouraged to understand that they must wait until a car actually stops and not assume that it will do so, and that Kirstie needed now to start the whole process over again. Illustrative static views taken from different sections of the software are presented in Appendix 2.

3.2 Detailed breakdown of each route and associated learning objectives

A brief look at the detail of the routes shows the way in which each of the crossings was designed to introduce a new situation or event or else to reinforce a previous message.

3.2.1 The first route - taking Jimmy from home to school

1. The first crossing is a *zebra* crossing with clear ground markings and a double headed beacon. On looking right the second time a car approaches and stops at the white line. On looking straight again, the car is seen stopped on the side of the screen. If a crossing is attempted without correctly looking then the car appears fast from the right and the action is paused with the car in the middle of the crossing. After a successful crossing the car drives across and the continue button appears.

*Learning objective:*To introduce the features of a zebra crossing and the correct procedure to follow when using a zebra crossing; to emphasise the need to look right, left and then right again and to wait until an approaching car has stopped before crossing.

2. The second crossing is a standard *pelican*crossing with clear road markings, the red man showing and the wait button unpressed at the start. Trainees must click on the red man to make Jimmy acknowledge it and then on the wait button so that Jimmy walks over and presses it. A car passes on the far side after the wait button has been pressed. To make a good crossing it is necessary to look right, left and then right again *after*the red man has changed to green. If done in the correct sequence then a car approaches and stops on the far side of the road. If the looking is started before the lights change then no car appears. In this case, if a crossing is attempted, Jimmy will cross the road but then the only option available to continue the program is the ’Try Again’ button. This is to prompt the question of why they cannot continue, of what the mistake was. After crossing correctly, the action pauses and the continue button appears.

*Learning objective:*To introduce the features of a stand-alone signal-controlled crossings crossing, notably the green and red men, and the procedures that should be followed.

3. A pedestrian crossing on the *stem of a T-junction*. Again, the road markings are clear and the red man is showing, the wait button unpressed. There is a pedestrian crossing on each arm of the junction which is on Jimmy’s left side. As before, Jimmy must look at the red man, press the wait button and stand on the pavement between the road markings. From this position, it is possible to see a small portion of the right arm and this time, as the lights change, a car approaches and stops at this arm. On looking left it can be seen that this car is turning left into Jimmy’s road. Looking further left, it is possible to see down the other arm of the junction. There are no other cars. After a successful crossing, the lights change, the car passes in front of Jimmy and the continue button appears.

*Learning objective:*Following the standard pelican crossing on this first session, this crossing introduces the trainees to one of the differences between free standing pedestrian crossings and a crossing at a junction where it is necessary to look down ALL the arms of the junction.

4. The last crossing of the first session is a *puffin*crossing with the red and green men on the near side of the road instead of the far side. This time, although the red man is showing, the wait button has been pressed and Su-Ming is waiting to cross. A click on Su-Ming and she will turn and wave. Jimmy needs to ’notice’ the red man and the wait sign and then go and stand next to Su-Ming. If they wait until the green man appears before looking right/left/right then a car pulls up each time. After a successful crossing, the lights change and all three cars pass.

*Learning objective:*To introduce the trainees to the fact that the relevant features of a pedestrian crossing may not always be in the same place - there is no need for the trainees to be aware that this is an ’intelligent’ crossing! Also, that on arrival at a crossing, the period on the light changing cycle will vary - in this case, the wait button has been pressed; later in the training the green man will already be showing.

3.2.2 The second route - taking Su-Ming from school to the supermarket

1. The first crossing of the second training session is the same *puffin* crossing with nearside signal as the last crossing of the previous session but seen from the opposite side. At this crossing there are no cars.

*Learning objective:*There are six crossings on this route so this first one is kept deliberately uncomplicated and allows the children to revise the features of a pedestrian crossing from the first session.

2. The second crossing is the pedestrian crossing on the *right arm of the T junction.* This time the stem of the T is on Su-Ming's left so that when looking left it is necessary to look left and then further left. If the green man is visible then a car approaches and stops on the first arm and another is seen to have stopped on the second arm. After a successful crossing the action is paused with the green man on and Su-Ming waits until the continue button is pressed.

*Learning objective:*Again, there is no new message in this crossing other than practice in looking all around and in noticing the traffic lights.

3. To continue on her route, Su-Ming must use the pedestrian crossings on two of the arms of a crossroads. This third crossing is the first of the pedestrian crossings at a *crossroads*. There are no cars involved in this crossing but the trainees have to click three times on the right eye button to get a view down all three right-hand arms of the crossroads. Also, once in position with the wait button pressed, if Su-Ming is made to look right then it can be seen that the traffic lights have changed to amber. Then, after, the green man appears, on looking right, the traffic lights are red.

*Learning objective:*This is the first time that a crossroads has been used with the need to look down all four arms and it is a further chance to observe the change in traffic lights, and how the driver signals relate to the pedestrian signals.

4. The second *junction*crossing, on another arm of the same crossroads. This time one arm of the crossing is visible from the straight view and also, in addition to the red/green man, one set of lights is visible from where Su-Ming stands. This means that when Su-Ming arrives, the red man shows and the traffic light is green. After Su-Ming presses the wait button and moves into position the light changes to amber and then, when the light changes to red - the green man becomes visible. Again there are no cars, but, when Su-Ming reaches the middle of the road, the green man changes to red and the traffic lights then change to red and amber. When Su-Ming reaches the far side, the traffic lights change back to green.

*Learning objective:*This is the first time that the traffic lights and the green/red man are visible at the same time from the 'straight forward' looking position and is, therefore, a real chance to observe the relationship between them. Also, this crossing illustrates that, on a crossroads there is no flashing green man; the green man changes directly to red - while the traffic signal shows both the red and amber light. The message here is that if the green man changes to red whilst crossing, it is still the correct procedure to continue to cross.

5. The fifth crossing is a *zebra*crossing with single light beacons. Although the scenery is quite different, the events of this crossing are the same as on the zebra crossing of the first route - a car appears from the right if the correct sequence is followed and appears to almost knock Su-Ming down if an incorrect sequence is followed.

*Learning objective:*To remind trainees of the procedure at a zebra crossing now that they will have had some practice with other types of designated crossing.

6. The final crossing on this route is a typical *pelican*crossing. The only car in this sequence passes as the wait button is pressed. The difference in this crossing is that when Su-Ming looks left or right the viewpoint of the trainee is from further back along the road which means that the green or red man is visible at the same time as the traffic lights. The action pauses with the green man still visible.

*Learning objective:*To allow the trainees to explore the link between the traffic lights turning from green, through amber to red and the pedestrian lights turning from red to green.

3.2.3 The third route - taking Kirstie from the supermarket back home

1. The first crossing in this route is the same *pelican*crossing as in Route 2 Crossing 6, but seen from the other side. There are no special features about this crossing.

*Learning objective:*This is the start of the third session and as before this is a straightforward first crossing to allow recapitulation.

2. The second crossing is the *zebra*crossing with single light beacons seen from the other side. This time, as Kirstie moves into position, a car arrives and stops on the right side. There are no further cars on the right side but, when Kirstie looks to the left, a car approaches fast and goes straight over the crossing without stopping. Kirstie cannot just look right again and then cross (the action freezes if this is attempted and there is no option but to repeat the crossing): she must start the looking routine over again.

Learning objective : To illustrate that an approaching car may not stop - even though the car on the other side of the road has stopped - and that when this happens it is necessary to start the crossing routine again from the beginning.

3. The third crossing is a *toucan*crossing for pedestrians and cyclists with nearside signal. The emphasis here is the idea of sharing a crossing with non-pedestrians and that this means that there are wait buttons on both sides of the waiting area. A car passes as Kirstie moves into position but there are no other cars.

*Learning objective:*As with the puffin crossing, to introduce some of the variations of pedestrian crossings.

4. The last crossing on this route is a standard *pelican*crossing. Two cars pass while the red man is still showing but no cars approach after the lights change. However, as Kirstie reaches the middle of the road the green man starts to flash and turns to red as Kirstie reaches the pavement.

*Learning objective:*To introduce the trainees to the flashing green man and to the fact that this precedes the change to the red man. Also to demonstrate again that the correct procedure, if a crossing has been started, is to continue to cross.

3.2.4 The final route - taking Ajay from home to the swimming pool

1. The same *pelican*crossing as in Route 3 Crossing 4 but seen from the other side. When the scene opens, the green man is showing but after Ajay has looked right, left and right again the green man is flashing. This time Ajay must wait because a crossing has not yet started. Two cars pass Ajay while the red man is showing.

*Learning objective:*To illustrate the correct procedure at stand-alone signal-controlled crossings if the green man is flashing before a crossing has started.

2. Pedestrian crossing on the third arm of the *crossroads.* Again, one of the arms is visible from where Ajay stands and so is one of the traffic lights - showing green. A car passes along this arm, on the left of Ajay, as the scene opens. After Ajay has pressed the wait button and taken his position on the pavement, the traffic light changes to amber and a car crosses the pedestrian crossing. No further cars are seen in this scene. However, as Ajay crosses the road the signal changes to the red man just as Ajay reaches the centre.

Learning objective : That cars may well continue to pass while the amber light is showing.

3. The pedestrian crossing on the final arm of the *crossroads.* This time the traffic lights are not visible but as the simulation starts the green man is showing and there is a car stopped at the white line; however, after Ajay looks right for the first time the red man is now showing and it is no longer safe to cross. He needs to go through the sequence again from the start.

Learning objective : This crossing immediately follows the one where the lights change half way across and emphasises that, while it is correct to continue crossing once started, it is not correct to start a crossing even though the cars have not yet started to move.

4. The final crossing is a *zebra.* A car passes from the right as the scene opens. A car approaches and stops as Ajay looks right the first time and another approaches from the other side when Ajay looks left.

*Learning objective:*To recapitulate on zebras, and the differences between zebras and light controlled crossings; they involve negotiation between drivers and pedestrians, hence the importance of eye contact.

4. Evaluation methodology

4.1 Overview

The effectiveness of training in the use of designated crossings via the software described in Section 3 was evaluated by means of a full-scale implementation of the training programme. The participants were primary age children from deprived or semi-deprived locations in two areas, West Dunbartonshire and Gateshead. These locations were chosen in order a) to gauge the effects of training on those in the most vulnerable social categories, who would be the priority for any wider implementation; and b) to establish the generalisability of the training procedures and their impact on understanding and crossing performance. Within each location, children from three age groups, 5-6-, 7-8- and 9-10-year-olds, progressed through the four training sessions at the rate of roughly one session per week over a four to five-week period. Training took place within schools, with children working in threesomes under the guidance of one of four project researchers, who acted as trainers. The impact of training was assessed via individual pre- and post-tests, conducted at the roadside, on children’s use of pelicans, zebras and junction lights with a pedestrian-called crossing phase, and on their grasp of key areas of conceptual understanding relating to each crossing type. At both time-points, crossing behaviour and conceptual grasp amongst trained children were compared to that exhibited by matched controls who had received no training. The object was to detect the presence of changes from pre- to post-test amongst the trained children that were absent amongst the controls, which would help gauge the value of training. A small sample of adults from Glasgow and Newcastle was also tested using the same procedures as employed for the children, in order to establish a) how far the baseline performance of children in each group at pre-test compared to that of more ’expert’ crossing users; b) what the relative need for training was in each age group; and c) what levels of performance it might be realistic to expect children to achieve post-training.

4.2 Experimental design

The evaluation employed a Test - Intervention/Control - Re-test experimental design. Participants were individually pre-tested to gain baseline measures of their existing performance and understanding. They were then randomly allocated in a 2:1 ratio to an Intervention (training) or Control (no training) condition. In order to provide as close as possible a match between conditions in terms of age and background, both Intervention and Control children were taken from the same school classes. After the completion of training, and following a 10-week interval straddling school summer vacations, all participants were individually post-tested using the same procedures as the pre-test. Both phases of testing took place at the roadside, with each taking approximately six weeks to complete. Data from the adult sample were collected after post-testing for the evaluation was completed, but represented, in design terms, a sub-element of the pre-test data. Figure 4.1 presents an outline of the design in schematic form.

Figure 4.1 Schematic representation of the experimental design

Figure 4.1: Schematic representation of the experimental design

4.3 Participants

A total of 279 children, made up of similarly-sized cohorts from the two locations, participated in the evaluation. Details of the composition of each cohort are laid out below.

4.3.1 West Dunbartonshire cohort

A total of 133 children from two primary schools in Faifley, a deprived area on the outskirts of Glasgow, formed the West Dunbartonshire cohort. Of these, 89 children were allocated to the intervention condition (45 in School 1 and 44 in School 2). The remaining 44 children (22 in each school) were allocated to the control condition. The participants were drawn from three age groups, corresponding to classes P2, P4 and P6 under the Scottish system. Since data collection took place either side of the school summer vacation, these children had moved to P3, P5 and P7 respectively by the time the evaluation was completed. The number of children in each age group and condition, together with their mean ages in years and completed months at the start of the week training commenced, are shown in Table 4.1.

