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The Role of Skills, Attitudes and Perceived Behavioural Control in the Pedestrian Decision-making of Adolescents Aged 11–15 Years

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CONTENTS

EXECUTIVE SUMMARY

The peak age for pedestrian accidents among school pupils in the UK is between 12 and 14 years, following the transition to secondary school, and **after** children have apparently become relatively competent at interacting with traffic. The reason why vulnerability should increase when underlying skills have improved is unclear. A better understanding of the processes at work is therefore needed in order to determine what steps might be taken to counteract this problem.

One contributing factor may be that young adolescents' road-crossing skills are first acquired in the quieter environments around primary schools. As a result of this, pupils may in fact be inadequately prepared for dealing with the busier roads that surround secondary schools, especially when they are typically no longer accompanied by parents. This problem may be compounded by adolescents thinking that they are more able than is actually the case, because of a widespread tendency to regard road safety as an issue that only concerns primary school children. As a result, they may fail to notice any need to adjust their behaviour to the more demanding conditions which they now face. In addition, a bias among adolescents towards rule-breaking as part of attempts to establish an identity distinct from that of their parents may actually lead to deliberate risk-taking by some.

This report details two studies designed to unravel which of these factors contributes most to increases in unsafe pedestrian behaviour between the ages of 11 and 15 years. **Study 1** focused on whether young adolescents do, in fact, have limited skills for dealing with more complex traffic environments; and whether, in spite of this, they underestimate the difficulty of road-crossing decisions, and ignore signs that their performance is less adequate than they believe.

Pupils aged 12 to 15 years, drawn from secondary schools in a socially-mixed area of west central Scotland, were tested on computer-simulated problems relating to four aspects of pedestrian skill. The same tests were also undertaken by 11-year-olds from primary schools in the same area, and by adults, to allow skill levels and perceptions of difficulty among young adolescents to be compared with those before the transition to secondary school, and amongst adept pedestrians. The four areas of skill were as follows:

- **safe route planning** – the ability to recognise the dangers posed by aspects of the road layout and to adjust crossing routes to deal with these hazards;
- **visual timing** – the ability to co-ordinate road crossing with vehicle movements;
- **use of designated crossings** – the ability to pick up signals from different types of crossing infrastructure and from traffic at these crossings, and to adopt appropriate crossing strategies; and

- **perception of drivers' intentions** – an awareness of different types of clue to drivers' impending actions, and the ability to use this information to adjust road-crossing decisions.

The problems for each skill were designed to cover a range of difficulty, to provide a realistic assessment of performance under conditions of the type encountered by secondary school pupils. As part of testing, pupils were also required to make periodic judgements of the difficulty of the problems, both before completing them and afterwards, in the light of their actual performance.

In order to check that the simulated problems provided an accurate measure of skills, sub-samples of the 11-year-old, 13-year-old and adult participants were tested on related problems at the roadside. Data from these tests confirmed that computer-based and roadside assessments were well correlated on key measurements for each of the four skills, although some elements of visual timing and poorer levels of ability on safe route planning appeared to be captured less well by the computer.

Performance on the simulated problems themselves showed that secondary pupils possessed only slightly better skills than primary school children, and that they were notably poorer than adults in various important respects. For instance, the secondary pupils performed as well as the adults on safe route planning, and only 12-year-olds did worse than adults on timing judgements. However, the majority of them did less well than the adults on identifying clues to driver action, and on the safe use of designated crossings. They were particularly poor at making visual checks for moving traffic at automated crossings, although even the adults performed at less than ideal levels in this respect. In contrast, the secondary school sample did not differ more than marginally from the primary school pupils in any of the four skill areas.

In spite of this, secondary school pupils tended to rate the problems in all four skill areas as easier (relative to their actual skill levels) than either 11-year-olds or adults. Only adults showed signs of revising estimates of difficulty upwards after completing problems, acknowledging that they might have been harder than anticipated. These points suggest that the secondary school pupils were particularly insensitive to the adequacy of their own performance, as had been anticipated. However, this characteristic was only prevalent among the 13- to 15-year-olds. This indicates that it is not an automatic consequence of the shift to secondary school but of some alteration in perceptions that occurs subsequently. It should be noted that there were no gender differences in the pattern of performance for any of the four skills or for estimates of difficulty.

Whilst the data are suggestive, Study 1 on its own did not demonstrate that underestimating difficulty or failing to notice signs of inadequate performance actively leads to more hazardous behaviour. It also provided no information about the process that produces the shift towards such misperceptions in the period after children start secondary school. In particular, it is important to determine whether they are linked in some way to peer attitudes and behaviour (i.e. to external influences), or to the growth of a more internally-driven bias towards carelessness and risk-taking.