Table 4.1

Numbers and mean ages of participating children at the start of training: West Dunbartonshire cohort			
Trained group			
Year group	**Participants**	**Mean age**	**Range**
P2/3	29	6 years 8 months	16 months
P4/5	30	8 years 8 months	12 months
P6/7	30	10 years 9 months	13 months
Control group			
Year group	**Participants**	**Mean age**	**Range**
P2/3	16	6 years 8 months	15 months
P4/5	14	8 years 8 months	13 months
P6/7	14	10 years 8 months	23 months*
(*The age range here is larger than the other age groups as it includes one child who was over a year older than the rest of their class. This child had learning difficulties and physical disabilities as a result of a RTA several years previously, but was mobile and the school head teacher felt that they would benefit from taking part in the research.)			

4.3.2 Gateshead cohort

The Gateshead cohort was made up of 146 children drawn from two schools under the aegis of Gateshead Metropolitan Borough Council Education Department. One school was in a deprived area of the borough broadly comparable to Faifley, whilst the other was located in a slightly more socially mixed area. Of these 146 children, 83 were allocated to the intervention condition (40 in School 3 and 43 in School 4), and 63 to the control condition (31 in School 3 and 32 in School 4). The number of children taking part in the control condition was slightly higher in this cohort as a result of larger class sizes, and a keenness on the part of the head teachers for all children in the participating classes to be involved in the research.

The composition of the cohort by age group and condition, together with mean ages in years at the start of training, is shown in Table 4.2. The slightly younger mean ages in this cohort, compared to the West Dunbartonshire children, reflects the use of a later date in the calendar in England as a cut-off point for determining the year of entry to school for children with a given birthday. This, together with the earlier point of transition to secondary school in England, also meant that in contrast to the Scottish cohort children were taken from Years 1, 3, and 5, rising to 2, 4 and 6. These differences between the two cohorts were unavoidable, and were in any case not felt to be of sufficient scale to impact on the data, given the considerable variation in pedestrian skills within age bands reported by Whitebread & Neilson (1998).

Table 4.2

Numbers and mean ages of participating children at the start of training: Gateshead cohort			
Trained group			
Year group	**Participants**	**Mean age**	**Range**
Year 1/2	28	6 years 2 months	13 months
Year 3/4	28	8 years 4 months	22 months*
Year 5/6	27	10 years 3 months	15 months
Control group			
Year group	**Participants**	**Mean age**	**Range**
Year 1/2	21	6 years 3months	12 months
Year 3/4	22	8 years 2 months	11 months
Year 5/6	20	10 years 4 months	10 months
(*The age range is inflated here by the presence of a child who was repeating a year.)			

4.3.3 Adult sample

The adult sample consisted of 24 people, 12 from the Glasgow area and 12 from the Newcastle area. All were over the age of 21, and they comprised a mixture of parents of children in the participating schools and postgraduate university students from a variety of backgrounds (none involved in either the present work or in other research in this area). The aim was to achieve as far as possible a representative spread of performance for individuals in this age range.

4.4 Training procedure

Following pre-testing (see Section 4.5 below for details of the testing procedures), those children in each school who had been allocated to the intervention condition were assigned to groups of three for the purposes of working through the training sessions. These groups were always drawn from the same class, so that the children were familiar with each other, an important consideration for collaborative activity. Assignment to groups was, however, made without regard to gender, since there is little evidence to suggest that this is a material influence on either peer collaboration or pedestrian skill amongst primary age children. Thus all gender combinations were represented. It should also be noted, though, that the groups were not entirely stable in composition across the training sessions. On occasion, the absence of a child from a group due to illness meant that it was necessary for him or her to be substituted by another classmate from the training condition, in order to maintain the level of child-child dialogue generated by threesomes, and not lose a training slot. Similarly, on their return, the absent child might be added to another group to ensure that he or she still received the same number of sessions. This meant that training sometimes took place in foursomes. These variations were an inevitable consequence of adaptation to the practicalities of the training situation, and were not thought likely to impact on outcome. Indeed, a training programme that was not robust enough to operate in the face of such variation would be of dubious value.

Irrespective of these variations, children from a given school always worked through the training sessions under the guidance of the same project researcher, who had responsibility for all intervention work in that institution. As well as facilitating blind testing at post-test (see Section 4.5.5 below), this ensured a continuity of approach would be experienced by children from one session to another, although steps were also taken to maximise consistency of interactional style as far as possible across the four researchers. Two (those working with the West Dunbartonshire cohort) had had substantial previous experience of analysing productive interactions in pedestrian training, had run induction sessions for volunteer trainers in earlier projects, and had observed training sessions run by these trainers and provided feedback on them. Both were therefore well versed in the need to adopt a child-centred approach, encouraging children to make suggestions and discuss them between themselves, whilst providing guidance when necessary, as described in Section 1.1. At the same time, as noted in Sections 1.1 and 3.1, the demands in terms of guidance and feedback placed on trainers both by the nature of the present software and its novelty meant that these two researchers could not rely entirely on previous experience. Prior to commencing training for each of the four sessions, they therefore worked through the software together, agreeing the points to focus on, bearing in mind the details of the strategies devised for each crossing type (see Section 2). They also agreed on the elements of the software to be used to back up their guidance, and the methods to be employed in providing feedback. The researchers working with the Gateshead cohort had less direct experience of using the required style of interaction, but one was a qualified teacher, and both had good theoretical knowledge of the objectives of the training and the methods to be used. In addition, the timing of the school summer vacations differed fortuitously between Scotland and England, that in England being a month later. The resulting lag in the research schedule between the two cohorts meant that it was possible for the Gateshead researchers to visit the West Dunbartonshire sites whilst training was in progress, before beginning their own sessions. This enabled them to witness first hand how the sessions were run by the more experienced researchers, discuss any points of uncertainty with them, and then model their own performance on what they had seen. In this way, then, a good measure of uniformity of approach across trainers was guaranteed. Whilst not the subject of formal analysis, all training sessions were videotaped in order to check that this was in fact the case.

The training sessions themselves lasted between 20 and 30 minutes each, with children working through them at the rate of approximately one per week. All training took place in school, in a quiet room set aside for that purpose. In each session, the participating children were seated in a semi-circle in front of the computer that displayed the software, thus ensuring that all of them had a good view of what took place. The adult trainer sat slightly off to one side, and initially retained control of the mouse used to direct progress through the software. As training proceeded, however, and children became clearer about what they were doing, they were allowed to take over control of the mouse, on a turn-by-turn basis, in order to sustain engagement with the task. Each session began with the travel objective of the focal character being shown on-screen and read out by the trainer. The route choice map was then displayed, and the trainer asked the children to make suggestions about the route that should be taken, the crossing points that should be used along the way, and why, commenting on each others' ideas until they reached a consensus. Once a consensus had been achieved and the route had been marked on-screen, the continuation button was pressed, the character moved along the road to the first crossing, and the view dropped down to the roadside perspective. The trainer then asked the children to suggest what the character should do first to make a safe crossing, what should follow on from that, and so on, encouraging them to discuss each point in turn before enacting it. When important steps were missed, the trainer either prompted children to think about these (for example "is there something that Kirstie needs to do *before*pressing the button?"), using the on-screen resources to help illustrate points where necessary; or alternatively allowed the action to proceed if the software provided feedback that achieved the same objective (see for example Section

3.2.1, crossing 1). At all times, trainers directed discussion towards not just what children needed to do, and in what order, but also the *reasons* underlying these actions (for example why it is important to make eye contact with drivers at zebra crossings). This approach was taken at each crossing in turn, and on each route, although the trainer tended to recede into the background more as children became familiar with the task and their performance improved.

4.5 Test materials and procedure for pre- and post-tests

Children in both the training and control conditions underwent exactly the same programme of roadside testing in use of designated crossings, both prior to training commencing, and then again approximately 10 weeks after training had finished. Whilst the precise locations at which testing took place inevitably varied across the two cohorts, in both, children were tested on the same three types of designated pedestrian crossing: pelicans, zebras, and junction traffic lights with a pedestrian-called phase. Instances of puffins and toucans were sufficiently infrequent in the environs of the schools participating in the research to enable them to be used, at least in any systematic fashion. Moreover, since these crossings bear a strong resemblance to pelican crossings, performance on the latter provided some guide as to children's likely patterns of usage of them. Data was gathered on children's behaviour at four instances of each of the three crossing types, and records made of their responses to a subsequent series of questions addressing central conceptual points about each type. Data from the adults was gathered in exactly the same way, with the Glasgow half of the sample being tested at the same sites as the West Dunbartonshire children, and the Newcastle half being tested at the same sites as the Gateshead children. The materials and procedures used to collect the behavioural and conceptual data for each crossing type are outlined separately below.

4.5.1 Materials for the behavioural measures

Behavioural testing on each crossing type utilised observation sheets, attached to a clipboard, that presented a step-by-step checklist of the behaviours that would be evident in an ideally safe crossing. These checklists were based very closely on the strategies detailed in Section 2.2 above, but for pragmatic reasons they were not completely identical. For instance, since children were accompanied to the crossings (see Section 4.5.3 below), it was impossible to obtain an independent test of the first element in each strategy, approaching the crossing at a moderate walking speed. Other elements in the strategies logically consisted of two independent behaviours (for example looking right, and keeping looking right till traffic had stopped; stepping out smartly and walking across the road), and these were therefore separated in the checklist. Finally, some elements dealing with particular eventualities, such as the signal changing whilst halfway across, could not be tested since the circumstances could not be brought about with any degree of reliability. The full list of items employed for each crossing type is given below.

For the *Pelican* crossing:
1) Takes up position beside the request button
2) Looks at pedestrian light to check phase
3) Presses button and ensures that light comes on/check has been done
4) Stands on pavement close to (but not on) kerb
5) Remains still while waiting for green man
6) Looks right for vehicles stopping - all lanes
7) Keeps looking right till all salient traffic stops
8) Looks left for vehicles stopping - all lanes

9) Keeps looking left till all salient traffic stops
10) Looks right again to double check
11) Checks signal still showing green man
12) Steps out promptly
13) Walks at appropriate speed
14) Keeps looking while walking
15) Remains on crossing area while walking
16) Mounts pavement within crossing area
17) Moves to inside of pavement to continue

For the *Zebra*crossing:
1) Takes up position between the road markings
2) Stands on pavement close to (but not on) kerb
3) Looks right for vehicles stopping - all lanes
4) Looks left for vehicles stopping - all lanes
5) Engages eye-contact with leading driver on right
6) Looks right until all salient traffic stops
7) Looks left to confirm all salient traffic stopping
8) Looks right again to double check
9) Steps out promptly
10) Walks at appropriate speed
11) Keeps looking while walking
12) Remains on crossing area while walking
13) Mounts pavement within crossing area
14) Move to inside of pavement to continue

For the *Junction*crossing with pedestrian-called phase:
1) Takes up position beside the request button
2) Looks at pedestrian light to check phase
3) Presses button and ensures that light comes on
4) Stands on pavement close to (but not on) kerb
5) Remains still while waiting for green man
6) Look down all roads - checks all lanes
7) Looks in correct sequence
8) Keeps looking all round till salient traffic stops
9) Repeats sequence again to double check
10) Checks signal still showing green man
11) Steps out promptly
12) Walks at appropriate speed
13) Keeps looking while walking
14) Remains on crossing area while walking
15) Mounts pavement within crossing area
16) Moves to inside of pavement to continue

4.5.2 Materials for the conceptual measures

Conceptual testing for each crossing type was carried out by taking participants through a list of questions laid out on a sheet accompanying the relevant behavioural observation sheet. An audiotape recorder was used to record these interviews. The questions relating to each crossing type were based on the conceptual elements of the strategy for that crossing, and are presented below.

For the *Pelican*crossing:
1) Where is the best place to stand?
2) Why?
3) When is it safe to cross?
4) Is it safe to cross as soon as the green man comes on? Why?
5) What do the studs/white lines mean?
6) When crossing, where should you walk?
7) Should you be doing anything else while you’re crossing? Why/what for?
8) What does the flashing green man mean?
9) What should you do if it starts to flash before you’ve started to cross?
10) What should you do if it starts to flash while you’re crossing?
11) Where should you go when you get to the other side?
12) Why?

For the *Zebra*crossing:
1) Where is the best place to stand?
2) Why?
3) When is it safe to cross? Why?
4) What do the flashing beacons mean?
5) Is there somebody in particular that you should be looking at?
6) Why?
7) What do the white lines mean?
8) When crossing, where should you walk?
9) Should you be doing anything else while you’re crossing? Why/what for?
10) Where should you go when you get to the other side?
11) Why?

For the *Junction*crossing with pedestrian-called phase:
1) Where is the best place to stand?
2) Why?
3) When is it safe to cross?
4) Is it safe to cross as soon as the green man comes on? Why?
5) Where is the first place you should look for cars?
6) Why?
7) Where should you look after that? Why?
8) What do the studs/white lines mean?
9) When crossing, where should you walk?
10) Should you be doing anything else while you’re crossing? Why/what for?
11) Where should you go when you get to the other side?
12) Why?

4.5.3 Procedure for the behavioural measures

The roadside sites used for testing children from each school were chosen so that there were always two instances of a given crossing type within walking distance of each other. Since the sites for a specific type were mostly located some distance apart, however, children were only tested on one type at a time, so as to prevent too long an absence from class. The order in which children underwent testing on each crossing type varied, depending on their availability on the days on which testing at particular sites was scheduled, and it was therefore effectively randomised across the sample. The procedures used for testing each crossing type were as follows.

For the *zebras*, children were taken in twos (to speed up the process of testing) to each of two crossings. At each, they were told in turn by an accompanying researcher "I want you to show me how you cross the road safely using a crossing like this". The child then crossed the road using the crossing, under close supervision from the researcher, who noted whether each action on the zebra checklist was performed, and if so in what order. The researcher always crossed with the child, keeping two or three steps behind in order that their own crossing behaviour would not influence the child’s, but staying close enough to intervene in any potentially dangerous situation. No child was asked to cross a road alone at any time. Other field workers or parent volunteers supervised the child not being tested, who waited a little distance off until it was their turn. Children all completed two crossings at each of the two zebras, one in one direction, one in the other, thus providing data on four attempts in total.

Broadly the same procedure was followed for *pelicans.* However, in a number of cases the pelican sites were some distance from the schools, and the children being tested were therefore bussed to them in groups of four (accompanied by field workers or parent volunteers to supervise them while the researchers were carrying out the testing). Once at each site, children were taken individually by a researcher to the two pelican crossings in turn, where the researcher monitored crossing performance against the checklist of actions in the same way as for zebras. Each child completed two crossings at each of the two pelicans, again giving data on four attempts in all.

Similar procedures were followed for *junctions.* These sites were also at a distance from the school for some children, and they were therefore also bussed to these. At each site, children were taken individually by a researcher to an arm of a four-way light controlled junction, where their crossing performance was monitored as for zebras and pelicans. Each child completed two crossings at each of two arms of the junction.

The testing procedures employed with the adult sample were identical to those used with the children in all respects, the sole difference between the adults and the children lying in how the sessions were organised. For the adults, participants were either taken by car out to the test sites, or else collected from the schools to walk to them. As with the children, testing typically took place in small groups for the sake of efficiency, but unlike the children adults were tested on all types of crossing on the same day.

4.5.4 Procedure for the conceptual measures

For each type of crossing, administration of the conceptual measure took place after observations for the behavioural measure had been completed, so as to avoid any potential contamination. Questioning took place individually, either at the roadside, or at school, depending upon the weather conditions. Children were told "Now I have a few questions for you", and were then asked the questions relevant to the crossing type they had just been tested on. Their responses were audiotaped in their entirety for subsequent coding. When the conceptual questioning was complete, the children were returned to their classrooms.

Conceptual questioning with the adult sample again followed the same format as used with the children.

4.5.5 Blind post-testing

Since participating children were not assigned to the training and control conditions until after pre-testing had been completed, the researchers for each cohort carried out this testing together in their two schools, aided when necessary by additional field workers (postgraduate students). In order to maintain acceptable levels of objectivity during the post test phase, however, the researchers only engaged in testing children from the school where they had *not*been involved in training, again aided by field workers where necessary. This meant that the testers were in all instances blind to whether a given child had received training or not.

4.6 Scoring of pre- and post-test performance

Records from the test sessions were of two kinds: the completed observation sheets of the behaviours performed by each individual whilst making the four traverses of the three different types of crossing, and of the order in which these had occurred; and the audio tapes of each individual's responses to the conceptual questions relating to each crossing type. These records were used to derive three basic forms of measure for each individual's pre-test and (where relevant) post-test performance: 1) scores for the extent to which specified behavioural elements for each crossing type were present; 2) scores for how far looking behaviours were performed in the correct order at each crossing type; and 3) scores for understanding of the key conceptual elements relating to each crossing type. The way each of these measures was constructed and scored is described in more detail below.

4.6.1 Scores for the presence of the specified behavioural elements

For each crossing made at the roadside, the researcher had noted at the time on the observation sheet whether each behavioural element was present by assigning it a number for the order in which it was taken (that is, '1' for the step taken first, and so on). If the element had not been present at all, then a '/' was marked on the observation sheet. However, in some cases (for example, Elements 7 and 9 for pelicans, Elements 5 and 6 for zebras, and Element 8 for junctions), a step might not have been taken, because it was not possible for the individual being tested to do so, and the absence of these elements had been recorded differently. For instance, in the case of the zebra crossing, if a child had failed to make eye-contact with the driver of a vehicle because there were no vehicles present, then this was marked as 'X', rather than '/'. This enabled missed steps and unnecessary steps given the specific circumstances of the crossing to be distinguished from each other, and from those elements that were actually present. These records permitted scores for the presence of the specified behavioural elements for each crossing type to be derived by calculating for each **the proportion of trials or traverses out of the completed four on which the element was observed**(not taking into account the order in which it occurred). However, if an entry of 'X' had been entered for any of the trials, then to avoid biasing the score, this instance was ignored, and the proportion derived from the remaining trials. If an entry of 'X' had been assigned on every trial, then a separate category of 'NA' (not applicable) was given to this element, rather than a proportion, and the individual's score on this element was effectively treated as missing data in subsequent analyses.

Scores for each behavioural element for each of the three crossing types, pelicans, zebras and junctions, were derived in this way for each individual at pre-test and (save in the case of adults) post-test. Composite scores for overall performance on each crossing type, and for the approach/set-up, looking and crossing phases of each, were also derived by averaging individuals' scores across the relevant behavioural elements (see the results sections below for details of the elements included in each phase).

4.6.2 Scores for the performance of looking behaviours in the correct order

The order in which the elements concerning looking behaviour for each crossing type are performed is important, because of the different priority that needs to be attached to information about vehicle movements according to their proximity to the pedestrian at different points in the crossing sequence. In particular, on a straight road (zebras and pelicans), the pedestrian should always look right, left and then right again before commencing crossing because (in the UK) it is traffic from the right that needs to be dealt with first. The same principle applies to junctions, but the looking sequence is made more complex in this case by the fact that the rightmost traffic may be coming from behind, and by the need to address all other roads in an anti-clockwise sequence from the rightmost.

As far as *junctions*were concerned, an index of looking in the correct order during testing was provided by **the score for Element 7 in the behavioural checklist**, which addressed this directly. However, for *pelicans*and *zebras*, a comparable index needed to be extracted from the information regarding Elements 6, 8, and 10 (pelicans), and Elements 3, 4, and 8 (zebras). In both cases, a score for looking in the correct order was derived as **the proportion of trials out of four on which these elements were all present and in the right sequence**. As with the behavioural elements more generally, individuals were given a score for both pre- and post-test on these indices.

4.6.3 Scores for understanding of the conceptual elements

The conceptual questions for each crossing type were scored directly from the audio recordings made of individuals' responses. For each question asked, these responses were assigned **a score from 0 to 2 according to their quality**. Scores of 0 were given to "don't know" responses, wrong or nonsensical answers, and to no responses. Scores of 1 were given to relevant, but only partially correct answers (for example, for "where is the best place to stand?" replying "by the kerb"). Scores of 2 were given to full answers displaying a real grasp of the concepts involved (for example, "near the kerb but not too close so that cars don't hit you going past"). As a check on the reliability of this scoring system, pre-test responses to each question given by 12 different children (close to 5 per cent of the pre-test data) were scored by two of the researchers. The mean correlation between scores for each question was highly significant ($r = .69$).

Individual participants were given pre-test and post-test scores arrived at in this way for each question for each of the three crossing types. Composite scores for overall conceptual grasp for each crossing type were derived by averaging scores across all the questions relating to that type.

5. Evaluation results - pelicans

5.1 Pre-test performance

Table 5.1 shows how frequently children executed the different behavioural elements at pre-test. These scores represent the proportion of crossings on which a child exhibited the desired behaviour and are averaged across children as a function of age. Data on children's conceptual understanding at pre-test, on a scale of 0 to 2 (see Section 4.6.3), are presented in the same manner in Table 5.2. Preliminary statistical analysis revealed no effect of gender on either behavioural or conceptual performance. For this reason, gender has been omitted from subsequent analyses.

Table 5.1

Mean proportion of children exhibiting the target behaviours for pelicans at pre-test as a function of age			
	6-year-olds	**8-year-olds**	**10-year-olds**
1. Takes up position beside request button	.91	.95	.96
2. Looks at pedestrian light to check phase	.35	.48	.58
3. Presses button and ensures that light comes on	.83	.91	.96
4. Stands on pavement close to (but not on) kerb	.50	.63	.67
5. Remains still while waiting for green man	.83	.88	.93
6. Looks right for vehicles stopping - all lanes	.24	.42	.50
7. Keeps looking right till all salient traffic stops	.10	.18	.24
8. Looks left for vehicles stopping - all lanes	.22	.37	.47
9. Keeps looking left till all salient traffic stops	.09	.12	.23
10. Looks right again to double check	.04	.05	.06
11. Checks signal still showing green man	.27	.32	.32
12. Steps out promptly	.64	.89	.91
13. Walks at appropriate speed	.75	.88	.87
14. Keeps looking while walking	.14	.23	.41
15. Remains on crossing area while walking	.68	.82	.88
16. Mounts pavement within crossing area	.77	.84	.91
17. Moves to inside of pavement to continue	.42	.59	.46

Table 5.2

Mean scores for each of the conceptual questions for pelicans at pre-test as a function of age			
	6-year-olds	**8-year-olds**	**10-year-olds**
1. Where is the best place to stand?	0.15	0.40	0.57
2. Why?	0.12	0.17	0.49
3. When is it safe to cross?	0.54	0.78	0.77
4. Is it safe to cross as soon as the green man comes on? Why?	0.17	0.79	0.81
5. What do the studs/white lines mean?	0.10	0.30	0.37
6. When crossing, where should you walk?	0.52	0.91	1.00
7. Should you be doing anything else while you're crossing? Why?	0.04	0.17	0.29
8. What does the flashing green man mean?	0.01	0.27	0.27
9. What should you do if it starts to flash before you've started to cross?	0.17	0.50	0.37
10. What should you do if it starts to flash while you're crossing?	0.06	0.32	0.26
11. Where should you go when you get to the other side?	0.09	0.39	0.57
12. Why?	0.03	0.13	0.60

The pre-test scores on the different behavioural elements show how well children of different ages performed prior to training. These are important because they provide an insight into those aspects of crossing that might need emphasis in training, and those aspects requiring less attention. More generally, the pre-test scores also provide a baseline against which the effects of training can be measured. Statistical analysis revealed no significant difference in overall baseline performance between children in the trained and control conditions, nor was there a significant difference on any of the individual elements except for Element 17 ('moves to inside of the pavement to continue'), where the control group performed better than the experimental group. These findings show that the two groups were well matched prior to training.

The effect of age on overall baseline performance is illustrated in Figure 5.1, which shows the mean behavioural and conceptual scores for children in each age group. Age proved significant on both measures, with older children performing better than younger ones. It can be seen that the age trend particularly affected the 6-year-olds who lagged some way behind the other two groups, especially in terms of their conceptual scores. Thus such correct behaviour as was seen in the youngest children would appear to have been much more weakly underpinned by conceptual understanding of why the behaviour was appropriate. In addition to the effect on children's overall scores, an effect of age was also obtained for 16 of the 17 individual behavioural elements, and for all 12 of the conceptual items.

Although the results show clear age trends, it is nevertheless the case that some behaviours were adhered to quite well at pre-test even by the youngest children. For example, Table 5.1 shows that even the 6-year-olds were very likely to take up position by the request button (.91); press the button in order to call the green man (.83); remain still whilst waiting for him to appear (.83); walk at an appropriate speed while crossing (.75); stay between the lines demarcating the crossing area (.68); and mount in this area (.77). On a cautionary note, though, it should be borne in mind that some of these behaviours (such as standing still while waiting, or walking at an appropriate speed) may be artificially high simply because the children were always accompanied and were probably on their best behaviour. Nevertheless, it is apparent that even the youngest children already had some inkling of what to do at pelican crossings, even if, as already noted, this was not apparently based on an explicit conceptual understanding of the issues involved.

Figure 5.1: Pre-test scores for pelicans for children aged 6, 8 and 10 years

At the same time, many aspects of the crossing task were poorly served prior to training and, in some cases, the target behaviours were scarcely exhibited at all. This was particularly apparent in those elements relating to the perceptual search strategy that children deployed in deciding whether or not it was safe to step out. Even the 10-year-olds were poor at this, failing to look at the approaching traffic to right or left on more than half the crossings (Elements 6 and 8). Moreover, when they did look they tended merely to glance in the appropriate direction, failing to monitor whether the lead vehicle really intended to stop (Elements 7 and 9). They were still less likely to double check that the traffic on the right had definitely pulled up before committing themselves to stepping out (Element 10), and they did not continue to look and listen for traffic as they crossed (Element 14) on more than 41 per cent of crossings. Significant age trends on each element show that younger children were even less likely to do any of this.

These results show that, whilst all the children had some general notion of what to do at pelican crossings, they also suffered weaknesses in key areas. As already suggested, many of these centred around the cursory looking strategy that children used to determine what the traffic around them was doing. To help illustrate this, the 17 individual behavioural elements were aggregated into three phases as follows: (1) an approach/set-up phase consisting of the initial elements involved in taking up position at the kerb (Elements 1-5); (2) a looking phase consisting of elements directed at assessing the situation and, especially, the behaviour of approaching traffic (Elements 6-11); and a crossing phase consisting of elements relating to what the child should do once crossing is initiated (Elements 12-17).