Study 2 was designed to investigate the source of young adolescents' misperceptions of difficulty, and the relative impact of these and attitudes or other perceptions on pedestrian decision-making. A sample of 12- to 15-year-old pupils, drawn from four secondary schools in the same area as those used in Study 1, were assessed on:

- computer-based tests of their skills and perceptions of difficulty in the four areas focused on by Study 1;
- their attitudes toward 11 pedestrian behaviours, some cautious (e.g. waiting for the green man) and some risky (e.g. running through a tight gap in the traffic);
- their perceptions of how far each behaviour was approved of by others;
- the extent to which they thought parents and peers performed each behaviour;
- how far they saw each behaviour, and risk-taking more generally, as part of their self-identity (i.e. as something characteristic of themselves);
- the extent to which they intended to perform each behaviour in future;
- the frequency with which they did in fact carry out each behaviour over a subsequent two-week period;
- their accident and recent near-miss history;
- where they lived (used to derive a measure of socio-economic status); and
- how they travelled to and from school (providing a measure of exposure).

Skills and perceptions of difficulty were very similar in character to those observed in these age groups in Study 1, the only notable difference being that misperceptions of difficulty were more prevalent among 12-year-olds in this sample. Pupils' attitudes were, on balance, positive towards cautious behaviour and negative towards risky behaviour. Perceived approval of the different behaviours showed the same profile, as did reports of parents' behaviour. Peers, in contrast, were seen as much more likely to engage in risky behaviour, especially by 15-year-olds. Perceptions of self-identity and personal risk-taking lay between the parent and peer profiles, being less cautious than parents, but more so than peers. There was, however, a drift towards greater risk-taking among 15-year-olds, reflecting the perceived shift in peer behaviour. Reported intentions and actual behaviours again favoured caution over risk-taking, but both showed the same drift, and behaviour tended to be less cautious than had actually been intended.

These general trends masked considerable individual variability, which to some extent was accounted for by gender differences, girls tending to be more cautious than boys. The larger sample size employed in this study also made it possible to detect marginal gender differences in skills and perceptions of difficulty, with boys tending to exhibit slightly higher skill levels and lower ratings of difficulty. There were large variations in responses above and beyond the effects of gender, however. This made it possible to examine in detail which other factors were associated with the intention to perform each of the 11 target behaviours, and which were associated with the reported frequency of carrying out each behaviour subsequently. These analyses produced highly consistent results.

As far as intentions were concerned, attitudes and perceived approval were moderate influences, especially for the cautious behaviours, but the strongest influence was participants' self-identity and risk-taking profile. Parent and peer norms of behaviour also had a moderate direct influence on the intention to perform cautious and risky behaviours respectively. They appeared to act on intentions primarily in indirect fashion, however, with parents' behaviour influencing perceived approval and peers' behaviour influencing individuals' self-identity.

This said, intention was at best only a moderate influence on actual behaviour, as was self-identity. Instead, peer norms had a strong direct influence on carrying out risky behaviours, and parent norms on acting in cautious manner. Moreover, self-reports of carrying out risky behaviour were related to near-miss history and thence to accidents, indicating they resulted in genuine hazard. Misperceptions of difficulty were found to be associated with self-identity rather than self-reported behaviour, suggesting that carelessness of this kind is symptomatic of risk-taking rather than a strong source of hazardous behaviour in its own right. Better skills, especially in the area of safe route planning, were associated with more cautious behaviour. Although boys exhibited riskier intentions and behaviour, the pattern of effects leading to increases in risk was identical for males and females. Socio-economic status and exposure had no detectable influence on either intentions or behaviour.

To summarise, few adolescents showed markedly positive attitudes to hazardous behaviour, but they were pulled towards riskier attitudes, intentions and actions – and increased carelessness – by the perceived presence of an element of risk in peer behaviour and attempts to be like them. Peer behaviour had this influence even when individuals had no particular intention to act in risky fashion, suggesting it created a direct pressure to behave carelessly. This is especially concerning given that two-thirds of the sample reported frequently making the journey home from school, one of the peak periods for accidents, in a group. Crucially, however, parental behaviour provided an equivalent pull in the opposite direction, through the instilling of safe habits and the creation of a sense of disapproval of hazardous behaviour.