Figure 5.2: Mean proportion of behaviours at pre-test for each of the three phases of pelican crossings as a function of age

Figure 5.2 shows that, when aggregated in this way, the looking phase does indeed emerge as weaker at pre-test than the other two phases, and in all age groups. Scores for looking in the correct order emphasised this general weakness, with all three age groups having a mean of zero on this measure; that is, none of the children engaged in the main looking elements in the correct order at pre-test. It seems, then, that even the oldest children tended to assume that approaching traffic would automatically stop at the green man, and that there was therefore no need for them to check that this was actually happening. There seemed to be little, if any, appreciation that vehicles close to the crossing might be unable to stop in time (or might choose not to stop in time); or that others might jump the lights towards the end of the phase whilst pedestrians might still be on the crossing. Since common experience shows that drivers do this quite frequently, children’s performance in this respect is an obvious cause for concern.

The suggestion that these aspects of children's performance reflect a lack of underlying conceptual clarity is, of course, consistent with the relatively poor scores on conceptual understanding found at pre-test. Whilst direct questions on looking behaviour were restricted to the need to look while crossing (Question 7), in all three age groups responses to this question exhibited a general lack of understanding. The picture is perhaps not entirely gloomy, since amongst the older age groups at least responses to Question 4 ("Is it safe to cross as soon as the green man comes on?") reveal some understanding of the fact that it is not safe unless the traffic has come to a halt. Indeed, when it was safe to cross, and where it was appropriate to walk, were the only areas on which even the older children showed any basic conceptual grasp. Such awareness did not feed through into systematic monitoring of vehicle movements, however.

5.2 Outcomes of training

5.2.1 Post-test performance - behavioural measures

The effect of training on children's overall behavioural performance is illustrated in Figure 5.3. Although there was no difference in performance between trained and untrained children at pre-test, Figure 5.3(a) shows that trained children's post-test performance was significantly better in all three age groups. This is also shown in Figure 5.3(b), which plots the shift scores attained in each condition. Shift scores represent the difference between each child's pre-and post-test performance and therefore reveal any improvement (or deterioration) that took place over the intervening period. These scores confirm that trained children improved significantly more than control children although, interestingly, control children also improved. The latter effect was inversely related to age, with younger children in the control group improving most. In the trained group, by contrast, all three groups improved to about the same extent.

Figure 5.3 Post-test behavioural performance for pelicans by age and condition

Figure 5.3: Post-test behavioural performance for pelicans by age and condition

Table 5.3

Table 5.3: Post-test scores and shift values by age group and condition on individual elements of pelican behavioural measures

These improvements in overall performance were mirrored at the level of the individual elements (see Table 5.3). Indeed, children in all three age groups improved significantly on almost every element. Even behaviours which were very likely to be performed at pre-test anyway (such as Elements 5, 13, 15 and 16) nonetheless improved significantly at post-test. The only exceptions are Elements 1 (taking up position by the request button) and 3 (pressing the button) where pre-test performance was so high that there was no realistic chance of further improvement - although children continued to execute these behaviours to the same high degree.

As would be expected from the pre-test data, the largest improvements were on the elements of the looking phase, where most of the room for improvement lay. The trends are illustrated in Figure 5.4. Thus children in all three age groups were more likely to look for traffic to both right and left; to keep watching until they could tell whether or not the traffic intended to stop; to double check that the green man was still illuminated before stepping off the pavement; and they were much more likely to keep looking and listening as they crossed. Although there were slight differences from element to element and from one age group to another, in general trained children were about twice as likely to do any of these things as in the pre-test, with the 6-year-olds making comparable gains to the two older groups. Whilst smaller, similar shifts were apparent for the control children. Finally, although infrequent, instances of carrying out looking behaviours in the correct order began to appear at post-test, occurring from 4-9 per cent of the time for the 6-year-olds, rising to 12-16 per cent of the time for the 10-year-olds, and being slightly more prevalent among trained children.

Figure 5.4: Mean proportion of behaviours at post-test for pelicans, together with shift values, for each of the three phases as a function of condition and age

Figure 5.4: Mean proportion of behaviours at post-test for pelicans, together with shift values, for each of the three phases as a function of condition and age

5.2.2 Post-test performance - conceptual measures

The effect of training on children's conceptual performance is illustrated in Figure 5.5. Figure 5.5(a) shows that trained children in all three age groups attained substantially higher scores at post-test than the corresponding controls, a finding confirmed by the shift scores plotted in Figure 5.5(b). These shifts (see Table 5.4) generally reflected behavioural improvements, although it was noted that gains with respect to the flashing green man and how to respond to it, where behavioural testing was not possible, were restricted to the older children. Interestingly, although control children's behaviour improved at post-test, this was not matched by a corresponding improvement in conceptual performance. Figure 5.5 and Table 5.4 both show that not even the 10-year-olds made much headway in this regard, although, unlike the 6- and 8-year-olds, they did exhibit increased insight on a few issues. Overall, the three age groups improved to about the same extent. This suggests that, while control children did behave in a somewhat more structured manner at post-test, they were still acting rather 'blindly' without really understanding why the various actions were important.

To examine this further, the correlations between children's behavioural and conceptual performance at pre- and post-test were examined. If training were successful it would be expected not just to produce an overall improvement in behavioural and conceptual performance in the trained group, but a tightening of the link between behaviour and understanding. Thus, those children who did well behaviourally would be expected to do equally well conceptually, and vice-versa for less able children. Poor correlations would imply that children were 'going through the motions' in a somewhat limited manner, whereas higher correlations would imply that the children better understood why the behaviours were necessary or important. In general, a successful educational programme would be one which strengthened the link between these two aspects of competence, increasing the correlation at post-test.

Figure 5.5: Post test conceptual performance as a function of age and training

Figure 5.5: Post test conceptual performance as a function of age and training

Table 5.4

Table 5.4: Post-test scores and shift values by age group and condition on pelican conceptual questions

The correlations found in trained and control children at pre- and post-test are shown in Figure 5.6. It can be seen that at pre-test, correlations were relatively low in both groups, although the relationship was higher in the control children (.45 as opposed to .30 in the trained group) giving them an initial advantage. Both these correlations were significantly greater than 0, indicating that there was already some relationship between behavioural and conceptual performance. In trained children, however, this relationship grew much stronger at post-test, with the correlation increasing from .30 to .55. In controls, by contrast, there was no change at all. Indeed, the correlation decreased slightly from .45 to .44.

Figure 5.6 Correlations between behavioural and conceptual performance for pelicans at pre and post-test, as a function of training

Figure 5.6: Correlations between behavioural and conceptual performance for pelicans at pre and post-test, as a function of training

These results suggest that the behavioural improvements found in the trained group were underpinned by corresponding improvements in their understanding of why these behaviours were required or important. Although there was also behavioural improvement in the controls, this was not accompanied by the same kind of enhanced meta-cognitive awareness. As such, it seems likely that the behaviour observed in the controls would be less robust and probably less amenable to the fine tuning and minor modifications that are required from time to time to deal with local conditions.

5.3 Adult performance

Whilst children's behaviour and conceptual thinking improved as a result of training, it was still the case that their scores did not reach ceiling level. This means there remained scope for further improvement. To place the achievement of the programme in context, and to estimate how much further improvement could realistically be expected, the performance of the trained children was compared to that of the sample of adults who were roadside tested in the same way.

The overall results for behavioural and conceptual performance are shown in Figure 5.7. The figure also shows the pre- and post-test performance of trained children, thus allowing estimates to be made of how close training brought children to adult levels of performance. For conceptual performance, there was no difference between the Gateshead and Glasgow adults and their data are combined in Figure 5.7(b). However, since the behavioural performance of Gateshead adults was superior to that of the Glasgow adults, behavioural scores are presented separately for the two groups in Figure 5.7(a).

Figure 5.7 Overall behavioural and conceptual scores for adults in comparison to trained children at pre- and post-test

Figure 5.7: Overall behavioural and conceptual scores for adults in comparison to trained children at pre- and post-test

It would appear, then, that the programme can justifiably claim success in bringing children closer to adult levels of performance in using stand-alone signal-controlled crossings. Although pre-test performance was fairly weak, even in the oldest children, just four short training sessions was sufficient to bring performance much closer to adult levels. It seems likely that small amounts of additional experience, gained for example when children are out and about with their parents, would reinforce the achievements of the programme, especially in terms of conceptual understanding. Unfortunately, it was not possible to assess these possible longer-term effects within the confines of the present research.

Finally, although adult performance was used as a measure of where children are likely to end up eventually (in the absence of training), it should not be assumed that adult performance represents the last word in the safe use of pelican crossings. Although adults clearly understood the function of pelicans and could comment appropriately on how they should be used, in fact their behaviour showed shortcomings that to some extent mirrored those seen in the children. Figure 5.8 shows that, like the children, the main area of weakness lay in the perceptual search strategy used to determine what the surrounding traffic was doing. Whilst scores in the approach/set-up and crossing phases approached the maximum, this was clearly not the case for the looking elements, especially in the Glasgow sample.

Figure 5.8 Performance of adults during the three phases of the crossing task for pelicans

Figure 5.8: Performance of adults during the three phases of the crossing task for pelicans

Examination of the individual scores shows that, while adults were much more likely to look to right and left before stepping out, they also tended merely to glance at the traffic rather than follow the traffic movement to ensure that the vehicles intended to stop. They seldom looked right again to double check that all was well before stepping out; some consistently failed to double check that the green man was still on green; and 33 per cent never on any occasion looked to right or left while crossing. Whilst it is possible that, to some extent, these adults were taking the situation in by means of audition and peripheral vision (and therefore did not make overt head movements), it is hard to see that a full appreciation of traffic could be gained in this way. Interestingly, this pattern was not uniform across the sample: by far the worst offenders were a group of postgraduate students from Glasgow, who had been recruited mainly to broaden the age and social class make-up of the sample. It cannot therefore be assumed that adults use pelican crossings in the manner intended by their designers. This would, of course, have implications for how children learn to use them, for this must, in the main, be based on observation of their parents and other adults. This would seem to strengthen the case for a training course teaching children the best and safest way of using such structures.

5.4 Summary

At pre-test, even 6-year-olds appeared to have some grasp of the basic behaviours required for safe use of pelican crossings, but all age groups of children were poor at engaging in appropriate monitoring of vehicle movements both immediately prior to, and during, crossing. Conceptual understanding of the rationale for most aspects of behaviour was also poor, especially amongst 6-year-olds. Training had the effect of improving behavioural performance substantially, especially as regards monitoring behaviours, increasing conceptual understanding by an even greater margin, and bringing about greater integration between concepts and behaviour. Control children showed smaller behavioural improvements, their conceptual gains were much more restricted, and they exhibited no increase in concept/behaviour integration. The gains shown by the trained children brought their behavioural performance up towards adult levels, though they still lagged behind adults to some extent in terms of conceptual grasp. It was noted that adults, in common with children, tended to be poorer at monitoring vehicle movements, seemingly taking for the most part on trust the impact of the infrastructure on these. The relative poverty of adult perceptual strategies at pelicans renders the gains in looking behaviours achieved by training even more significant.

6. Evaluation results - zebras

6.1 Implications of differences between pelicans and zebras

Zebra crossings present a rather different challenge to pedestrians than do pelicans, toucans and junctions with a pedestrian signal. Whereas the latter all have light-controlled phases that afford explicit turn-taking rights and priorities to drivers and pedestrians, zebras require a more subtle and implicit negotiation of passage. Rights and priorities are established by the positioning and actions of road users rather than by the state of external cues like ’walk’ and ’stop’ or ’don’t walk’ lights. For this reason safe use of zebra crossings depends more than in other types of crossing upon a clear encoding of intentions (for example, pedestrians making it obvious by their position and posture that they are waiting to cross) and by complementary clear decoding (for example, that the driver of the first approaching vehicle intends to yield). The challenge for pedestrians lies in trying to ensure that they have been seen by approaching drivers and, through eye contact, trying to encourage drivers to yield. Adult pedestrians may even take one step onto the crossing in order to ’force’ drivers to give way.

Therefore, the emphasis on the approach/set-up, looking and crossing phases (cf. Section 5.1) of behaviours for pedestrians at zebra crossings is somewhat different from those behaviours at other types of crossing. Table 6.1 lists the essential elements associated with these phases. At a glance it is clear that the approach/set-up phase is basically a simpler sequence of operations because there are no buttons to press, no light signals to monitor, and the child merely has to stand in the correct position at the crossing making clear their desire to cross. Looking behaviours are crucial because of the need to engage eye contact and to check and double-check that cars are stopping from both directions at the same time. Crossing also requires constant monitoring, especially since traffic may start moving immediately behind pedestrians before they have reached the opposite kerb.

As for the pelican data, baseline performance at the pre-test will be examined first of all below, followed by an analysis of the impact of training on post-test performance and children’s conceptual understanding of how to use the zebra crossing successfully. Given its value in interpreting children’s performance on pelicans, data from the adult sample for zebra crossings will be considered in the section on baseline performance.

Table 6.1

Elements of behaviour within the approach/set-up, looking and crossing phases for zebras		
Approach/set-up	**Looking**	**Crossing**
1. Takes up position between the road markings	3. Looks right for vehicles stopping - all lanes	9. Steps out promptly
2. Stands on pavement close to (but not on) kerb	4. Looks left for vehicles stopping	10. Walks at appropriate speed
	5. Engages eye contact with leading vehicle's driver on right hand side	11. Keeps looking while walking
	6. Keeps looking right until all salient traffic stops	12. Remains on crossing area while walking
	7. Looks left to confirm all salient traffic stopping	13. Mounts pavement within crossing area
	8. Looks right again to double-check leading right hand side vehicle stationary	14. Moves to inside of pavement to continue

6.2 Baseline performance at pre-test and amongst adults

6.2.1 Behavioural measures

Figure 6.1 presents the mean proportion of trials on which target behaviours were successfully completed at pre-test, both overall and for each of the three phases. Performance steadily and significantly improved with age. Not surprisingly skill level was relatively high at pre-test for the approach/set-up phase: as described, this operation requires few demands other than correct positioning at the roadside, and even the 6-year-olds showed a high level of success. Engaging in the correct behaviours for looking and crossing is more demanding and the untrained 6-year-olds started at a significantly lower baseline than untrained 8- and 10-year-olds on both these phases. Adults' performance was not at ceiling on these phases either, though, and was only marginally better than that of 10-year-olds. Interestingly, performance with respect to the looking phase was nevertheless substantially higher in all age groups than was the case for pelicans, lending credence to the notion that both adults and children are less likely to engage in systematic checks of vehicle movements when they know these should be regulated by the infrastructure itself. In the absence of such regulation, they all take more care, though untrained performance is still not at ideal levels.

Figure 6.1. Pre-test scores by age group on zebras behavioural measures (overall and for each phase), with adult scores for comparison

Figure 6.1: Pre-test scores by age group on zebras behavioural measures (overall and for each phase), with adult scores for comparison

A more detailed breakdown of the pre-test scores, element by element, is presented in Table 6.2, which reveals significantly higher scores with increasing age on every measure except Elements 1 (taking up position), 12 (remaining on the crossing area while walking) and 13 (mounting the pavement within the crossing area). The absence of age differences for these elements is not surprising when their successful completion is so close to ceiling. It is worth noting, however, that while the counterparts for Elements 12 and 13 were performed well by all age groups for pelicans, taking up an appropriate position is notably better here, implying that the presence of the pedestrian call facility at pelicans creates an uncertainty about where to stand, that is absent at zebra crossings.

The data in Table 6.2, however, also draw attention to those particular elements at which the untrained children were poor. This includes Element 5 (engaging in eye-contact), Element 8 (checking the lead car in the right lane), and Element 11 (keeping looking while walking). Performance in these elements, taken together, suggests that, as with the pelicans it was the more subtle procedures involving checking and monitoring at which untrained children are generally poorer. The 6-year-olds were particularly poor in this respect, relative to 8- and 10-year-olds. Unlike pelicans, they were also very poor at stepping out promptly (Element 9) when cars had stopped, suggesting poorer decision-making or else greater caution when there were no fixed signals to rely on. Consistent with the latter, children were better on the basic looking behaviours here than they were for pelicans.

Adult performance was comparable to that of the 10-year-olds but slightly better, particularly on those elements on which the children performed particularly poorly, for example, engaging in eye-contact (Element 5) and stepping out promptly (Element 9). In general, though, they were no better and sometimes worse than 10-year-olds on those elements (3, 4, 6, 7, 8 and 11) which involve monitoring and checking.

Table 6.2

Mean proportion of children exhibiting each target behaviour for zebras at pre-test as a function of age, together with adult scores for comparison				
	6-year-olds	**8-year-olds**	**10-year-olds**	**Adults**
1. Takes up position	.91	.91	.95	.93
2. Stands close to kerb	.56	.66	.74	.81
3. Looks right for cars stopping	.75	.94	.98	1.00
4. Looks left for cars stopping	.72 .	.91	.93	.96
5. Engages eye-contact (right)	.11	.20	.28	.54
6. Keeps looking right till cars stop	.50	.74	.85	.77
7. Looks left to confirm	.49	.69	.84	.68
8. Looks right to check	.09	.19	.28	.35
9. Steps out promptly	.33	.58	.69	.98
10. Walks at appropriate speed	.60	.82	.88	.1.00
11. Looks while walks	.18	.28	.40	.52
12. Keeps within crossing area	.97	.96	.99	1.00
13. Mounts pavement within crossing area	.99	.98	1.00	1.00
14. Moves to inside of pavement	.38	.45	.45	.53

Finally, the proportion of instances of looking in the correct sequence at pre-test reflected, not surprisingly, the low incidence of more subtle monitoring behaviours (age 6 = .08; age 8 = .15; age 10 = .22), but these were again notably higher than was the case for pelicans. Adults showed a slightly higher proportion of correct looking sequences (.30) than the 10-year-olds.

6.2.2 Conceptual measures

Table 6.3 presents conceptual scores for children at pre-test and baseline scores for adults. Both the overall conceptual score and the scores for individual questions are shown.

Table 6.3

Baseline scores for conceptual understanding on zebras, by age				
	6-year-olds	**8-year-olds**	**10-year-olds**	**Adults**
1. Where is the best place to stand?	.28	.52	.66	.71
2. Why?	.11	.44	.60	.71
3. When is it safe to cross?	.62	.94	.91	1.37
4. What do the flashing beacons mean?	.28	.46	.72	1.12
5. Should you look at someone in particular?	.03	.14	.21	.96
6. Why?	.00	.08	.17	.67
7. What do white lines mean?	.03	.18	.27	.46
8. When crossing where should you walk?	.48	.82	.98	1.04
9. What else should you do while walking?	.06	.21	.19	1.04
10. Where should you go when you get to the other side?	.19	.40	.48	.58
11. Why?	.02	.14	.30	.37
Overall	**.21**	**.41**	**.50**	**.83**

Untrained children's level of understanding of the requirements of zebra crossings was generally very low, and even adult understanding operated at only 41 per cent of 'full' understanding as measured by the conceptual test. However, concepts of where to stand and when it was safe to cross ran slightly in advance of the corresponding concepts for pelicans. Moreover, for children, understanding significantly improved with age on virtually all the individual test questions, especially those which involved providing explanations for beliefs/knowledge which tended to produce the poorest responses. In general, there were signs of a considerable lag of concepts behind behaviour for taking up position and walking on the crossing area, especially for 6-year-olds. For making eye contact, looking whilst crossing and moving to the inside, however, concepts seemed more in line with actual performance.

6.3 Outcomes of training

The impact of training was examined through post-test performance and the 'shift' values reflecting the change in scores pre- to post-test of each group of children.

6.3.1 Behavioural measures

Figure 6.2 presents the mean overall scores at post-test for the trained and untrained conditions, together with those for each of the three subsets of elements on the different phases of crossing. Scores systematically improved with age across all phases, but comparison of trained and untrained children showed that, on the approach/set-up behaviours, trained children performed significantly better than untrained children. Trained children also out-performed the untrained on looking behaviours. On both sets of measures, however, these differences were attributable more to the 10-year-olds than to the 6- or 8-year-olds. On crossing behaviours there were no significant differences between trained and untrained children.

Figure 6.2. Post-test scores by age group and condition on zebras behavioural measures, overall and for each phase

Figure 6.2: Post-test scores by age group and condition on zebras behavioural measures, overall and for each phase

These trends are mirrored in the element-by-element analysis of post-test and shift scores (see Table 6.4). Reflecting the baseline data in Table 6.2, training had little effect on Elements 1, 12 and 13 because scores were so close to ceiling. Nevertheless, trained children still managed to progress significantly more than the controls on Element 1 (taking up position). The impact of training was also visible on a number of other individual elements, with trained children showing significantly greater gains on Element 2 (standing close to but not on the kerb) and Element 8 (looking right to check); and coming close to doing so on Element 5 (engaging eye-contact) and Element 14 (moving to inside of pavement).

Table 6.4

Table 6.4: Post-test scores and shift values by age group and condition on individual elements of zebra behavioural measures

It would appear then that training conferred particular benefits with respect to the more subtle elements of behaviour, on which children had done poorly at pre-test. The data suggest that at post-test trained children engaged in the full range of behaviours required to monitor and check traffic status on at least 50 per cent of occasions on average. This brought the performance of 6-year-olds up to adult levels on these elements, and 8- and 10-year-olds now outstripped adults. As with pelicans, the control children also showed substantial gains, but these were focused more on the elements where older children had already tended to do reasonably well at pre-test, and where progress was more a matter of the younger children, both trained and controls, catching up. This difference in emphasis was confirmed by analysis of the proportion of trials on which children ’looked in the correct order’. If training had sensitised children to all the elements or actions required to execute competent looking patterns prior to crossing, then it should also have made them more aware of the correct sequence in which those elements should be deployed. Correct order scores for the trained and control children at post-test are shown in Table 6.5, where it can be seen that increases in these scores were indeed higher for the trained children, albeit only among the 8- and 10-year-olds. Although the difference between trained and control children was in consequence only near significant, the implication is that training did promote appropriate looking sequences, and once more to above adult levels. This appears to be sufficiently advanced a skill for only those already at a higher level of competence to have benefited specifically from this effect, but it should be noted that among the control children simply carrying out the crossings still led to improvements to about adult level.

Table 6.5

Mean proportion of trials at post-test for zebras on which children carried out looking elements prior to crossing in the correct order			
	6 years	**8 years**	**10 years**
Trained	.29	.43	.52
Control	.34	.30	.37

6.3.2 Conceptual measures

Figure 6.3 shows the overall conceptual scores for children at post-test, comparing age and experimental condition. It is evident from the shift scores in Figure 6.3(b) that trained children performed at a significantly higher level than at pre-test, and also that they had progressed significantly more than untrained children at each age level.

Figure 6.3 Post-test conceptual performance for zebras by age and condition

Figure 6.3: Post-test conceptual performance for zebras by age and condition

Examining the answers children gave to each of the 11 questions in the conceptual test (see Table 6.6), trained children scored higher than untrained children on all 11 questions and significantly higher on 7 of them (Questions 1, 3, 5, 6, 8, 10 and 11). Those questions on which the differences between trained and untrained children were greatest included those concerned with positioning and looking prior to crossing (both where and why), reflecting the changes in behaviour on these aspects that were apparent amongst the trained children. Training was therefore clearly effective in imparting some understanding of the rationale for the behavioural elements that are required for safe crossing, and this appeared to go hand in hand with improved crossing performance. This linkage was largely absent amongst the control children. Once again, though, there were signs that older children with higher ability levels were more likely to benefit from this than younger children, the trained 6-year-olds showing much less advance on Question 5 (eye contact), and Question 6 (why).

Table 6.6

Table 6.6: Post-test scores and shift values by age group and condition on zebra conceptual questions

Even with these gains, however, the conceptual performance of the trained children did not come up to adult standards overall, suggesting, as with pelicans, that this is the distinct advantage that adults possess. So, for instance, the older trained children attained adult level on Question 1 (where is it best to stand?), but fell short of it on Question 2 (why). Similar patterns were evident for Question 3 (when is it safe to cross) versus Question 4 (what do the beacons mean), and for Questions 5 and 6 (eye contact/why) versus Question 9 (looking while crossing). Only for Questions 10 and 11 (where to go on the other side and why) did the 10-year-olds outstrip adults. For the trained 6- and 8-year-olds gains were enough to bring them up to around the level of the next age group up at pre-test, but not more.

6.3.3 Correlations between performance and conceptual understanding

Further evidence of increased conceptual organisation resulting from training was provided by the correlations between the behavioural and conceptual measures. These showed significant relationships between post-test behavioural scores and post-test conceptual scores which were only marginally higher for the trained children (.37) than for the untrained children (.35). On the other hand, though, training moved forward the co-ordination of behaviour and understanding rather more from pre-test level (.29) to post-test level than was the case for the untrained children, whose pre-test level of co-ordination (.32) was more similar to that at post-test. Whilst there may have been an effect of double testing on the degree of co-ordination, the data suggest that training had a greater impact.

6.4 Summary

Systematic age differences were found in the baseline performance of 6-, 8- and 10-year olds in the ’approach’, ’looking’ and ’crossing’ phases of using zebra crossings. Untrained children (6-year-olds in particular) were especially poor at monitoring and checking traffic status when crossing at zebras, and at stepping out promptly to cross when traffic had yielded, though there were signs of increased caution being shown in the absence of fixed light controls. There were also systematic age differences in the baseline conceptual understanding of zebra crossings, and adults’ conceptual grasp was considerably greater than that of 10-year-olds. However, all children performed significantly better at post-test than at pre-test, with the greatest amount of progress on balance occurring among the trained 6-year-olds. Those measures which had been poorest at pre-test, involving monitoring and checking, were those that improved most at post-test. Moreover, comparison between trained and untrained children at post-test revealed that training had generally boosted performance beyond the level brought about by increased maturity and experience of testing. Performance on approach and looking behaviours was significantly better amongst trained than untrained groups, and particularly amongst the 10-year-olds. In addition to boosting the frequency of required actions for successful use of zebra crossings, training also boosted the production of the correct sequence of looking behaviours prior to crossing in 8- and 10-year-olds, though not in 6-year-olds. Training, therefore, appeared to benefit the older age groups more in terms of the most critical aspects of behaviour. It also had a direct beneficial effect on conceptual understanding of children of all ages with particular reference to positioning and looking behaviours, though these changes were also greatest amongst the older age groups. Improvements in conceptual grasp appeared to parallel improvements in performance, and there were indications of greater integration of concepts and behaviour among trained children.