Adolescents therefore appear to be more likely to behave in a hazardous fashion, to underestimate the difficulty of road-crossing, and to have both near-misses and accidents where peer influence is strengthened and parental influence is weakened. Measures which in one way or another counteract these trends ought therefore to increase safe behaviour. Four possible and realistic avenues for intervention are suggested by the data from these two studies:

1. Support for the parental modelling of safe pedestrian behaviour seems likely to be a productive arena for intervention, but it must be stressed that it is what parents do, rather than what they say, that appears to matter. Moreover, the data suggest that the influence of parental behaviour is greatest when it has led to established habits of safe practice. The key period for intervention would therefore be likely to be during the primary school years.
2. Skills training within the same period is also likely to have benefits, since higher skill levels were associated with safer behaviour, and thus exerted a further degree of protective influence – perhaps again because they reflected safe habits.
3. Encouraging adolescents to reflect more on their road-crossing behaviour might also be productive, for two reasons. First of all, intended (i.e. deliberate) behaviour tended to be more cautious than spontaneous behaviour. Secondly, greater reflection is likely to promote increased attention to the adequacy or otherwise of existing skills.
4. Participants' own behaviour could not logically have been systematically more cautious than that of their peers, who were also taking part in the research. It would appear that perceptions of risk-taking amongst peers are therefore the consequence of distorted impressions, perhaps due to deliberate posturing. The sensitisation of adolescents to the gap between perceived and actual peer behaviour ought to reduce the apparent peer pressure in favour of risk-taking, and the adoption of this as part of individual self-identity.

Contrary to popular belief, there is little indication in the present research that young adolescents are bent on courting danger, but they do appear to suffer from systematic misperceptions, both social and traffic-related, which bias them towards carelessness within potentially hazardous environments. Altering these false impressions and establishing better practices is likely to require a degree of sophistication and forethought that would be less necessary with younger children, but the suggestions above are practicable ways forward. There is no reason to suppose that adolescents would be particularly resistant to their influence if they were enacted appropriately.

1 BACKGROUND

1.1 Adolescents as pedestrians

In recent years it has become clear that the acquisition of pedestrian skills is a protracted process extending across the whole of early and middle childhood. Available evidence suggests that, generally speaking, on tests ranging from the choice of crossing routes to the use of designated crossings, children first approach adult levels of performance around the age of 11–12 years (Thomson *et al*., 1996; Tolmie *et al.*, 2003).

However, in spite of having attained this level of pedestrian competence, accident rates in 12–15-year-olds remain high. Indeed, peak pedestrian injury rates in developed countries tend to occur between 11 and 16 years (Roberts *et al*., 1998; Agran *et al*., 1998; Bly *et al*., 1999). This is particularly true in the UK, where analysis of police fatal accident files (Sentinella and Keigan, 2004) shows a peak in pedestrian fatalities at age 12 for boys and age 14 for girls. As an indication of the scale of the problem, in 2003 there were over 11,000 pedestrians and cyclists aged 11–16 involved in road accidents, of whom almost 2,000 were killed or seriously injured (Department for Transport, 2004).

Why should older children remain so vulnerable when their underlying pedestrian skills and competences have improved? One possibility is that past skills testing has presented an incomplete picture with respect to the development of pedestrian competences, and that adolescents suffer in fact from limitations or lacunae that place them at greater risk. There are clear indications that the transition to secondary school in the UK results in increased demands on children’s pedestrian skills. Secondary schools are typically located in busier areas than primary schools, and children often have longer journeys to and from school, increasing their exposure to these more demanding environments. Moreover, these changes occur at exactly the time when they start to insist on – and are generally allowed – greater independence (Lynam and Harland, 1992; Platt, 1998; Platt *et al*., 2003). Some evidence of the possible impact of the conjunction of these influences is provided by the fact that the increase in accidents post-transition to secondary school is primarily on busy roads (Harland *et al*., 1996). The implication is that, whilst adolescents’ pedestrian skills may have reached the level where they are competent to deal with quieter traffic environments, their competences are not yet adequate to meet the demands of busier ones, and require a period of further honing. If this is the case, the nature of the skills gap needs to be clarified as a matter of urgency.

Alternatively, it may be that additional factors emerge around this age to undermine the progress that has been made in skill development. Young adolescents typically regard road safety concerns as ‘childish’, regardless of whether or not their skills are fully developed. Both focus group and interview data suggest that they accord such issues a low priority, and see road safety as something they 'did at primary school' (Tolmie and Thomson, 2003; Lupton and Bayley, 2001). The shift from the dominance of parental to peer-group influence that happens at this age (Steinberg, 1988) may serve to reinforce these perceptions by granting them the appearance of a consensual view. In addition, the growth of a bias towards norm-breaking as part of the endeavour to develop an independent identity distinct from that of parents (see Erikson (1968, 1972) on the importance of this) may lead deliberate risk-taking to become more highly valued for some adolescents (Arnett, 1995). In turn, this may feed through to pedestrian behaviour (cf. West *et al*., 1998). Again, then, the crucial task must be to identify the factors at work and how they operate. Without a better understanding of these, it is very hard to know what steps might be taken to improve pedestrian vulnerability in this age group.