7. Evaluation results - junctions

7.1 Specific areas of concern with respect to junctions

The comparative European data presented by Bly *et al.* (1999) indicate that crossings at junctions are especially associated with increased risk for children in Britain. Although it appears that this risk may be substantially offset by the presence of pedestrian-called traffic lights, the extent of this moderating influence is unclear from the Bly *et al.* data. Given their inherently greater complexity and association with higher levels of traffic flow, it is probably the case in fact that junctions with pedestrian lights remain the most hazardous of the three crossing types considered by the current training programme. In many respects, of course, the behavioural and conceptual elements identified as important to safe use of this type of crossing are very similar to those which are significant for pelicans/puffins/toucans. The aspects which are distinctive, however, pinpoint exactly why junctions are potentially more dangerous, that is, the flow of traffic from more than two directions, contrary to the prototypical crossing situation, and thus the consequent need to remember to check multiple directions, *in the appropriate sequence* **.** In terms of behaviour, then, these two elements, checking in all directions and doing so in anticlockwise sequence from the rightmost arm (even when behind) are key; at a conceptual level, understanding of why this sequence is important is similarly central.

Thus, without downplaying the importance of the other behavioural and conceptual elements dealt with during training and testing for junctions, it was children's baseline performance on these elements in particular, and progress on them as a result of training, in which interest was necessarily greatest. This was especially so, given the relatively poor initial performance of children on looking behaviours at pelicans and zebras. Analyses of the pre- and post-test behavioural data reflected this interest by paying specific attention to children's performance on the elements within the looking phase of junction crossing, especially the looking sequence (see Table 7.1). The conceptual data were likewise examined with specific regard to children's responses concerning the looking sequence, as well as their overall grasp of the issues salient to crossing at pedestrian-called junction lights. The results of these analyses are presented in the following two sections, the first of which details children's baseline performance at pre-test (with, for comparison, the performance of the adult sample). The second focuses on the outcomes of training. A further section examines the relationship between behaviour and conceptual grasp at pre-test and post-test amongst the trained and control children.

Table 7.1

Elements of behaviour within the approach/set-up, looking and crossing phases for junctions		
Approach/set-up	**Looking**	**Crossing**
1. Takes up position beside request button	6. Looks down all roads- checks all lanes	11. Steps out promptly
2. Looks at pedestrian light to check phase	7. Looks in correct sequence	12. Walks at appropriate speed
3. Presses button and ensures that light comes on	8. Keeps looking all round till salient traffic stops	13. Keeps looking while walking
4. Stands on pavement close to (but not on) kerb	9. Repeats sequence again to double check	14. Remains on crossing area while walking
5. Remains still while waiting for green man	10. Checks signal still showing green man	15. Mounts pavement within crossing area
		16. Moves to inside of pavement to continue

7.2 Baseline performance at pre-test and amongst the adult sample

7.2.1 Behavioural performance

Values for the mean proportion of target behavioural elements present in children's pre-test performance, both overall and across each of the three crossing phases, are shown in Figure 7.1, broken down by age group. For comparison, the corresponding values for the adult sample are also included here. As can be seen, performance improved steadily (and significantly in all cases) as children got older. However, there were marked discrepancies between the different phases of the crossing procedure in the level of children's skills. On the approach/set-up and the crossing phase, even the youngest children performed reasonably well given their lack of training, engaging in the target behaviours around half the time. Amongst 10-year-olds, these behaviours were present approximately three-quarters of the time, and on the approach/set-up phase at least their performance was at the same level as found in the adult sample. In contrast, on the crucial looking phase, the target behaviours were only present at a very low level in all three age groups. Whilst adult performance on this phase was better, though, it too was poor, with the target behaviours present only around a quarter of the time. In general, performance on the approach and crossing phases was slightly below the level for the comparable phases of pelicans and zebras, but for the looking phase it was dramatically worse, reflecting in all probability the point made above about the greater complexity of junctions.

Figure 7.1: Pre-test scores by age group on junctions behavioural measures (overall and for each crossing phase), with adult scores for comparison

Examination of the scores for the individual behavioural elements helps refine this picture somewhat (see Table 7.2). The general improvement with age in the level of performance on the approach/set-up phase was still apparent, but as Table 7.2 highlights, there was considerable variation from element to element within this. Thus Elements 1 (taking up position by the request button), 3 (pressing the button) and 5 (standing still) were good from early age and did not increase dramatically. Elements 2 (looking at the pedestrian light) and 4 (positioning on the kerb) were much poorer among the 6-year-olds, and the former in particular showed a steeper increase with age. Again, though, amongst adults performance on these elements was far from being at ceiling, and they were only marginally better than the 10-year-olds in checking the light. This may of course reflect a tendency among adults to check the light on the way to the crossing rather than at it, preparing in advance for necessary action. The relatively poor positioning of adults at the kerb may also reflect preparedness for action, that is, standing on the kerb to minimise the time needed to cross.

Table 7.2

Pre-test scores by age group on individual elements of junctions behavioural measures, with adult scores for comparison				
	6-year-olds	**8-year-olds**	**10-year-olds**	**Adults**
1. Takes up position beside request button	.76	.89	.97	.87
2. Looks at pedestrian light to check phase	.25	.44	.49	.55
3. Presses button and ensures light comes on	.74	.82	.90	.84
4. Stands on pavement close to (but not on) kerb	.33	.54	.57	.57
5. Remains still while waiting for green man	.71	.77	.84	.84
6. Looks down all roads - checks all lanes	.01	.02	.07	.26
7. Looks in correct sequence	.00	.00	.03	.18
8. Keeps looking all round till salient traffic stops	.01	.05	.13	.26
9. Repeats sequence again to double check	.00	.00	.03	.11
10. Checks signal still showing green man	.19	.39	.40	.36
11. Steps out promptly	.46	.72	.75	.94
12. Walks at appropriate speed	.71	.84	.88	.99
13. Keeps looking while walking	.09	.17	.32	.47
14. Remains on crossing area while walking	.61	.74	.85	.96
15. Mounts pavement within crossing area	.67	.79	.87	.96
16. Moves to inside of pavement to continue	.35	.43	.56	.83

A similar pattern was apparent in the behavioural elements making up the crossing phase. Young children were relatively good at Elements 12 (speed of walking), 14 (remaining on crossing) and 15 (mounting within area), but were poorer at Elements 11 (stepping out promptly) and 16 (moving to inside of pavement), and fail for the most part to engage in Element 13 (looking whilst crossing). As with pelicans, performance on stepping out promptly was better than for zebras, and looking whilst crossing was worse, perhaps reflecting again a greater trust in the infrastructure. Elements 11, 13 and 16 showed on the whole the biggest increases in performance with age, with older children notably better than the younger in particular on stepping out promptly. Here though 10-year-olds still lagged some way behind adults, who were at ceiling level of performance on virtually all elements of this phase. This is perhaps remarkable as far as remaining on the crossing area is concerned, since observation suggests this is something adults are typically not overly concerned about. The implication is that performance here was 'ideal' rather than representative of everyday behaviour. The major exception to this general pattern of good performance was looking whilst crossing, which improved to age 10, and increased again amongst adults, but still only occurred at peak on about 50 per cent of occasions, a striking point if adults were trying to perform at an ideal level.

This relatively low level of incidence of looking was of a piece with performance on the looking phase itself, of course, with Table 7.2 making it plain that the modest overall improvement with age shown by children was in fact largely attributable to an increase in checking the green man before crossing. Appropriate looking behaviours were almost entirely absent amongst children, let alone being enacted in the correct sequence. Adults did at least exhibit these behaviours, but only between a quarter (actually looking) and a fifth (doing so in the correct sequence) of the time, and repeating the sequence to double check was at a very low level.

The picture that emerges then is that even young children were relatively good at the more obvious, grosser behaviours involved in safe use of junction crossings. With age there were signs of improvement in the more strategic, time-saving behaviours such as stepping out promptly, and in appropriate use of the infrastructure itself. Looking for vehicle movements, and especially double-checking on these, remained poor into adulthood, however. The impression given by the adult performance is essentially that they expected the infrastructure to do the work for them; all they needed to do, having activated the system, was wait until the light changed and then cross promptly within the boundaries of the crossing. There was no real requirement to monitor traffic, because it should be stationary. It would appear that the 10-year-olds were acquiring a similar mindset.

7.2.2 Conceptual performance

The scores obtained by children and adults on the junctions conceptual questions are shown in Table 7.3. As with the behavioural measures, it can be seen that there was a fairly uniform progression with age in the insightfulness of children's responses, the only non-significant increases being on Question 3 ('when is it safe to cross'), all three age groups scoring moderately well on this; and on Question 5 ('where is the first place you should look'), all three age groups doing poorly. As these results imply, however, there was considerable fluctuation in the level of performance from question to question, and, as with pelicans and zebras, the overall level was not high. Even the 10-year-olds' mean score was only equivalent to generating partially correct answers on around 50 per cent of occasions. In absolute terms, then, the children had some way to go. Not surprisingly, given their behavioural performance, the area where the greatest improvement was required was once more with regard to the crucial looking behaviours. The 6-year-olds had more or less no idea where they should be looking prior to crossing or why, and were no better when it came to looking while crossing. The 8- and 10-year-olds appeared to have a glimmer more understanding, but were still not performing well. Interestingly, the 10-year-olds did slightly less well than the 8-year-olds in articulating the need to look whilst crossing, but looking at the behavioural data, they actually did it more often. The 8-year-olds may have had some idea that they should be doing this, but they typically did not.

A different kind of disjunction between behaviour and concepts, where real grasp of the situation lagged *behind*action, was apparent elsewhere. For instance, there was a relatively smooth increase with age in grasp of where it is best to stand, which reflected the increased frequency with age in standing close to but not on the kerb in the behavioural measures. Responses to the question *why* this is the best place to stand lagged some way behind, however. Similarly, understanding in each age group of where they should walk while crossing reflected well the relative tendency of each to stay on the crossing area while walking. Again, understanding of what the white lines or studs *mean*lagged substantially behind this. The same pattern was also apparent for moving to the inside of the pavement once the road has been crossed: knowing this was what they should do mirrored the tendency to actually do it, but understanding of why lagged behind again. Finally, in line with the picture from the behavioural measures of younger children being relatively good at performing the more basic safe behaviours, the 6-year-olds showed a reasonable appreciation that the time when they should seek to cross is when the green man is displayed. They showed much less understanding, though, of the fact that it is not necessarily safe *immediately*this occurs. This might in fact tie in with their apparently fairly good performance relative to zebras in the behavioural measures on stepping out promptly, that is, they do this because they are unaware of the need to pause. Fortunately, this would appear to have been rather less the case for the 8- and 10-year-olds.

Table 7.3

Pre-test scores by age group on junctions conceptual measures, overall and by individual question, with adult scores for comparison				
	6-year-olds	**8-year-olds**	**10-year-olds**	**Adults**
1. Where is the best place to stand?	.30	.48	.80	.79
2. Why?	.11	.28	.42	.75
3. When is it safe to cross?	.66	.81	.84	1.33
4. Safe to cross as soon as green man? Why?	.21	.66	.68	1.08
5. Where is first place to look for cars?	.09	.20	.15	.92
6. Why?	.00	.10	.19	.36
7. Where should you look after that? Why?	.06	.10	.23	.32
8. What do the studs/white lines mean?	.06	.26	.23	.62
9. When crossing, where should walk?	.47	.87	.99	1.17
10. Do anything else while crossing? Why?	.09	.26	.15	.92
11. Where go when you get to the other side?	.18	.28	.63	.62
12. Why?	.09	.15	.38	.42
Overall	**.19**	**.38**	**.48**	**.79**

In contrast, as for pelicans and zebras, the adults, whose overall level of response to the conceptual questions was rather higher than the children’s (though by no means perfect) tended to show much less in the way of these kinds of lags. Thus grasp of where to stand was more or less in line with understanding of why, and understanding of what the white lines/studs mean was substantially higher than amongst the children. They also showed much greater appreciation of what the Green Man does and does not signify. The only evident lag was on moving to the inside of the pavement once crossing has been completed, where their behavioural performance was good, but grasp of why was relatively poor. There were signs, however, of a similar disjunction to that displayed by the 8-year-olds when it came to looking behaviour. Whilst adult performance on the conceptual questions relating to looking was certainly not perfect, in general they showed a fairly good appreciation of where they should look first before crossing, if not why - that is they understood the basic priority - and of the need to continue to look while crossing. As noted above, of course, this understanding was not, on the whole, reflected in their behaviour.

In general, then, for the children, conceptual grasp at a basic level appeared to reflect their behaviour fairly accurately, but when it came to moving beyond an articulation of what they should do to the reasons why, there were typically lags in understanding. It is, of course, exactly this kind of understanding that has been argued to be central to the *flexible*deployment of crossing strategies. Adults did rather better on these points, but suffered from a tendency not to do what they said they should, especially when it came to looking and checking. This may simply be because, in line with the impression created by their behaviour, that they do not really believe they *need*to do these things, since they trust the infrastructure to produce safe outcomes. At the same time, though, understanding of why they should be looking in certain directions prior to crossing was the only area on which the adults did poorly. There may be some interplay of influences here: if adults trust the infrastructure, they may consequently think less about what they are doing. As a result, the may be less aware of why it might be better to engage in certain looking behaviours, and thus fail to perform them. If the 10-year-olds are indeed heading towards the same mindset in the absence of intervention, it emphasises how potentially important that intervention is, and what it needs to achieve.

7.3 Outcomes of training

7.3.1 Changes in behavioural performance in the training and control conditions

Figure 7.2 shows the post-test scores among the trained and control children in each age group for the mean frequency of targeted behaviours, overall and within each phase of the crossing. There were general (and statistically significant) improvements in performance at post-test for both the trained and control children, but these were significantly greater overall for the trained. Thus the 8- and 10-year-old controls advanced to about the level of adults, and the 6-year-old controls to around the same level as untrained 8-year-olds (see Figure 7.1). The trained 8- and 10-year-olds, however, progressed to a level slightly *beyond*that of adults, and the trained 6-year-olds went up to the level of untrained 10-year-olds.

Figure 7.2: Post-test scores by age group and condition on junctions behavioural measures, overall and for each phase

There were significant variations in this pattern according to crossing phase, though. For the control children, the bulk of their progress occurred on the approach/set-up phase, where the older children improved to a level beyond the adults; and to a slightly lesser extent on the crossing phase itself. These children made little advance on the crucial looking phase. In contrast, all the trained children improved on this phase, with the 8- and 10-year-olds progressing to the admittedly modest levels of adult performance, and the 6-year-olds not lagging far behind. Training therefore appeared to have had a particular impact in the most important areas, a notable if not large success, given the apparent intransigence of this aspect of junction behaviour to change with age and experience, going by the pre-test data.

Examination of the data for the individual behavioural elements both confirmed and qualified this picture (see Table 7.4). Whilst there were some fluctuations, in general improvements on the elements of the approach/set-up phase were much the same for both the trained and control children in each age group, and no significant differences were found between conditions in shift scores. These improvements brought 6-year-olds up to around adult levels of performance, with 8- and 10-year-olds outperforming adults in most respects. Overall, the level of performance at post-test was high, the sole exceptions being the 6-yearolds on kerb position, and both 6- and 10-year-olds on looking at the pedestrian light to check the phase. Even here, though, behaviour was appropriate more than 50 per cent of the time, around the same level exhibited by adults, so progress was made by the younger children at least. As was suggested for adults, the pattern for the 10-year-olds on checking the phase of the lights may be attributable to them doing so on the way to the crossing.

A fairly similar picture emerged for the elements of the crossing phase. For the most part progress was again the same for children in both the trained and control conditions, although there was a significant tendency for advances on remaining on the crossing area and on mounting the pavement within the crossing area to occur earlier amongst the trained children than amongst the controls. In general, these changes brought children up to around or slightly below the level of adult performance. The one exception to this pattern was performance on looking whilst crossing, which changed substantially and significantly more amongst the trained children than among the controls, where progress was only to the level of the trained age group below. The trained 6-year-olds advanced from zero to around the level of the untrained 10-year-olds at pre-test. Amongst the older trained children, post-test performance on this element was at or slightly better than the adult level, though the latter was of course not ideal. It should be noted, however, that the gains achieved here were, on the whole, less than those on the corresponding element of behaviour at pelican crossings.

The implied impact of training on looking behaviours in particular was confirmed by change on the elements of the looking phase. On four of the five behavioural elements included in this phase, trained children progressed significantly more than the controls, and the exception, checking the signal was still showing the green man, came close to this. These results reflect the fact that amongst the controls progress on these elements was almost entirely absent (unlike pelicans and zebras), whereas the trained children showed some advances in each age group. The precise nature of these changes varied from age group to age group, however. For the 6-year-olds, progress was restricted to looking round till the traffic stops, and checking the signal. No advance was made on looking down all the roads, looking in the correct sequence, and double-checking, which were more or less absent in all cases. Interestingly, the profile of the trained 6-year-olds at post-test on the looking elements was almost identical to that of the 10-year-olds at *pre-test.* For the 8-yearolds, progress occurred on looking down all the roads and looking in the correct sequence, which shifted from zero, and again on checking the signal. With the exception of double-checking, their post-test profile was similar to that of the *adults*, although they did check the signal rather more often. Among the 10-year-olds, progress occurred on looking in the correct sequence and double-checking, and once more on checking the signal. Their post-test profile was identical to that of the adults, save that they checked the signal nearly twice as often.

Table 7.4

Table7.4: Post-test scores and shift values by age group and condition on individual elements of junctions behavioural measures

These results carry a number of implications. Firstly, they confirm the broader picture that training successfully improved looking behaviours in particular. Secondly, taken in conjunction with the pre-test data, they indicate that there is a kind of natural order of progression in the acquisition of looking skills. After training, in common with the untrained 10-year-olds, the 6-year-olds appreciated the need to look all round them, including while crossing, at least some of the time. However, they showed no awareness of the sequence in which they should do this, or of the need to be thorough. The 8-year-olds had learnt something about sequence and thoroughness, but show no awareness of the need to double-check. Finally, the 10-year-olds had begun to show awareness of double-checking. Yet, and this is the third point, this only brings the 10-year-olds up to what seem ostensibly the modest levels of performance exhibited by adults. It is of course possible that amongst adults and older trained children some looking behaviour is less conscious and based on peripheral vision, and therefore not sufficiently evident to be coded. This would of course fit in with the idea, noted with regard to the pre-test data that, even for adults, understanding of the rationale underlying the looking behaviours lags behind its actual occurrence.

7.3.2 Changes in conceptual performance in the training and control conditions

Given the importance attached to conceptual grasp for the flexible extension of learned behaviour to new circumstances, the question was how far conceptual change amongst the trained children had kept pace with or even driven the progress they had evidently made in terms of behaviour. The mean conceptual scores and values for shift at post-test in the trained and control conditions, both overall, and by individual question, are shown in Table 7.5. As can be seen, there was a general and notably greater advance amongst the trained children than amongst the controls - significantly greater both overall, and in the case of Questions 1 (where the best place to stand was), 5 (where the first place to look was), 6 (why there), and 8 (what the white lines or studs mean); and close to significant for Questions 2 (why the best place to stand was at but not too near to the kerb), 3 (when it was safe to cross), and 9 (where to walk). The 6-year-old controls showed almost no conceptual advance at all (and where it occurred it was matched by regression on other questions), whereas the trained 6-year-olds improved in most respects, progressing overall to somewhere between the level of the 8- and 10-year-olds at pre-test. The 8- and 10-year-old controls did show improvement, but this was for the most part limited in comparison to that achieved by the trained children in these age groups, who advanced in terms of average scores to a level approaching that of the adults.

At the same time, it should be noted that conceptual progress among the trained children, the 6- and 8-year-olds in particular, tended to be more evident on the basic issues than on the underlying rationale, and the conceptual lags seen at pre-test were on the whole not reduced to any great degree. Moreover, the observed conceptual shifts did not necessarily map particularly well onto observed behavioural change. For example, the 6- and 8-yearolds, though not the 10-year-olds, showed bigger improvements on *where* the best place to stand was than on *why*. Conversely, while the change here for the 6- and 8-year-olds did at least roughly correspond to increases in standing in the appropriate location, for the 10-year-olds, behavioural change was not matched by conceptual change. The same pattern held for where to walk whilst crossing in comparison to what the studs and white lines meant: the 6- and 8-year-olds showed greater change on the basic knowledge than the underlying rationale, but this did correspond to the behavioural change they evidenced. For the 10-year-olds, however, behavioural change was not matched by conceptual change, unless it were the increased understanding of the rationale for remaining on the crossing area. For where to go on the other side versus why, and for when is it safe to cross versus is it safe as soon as the green man comes on, the pattern of increase in basic knowledge outstripping that in underlying rationale applied to the 10-year-olds as well as to the 6- and 8-year-olds. Here, though, conceptual change did mirror behavioural change on moving to the inside of the pavement and stepping out promptly, respectively.

Table 7.5

Table 7.5: Post-test scores and shift values by age group and condition on junctions conceptual measures, overall and by individual question

Interestingly, the one element where the perpetuation of a lag between basic knowledge and rationale was slightly less evident was on one of the crucial looking behaviours, viz. Where the first place to look was and why. Here, there were large shifts on both elements in all three age groups, with the 8-year-olds showing a greater increase on why than on where. These changes brought the 6-year-olds up beyond the level of the 10-year-olds at pre-test, and brought the 8- and 10-year-olds up to around adult levels on the where question, and well beyond on the why. These changes were not, however, repeated in responses to the questions about where to look next, and whether anything else should be done while crossing, where post-test performance amongst the trained children lagged well behind that of adults, and improvement was much more limited. In general, the pattern of conceptual change is consistent with the rather unfocused improvement in looking behaviours shown by the 6-year-olds, but suggests that there is still some conceptual lag for the older trained children, who, behaviourally at least, did show greater awareness of sequence and looking while crossing.

The opposite kind of disjunction was shown with regard to initial looking by the older control children, for whom conceptual change appeared to be running in advance of behaviour. For instance, despite the almost total lack of behavioural change in this respect shown by the control children, the 8- and 10-year-olds progressed on where the first place to look was and why, and on where to look next. The 10-year-olds also showed better awareness of the need to look during crossing, though this was more in line with the behavioural change they had exhibited on this point. The changes shown on all these elements were modest, of course, and on the first two they were significantly less than those shown by the trained children, but the fact that they occurred at all was noteworthy. In other respects, the control children's post-test performance was patchy, going down on the best place to stand whilst improving behaviourally; up on when it was safe to cross and the meaning of the green man, especially among the 10-year-olds, despite a lack of behavioural change; and changing modestly on the remaining elements, in line with behavioural progress. The source of the conceptual improvements the control children did show, especially with regard to looking, is not immediately apparent, though the fact that they were more prevalent as children got older may provide a clue, suggesting as it does that they were associated in some fashion with increasing cognitive competence.

7.3.3 Relationships between behavioural performance and concepts in trained and control children

As was noted previously, for pelicans and zebras behavioural change amongst the trained children was associated with a tendency towards increasing integration between behaviour and concept, as measured by changes in global correlation between the two, a tendency absent amongst the control children. For junctions, however, as outlined in the previous section, the picture seemed to be more one of unintegrated behavioural and conceptual change, except perhaps for some aspects of looking behaviour, stepping out promptly, and movement to the inside of the pavement. Indeed, if anything behavioural and conceptual progress appeared in step for a slightly greater number of elements for the *control*children. Since mismatches between behavioural and conceptual change might still be consistent with greater integration in actual performance, though, it was important to examine correlations between behaviour and concept scores at pre- and post-test. In fact, comparison of global correlations between these scores bore out the pattern implied by the values for change. For the trained children, the pre-test correlation between behaviour and concept was .38, dropping marginally at post-test to .36. For the control children, on the other hand, the pre-test correlation of .30 increased at post-test to .46. Closer examination of the data revealed that for the control children this increased correlation was largely attributable to stronger relationships between the behaviours and concepts for the approach/set-up and crossing phases (.10 to .24 and .15 to .34 respectively), shifts which were weaker in the trained condition. There was no sign, however, that improved concepts respecting looking amongst the trained children impinged particularly on their post-test looking behaviour, even though these were the most marked areas of growth in this condition. This seems to confirm the point suggested previously that, for junctions at least, looking behaviour is more complex, and seems to be less conscious and less well related to explicit concepts than is the case in other areas of performance, at least initially.

7.4 Summary

In general, the pre-test performance of children on the junction crossings was very patchy, with even 6-year-olds showing reasonable levels of appropriate behaviour on the approach/set-up and crossing phases, but all age groups doing poorly on looking prior to crossing and monitoring during crossing. Conceptual lags, especially with regard to underlying rationale, were evident in almost all areas of performance. Adults too performed less well on the looking and monitoring elements, compared to other aspects of behaviour, and seemed to suffer also from a specific lack of explicit understanding of why it was necessary to look in certain directions. Training improved both behaviour and conceptual grasp with respect to looking in all age groups, advances that were largely absent amongst the control children, although the latter did progress in other areas, especially with respect to behaviour. These gains in looking brought trained 6-year-olds up to about the level of the 10-year-olds at pre-test, and the trained 8- and 10-year-olds up to, or even slightly above, the levels exhibited by adults. There were signs, however, that the trained children continued to suffer from the same difficulties as adults in building up detailed concepts of appropriate looking strategies and using them to inform behaviour, perhaps because of the complexity of the latter; and they relied on more intuitive grasp of how to act. In approach/set-up and crossing behaviours, both trained and control children advanced to around adult levels of behaviour, but conceptual lags remained commonplace here too.

8. Conclusions and recommendations

Taken together, the data present a fairly comprehensive picture of how children and adults think designated crossings are meant to be used and of how they actually use them when asked to demonstrate best practice. The evaluation also allows general conclusions to be drawn regarding the benefits of training in different age groups and the extent to which this enables children to approach (or even surpass) adult levels of performance. In this section we draw the various strands together, paying particular attention to the overall effect of the programme; to any shortcomings or areas of concern; and to any adjustments that, in retrospect, might maximise the potential of the programme. This is followed by a set of more specific recommendations.

8.1 Overall effects of training

The first point to note is that training in the use of designated crossings is undoubtedly needed. Even the 10-year-olds' pre-test performance fell short of adults, particularly in terms of their conceptual understanding. Bearing in mind that such children will shortly be confronted with designated crossings on a much more regular basis (after the transition to secondary school), there is a clear case for prior training in the use of these as yet relatively unfamiliar structures. The performance of younger children shows that they are even less familiar with the correct use of such crossings.

The evaluation shows that the training programme worked, producing improvements both in behaviour, especially looking, and in conceptual understanding for all three types of crossing. The benefits were not limited to any one age group, and all children behaved more safely and strategically after training. However, older children improved much more in terms of their conceptual understanding, being better able to explain not just *what*actions were required at different stages of the process, but *why*those actions were necessary. The result is that, at post-test, the oldest children drew close to adult levels of performance and in some respects even surpassed it. Bearing in mind the importance of conceptual grasp for the extension and adaptation of behavioural strategies to novel circumstances, and the fact that training consisted of only four 20-30 minute sessions around the computer, this would seem to be a commendable result.

Although this general pattern was found for all three types of crossing, there were nevertheless identifiable differences in how well children coped with these. At pre-test, children generally coped best with zebras, followed by pelicans, with junctions lagging some way behind. This is perhaps not surprising, since the order corresponds to a fairly obvious increase in complexity. In spite of these differences in complexity, children actually improved to about the same extent on each type (that is, their shift scores were about the same in each case). However, because they started from different points, the differences observed at pre-test persisted at post-test. Thus children continued to under-perform at junctions relative to zebras and pelicans.

Too much should probably not be made of these differences, especially as they were not found for children's conceptual understanding which was about the same for each crossing type both at pre- and post-test. On a practical note, however, it may be that there would be benefit in devoting slightly more attention to behaviour at junctions during training in order to compensate for this imbalance in difficulty levels between the crossing types. This might be done quite easily within the existing software, by simply spending more time on the junction examples, where these occur, repeating them if necessary to cement efficient performance.

8.2 Performance of the control children

An interesting aspect of the findings is that the controls also improved across the course of the study. Improvements were, on the whole, limited to the grosser aspects of the crossing strategy and were noticeably weak when it came to conceptual understanding. Nevertheless, these improvements in children who had not received training merit comment.

The most likely reason for improvement is that the children were asked to make a total of 24 crossings over the course of the testing programme. By any criterion, this represents a fair amount of practice. Of course, children received no feedback during testing. Nevertheless, the process of being asked to cross the road under the watchful eye of an adult would probably cause children to reflect on what they were doing and behave in as ’correct’ a manner as they could, insofar as they could determine what this should be. This would also explain why those conceptual advances that were observed among the control children typically occurred amongst the 10-year-olds, who might be expected to have rather better capabilities to construe explicit principles from experience.

It seems likely that the observed improvements in control children’s behaviour reflect the ’transparency’ of designated crossings - that is, the extent to which individuals can deduce the best way of using them in the absence of overt instruction. In this regard, it seems there is more transparency in these structures than was initially anticipated, reflecting positively on the achievement of their designers. It would seem that deviations from intended use arise more often from implementation problems (for example, the signal is set to be insufficiently responsive to requests, so pedestrians have to wait too long and thus fail to do so), rather than basic flaws in their underlying conception. Some of these implementation problems may be eliminated through appropriate adaptation of the basic design (see for example, Carsten, Sherborne & Rothengatter, 1998).

Nevertheless, the improvements seen in trained children relative to controls shows that there is much merit in a short course of training in the use of designated crossing structures. The amount of training required is modest and, in older children especially, the results are quite impressive.

8.3 Performance at the two sites

The study was undertaken in Gateshead and West Dunbartonshire mainly to ensure that the results were not entirely specific to any one area - although it should be stressed that there was no intention to obtain a representative sample of the national population. However, given that two areas were involved, it is appropriate to consider the relative performance of children from those areas.

In terms of children’s behaviour, a general difference in favour of the Gateshead sample was found, with these children performing better at pre-test on all three crossing types, despite their slightly younger age profile. The effect was most marked for zebras (.68 vs. .56); least marked for junctions (.51 vs. .42); and was more pronounced in older children than younger ones. For zebras, this difference is understandable as zebra crossings have been virtually absent in the Glasgow area for many years (the crossings used in the study had been installed immediately before the start of pre-testing). It is less clear why the Gateshead sample should have enjoyed an initial advantage for the other two crossings. A possible reason is that there were no pelican or junction crossings in the immediate area where the West Dunbartonshire children lived and would likely spend most of their time. Indeed, it was necessary to take children by minibus to the nearest pelican and junction crossings in order that testing could take place in a timely manner. Nevertheless, they would undoubtedly have experience of such crossings when out and about with their parents, for the main shopping area for people from the district had several of these. Interestingly, however, these behavioural differences were not reflected in children’s conceptual scores, where no effect of site was detected.

Whatever the reason for the pre-test differences, this did not confer an undue advantage on the Gateshead children during training. In fact, the shift scores following training showed that the West Dunbartonshire children improved significantly more than the Gateshead children on both zebras and junctions. For pelicans, there was no difference between the sites. In West Dunbartonshire, even the control children improved more than their Gateshead counterparts on zebras. These improvements did not eliminate the differences between the sites at post-test, but they reduced them to a significant degree. For example, the advantage in favour of the Gateshead sample on zebras was reduced from .12 at pre-test to .6 at post-test. On junctions, the advantage fell from .11 to .05. Thus, while training did not eliminate the difference between the two areas, it brought performances more into line with each other than they had been initially. As at pre-test, there were no differences between the sites in terms of children's conceptual understanding.

The relatively greater impact of training on the West Dunbartonshire sample probably reflects the lower baseline from which these children started, which gave them more opportunity to register improvements than the Gateshead children, who started off significantly nearer their ceiling. The important point to note is that both groups improved significantly as a result of training. A weak starting position certainly did not reduce the effectiveness of training, which was clearly of value in both areas.

8.4 Areas for emphasis during training

Junction crossings have already been identified as an area where additional attention during training would be desirable. More generally, while pre-test performance identified room for improvement in most aspects of behaviour, children's perceptual search strategy on all three crossing types stood out as needing particular attention. Perceptual search includes not only observation of approaching traffic immediately before making the decision to cross, but observation during crossing itself. It also includes attention paid to the green man, where appropriate, which often seemed cursory. These activities attracted the lowest scores in all age groups (including adults) and, notwithstanding that significant improvements were made as a result of training, continued to attract the lowest scores at post-test. Interestingly, though, within certain bounds the issue appears to be as much one of knowing that search behaviours matter, since even young children showed a tendency to engage in them more often for zebras, where there was no fixed signalling system to rely on for marking out when to cross. The implication, then, is that an increased emphasis on appropriate search behaviours during training, and above all on *why*these are needed, ought to produce more substantial improvements. All the resources are available within the existing software to support this added emphasis; that it was not given so much attention during the evaluation was due to the fact that this specific shortfall in children's performance had not been anticipated, and so trainers had not been primed to focus on it in particular.

Another area deserving of special attention is children's conceptual understanding, which continued to lag behind their behavioural performance relative to adults even at post-test. This was especially true of the younger children. The greater scale of conceptual change, and, in some instances, the greater integration between concepts and behaviour shown by trained children, merely reflect how far they have to go. Insofar as conceptual understanding is generally regarded as being necessary in order to achieve robust and meaningful behavioural advance, additional efforts aimed at improving children's understanding further would therefore certainly seem warranted. Again, however, the design of both the software and the training procedures should allow increased emphasis to be given to conceptual grasp, now that it has been recognised as a specific requirement. Thus, without adapting the software, it should be possible to make sure that conceptual issues are always to the fore, that the purpose of the different elements is explained, and that children are constantly asked to say why they would do what they say they would do. There is every reason to suppose that this additional emphasis should produce further gains. At the same time, though, conceptual advance is always easier to achieve when there are other ideas already in place that can be built on. In particular, understanding of the patterns of vehicle movement, of the variability of driver behaviour, of its degree of conformity to convention, and of the cues that are available to anticipate such variation might all prove to be invaluable in enhancing children's sensitivity to the rationale for the elements of the designated crossing strategies. This carries strong implications about the timing of designated crossings training relative to that on more generic skills.

Finally, one other, more specific area where increased emphasis might be desirable is the issue of what to do when pedestrian lights change from the green to the red man either before or during crossing. It would appear that younger children in particular failed to grasp the appropriate strategies on the basis of the existing training, although it was only possible to test conceptual understanding in this area. In this case, changes to the software to provide more experience on this aspect of stand-alone signal-controlled crossings and junction light use would seem to be the way forward, and such changes have already been made.

8.5 Adult performance

A consistent feature of adult performance during testing on the different crossing types was their failure to engage in appropriate looking strategies. This was despite the high level of behavioural skill they exhibited in other aspects of crossing use, and the reasonable levels of awareness of the issues underlying perceptual search that they demonstrated in response to the conceptual questions. It was also despite the fact that, as the evaluation study showed, it is possible to raise the performance of children in this respect to a higher level than that exhibited by the adults, so there is no obvious inherent constraint on looking behaviour. In fact, as noted previously, there was some tendency, in common with the children, for adults to perform rather better on looking behaviour at zebras, where it was more critical. It is also possible that they relied in general on peripheral vision to some extent, rendering their search behaviours less detectable. However, this said, there are inescapable signs of adults regarding the infrastructure of stand-alone signal-controlled crossings and junction crossings as relieving them of the need to carry out thorough search strategies before and during crossing.

This mind-set is problematic not only because it may lead adults to underestimate the risks they face when using designated crossings, but also because of the impact it may have, by extension, on children. For instance, assuming eventual use of the designated crossings training programme by adult volunteers (as with the National Network for Pedestrian Training currently being set up by the Department for Transport), any tendency for these volunteers to regard looking strategies as less crucial at stand-alone signal-controlled crossings and junctions may feed through into a lack of attention to this issue when training the children. This point would therefore need to be paid attention to when providing training for trainers, and when designing the content of any putative materials aimed at supporting parents or other volunteers engaged in training. More generally, this shortfall in performance may also carry implications for the effects of parental behaviour in everyday contexts, given that parents almost certainly act to some extent as models for crossing use for both their own and other children. If parents appear not to regard looking at crossings as necessary - or even if their behaviour in this respect is not very detectable - it may well be harder to help children towards an understanding of its importance. Thus some form of campaign aimed at raising adult awareness of the need to engage in appropriate looking behaviours at crossings, especially in the presence of children, might be helpful.

8.6 Recommendations

In the light of all these points, the following broad recommendations are made:

- taking the evaluation study as a point of departure, a detailed formulation of the designated crossings training programme should be drawn up, including detail on the appropriate group-based use of the software, and giving particular emphasis to the points where special attention appears to be necessary, viz. behaviour at junctions, looking strategies, appropriate action when pedestrian lights change, and the concepts underlying the various elements of the safe crossing strategies;
- use of the training programme, given the evident need for it and its demonstrable effectiveness, should be implemented on a wide scale, ideally as part of the same initiative as use of the generic skills training software developed by Tolmie *et al* . (2002), in view of the likely benefits of having undertaken the generic training prior to designated crossings training;
- training in use of designated crossings via the software program should be coupled, where possible, with some limited roadside sessions on crossing use, as a means not only of assisting children to make connections between software and roadside, but also of adding value to the computer-based training, bearing in mind the effects of supervised use of crossings on the performance of the control children in the evaluation study; and
- whilst training using the designated crossings programme may be appropriately undertaken with children throughout the primary age range, it should be targeted in particular at older primary school children, since these are the most likely to be using crossings independently either at that time point or after the transition to secondary school; since they appear to have the greatest capacity to benefit from the training; and because they are more likely to have had the space to have already undergone training in generic pedestrian skills.

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Appendix 1: Technical material relating to designated crossings consulted during task analysis phase

Document Type	Title	Publisher/ Producer	Date of Publication
Leaflet	How to use Pedestrian Signals at a Junction	Unknown	Unknown
Leaflet	"Zig-Zag" markings at Pelican Crossings	DoT	1989
TAL 4/91	Audible and Tactile Signals at Pelican Crossings	DoT	1991
TAL 5/91	Audible and Tactile Signals at Signal Controlled Junctions	DoT	1991
NMAL	The Use of Puffin Pedestrian Crossings	DoT	1993
TAL 10/93	"Toucan": an Unsegregated Crossing for Pedestrians and Cyclists	DoT	1993
Report	The Assessment of Pedestrian Crossings	DoT	1995
Report	The Design of Pedestrian Crossings	DoT	1995
Report 277	Pedestrians' and Cyclists' Attitudes to Toucan Crossings	TRL	1997
Circular	The Zebra, Pelican and Puffin Pedestrian Crossings Regulations & General Directions	DETR	1997
Leaflet	How to use a Puffin Crossing	DETR	1998
TAL 4/98	Toucan Crossing Development	DETR	1998
Report	Toucan Crossings: Trials of Nearside Equipment	TRL	1998
Drawing	Proposed layout of a toucan crossing for Raynors Lane, Harrow. Drawings PRO/29/020&21D	TCSU	2000

Key to Publisher/Producer:

DETR - Department of the Environment, Transport and the Regions
DoT - Department of Transport
NMAL - Network Management Advisory Leaflet
TAL - Traffic Advisory Leaflet
TCSU - Traffic Control Systems Unit
TRL - Transport Research Laboratory

Appendix 2: Illustrative screen shots from the training software

a) Opening screen showing the cast of characters and access to the four routes/training sessions

Screenshot of opening screen

b) Section of route selection map

Screenshot of route selection map

c) Initial view at decision point (junction)

Screenshot of initial view at decision point (junction)

d) Taking up position ready to cross, Wait button pressed but red man still showing

Screenshot of ready to cross position

e) View to right

Screenshot of view to the right of position

f) View to left, traffic lights changing

Screenshot of view to the left of position

g) Feedback given by the computer when attempting crossing without looking correctly (zebra)

Screenshot of an incorrect attempt to cross a zebra crossing

h) An example of a crossing where the lights change when the character is halfway across

Screenshot of crossing where the lights change when the character is halfway across