1.2 Hypotheses for investigation

Whilst framed as alternatives, there is in fact no reason to suppose that these different strands of influence are mutually exclusive and, indeed, that there are various ways in which they might interact with each other. Putting them together, the following hypotheses about the sources of adolescents' vulnerability as pedestrians emerge as plausible possibilities:

1. **There is a sustained mismatch between actual and perceived competence.** Young adolescents may overestimate their abilities in more challenging road environments because they are less used to these, i.e. their **perception** of their competence has been shaped in less difficult conditions and therefore fails to match their **actual** competence in the circumstances to which they are now routinely exposed. As a result, they pay inadequate attention to the effectiveness of their judgements, and because they simply assume (with peer support) that they are able to cope, they persistently make poor or marginal decisions that remain uncorrected by feedback. A similar mismatch between perceived and actual skill has been noted previously amongst novice drivers, and found to be associated with increased accident rates (Matthews and Moran, 1986; Guppy, 1993; Mills *et al*., 1998). It might be noted here that past research on pedestrian skills may, in fact, also have led to overestimates of children's capabilities at the primary–secondary school transition, as a consequence of a tendency to assess skills in fairly straightforward contexts.
2. **Peer group norms create pressure to behave in riskier fashion**. There is no particular reason to believe that adolescents in general hold exceptionally negative attitudes towards road safety. Such work as exists to date suggests that extremely risky behaviours are uncommon, that adolescents tend to have a reasonably realistic view of at least some factors that increase risk, and that they are likely to behave more responsibly when in charge of younger siblings (Elliott and Baughan, 2003; Elliott, 2004; Chinn *et al*., 2004a; Lupton and Bayley, 2001). However, the coincidence of increased influence from the peer group and reaction against parental standards may result in a growing consensual

perception that riskier behaviours are the accepted norm, and a feeling that it is childish to behave carefully. The net effect of this may be an amplification of both direct and indirect pressures to take greater risks in traffic environments, in terms of a perceived need to conform to specific group norms of less careful road-crossing behaviour, and a more general espousal of risk-taking as part of self-identity (see, for example, Terry *et al*., 1999, on the role of group norms in shaping self-identity, intentions and behaviour). Given the greater tendency of boys to challenge existing norms, it is also likely that there would be gender differences in any such effects.

These hypotheses suggest that a combination of cognitive and social factors can be expected to influence pedestrian decision-making in adolescence. Since these factors appear likely to interact in complex ways, it would be helpful if a model were available to help conceptualise their modes of functioning. Such a model is provided by Terry *et al*.'s (1999) extended version of the Theory of Planned Behaviour (TPB). The original TPB framework (Ajzen and Madden, 1986; Ajzen, 1988) has been used to study a wide range of health-related behaviours, as well as decision-making in drivers (e.g. Conner and Norman, 1995; Parker *et al*., 1992). The theory posits that individuals' intentions to behave in a certain way (i.e. their decision-making) are determined by three influences:

- first, the individual's **attitude** to the behaviour in question, and the extent to which s/he believes the behaviour will lead to positive or negative outcomes;
- second, the **subjective norm**, or perceived approval or disapproval of important others for performance of the behaviour; and
- finally, their **perceived behavioural control**, i.e. the extent to which the individual feels free to determine for themselves whether to perform the behaviour or not.

To these elements, Terry *et al*. (1999) add two further component influences, **self-identity** and **group norms**. They argue that individuals' sense of their characteristic modes of behaviour (i.e. self-identity) is also an important influence on intention, provided that they feel free to enact these (i.e. perceived behavioural control is high); people are more likely to intend to engage in a particular behaviour if it is an important part of their self-concept. However, for those who strongly identify with their peer group (as is likely to be so for adolescents), self-identity is essentially a function of group norms, and these become the dominant influence. Under these conditions, they argue, freedom to choose how to act becomes effectively redundant. It should be noted here that group norms are distinct from the subjective norm in two ways: first, they are focused on the actual observed behaviour of others rather than impressions of approval or disapproval for personal behaviour; and second, they are concerned with a single source of influence (the peer group) rather than being a composite influence across different important others (e.g. parents and friends).

What is absent from the Terry *et al.* version of the TPB framework is any role for **actual** and **perceived skills** in forming intentions. Indeed, it is a weakness of much research within the TPB framework that it relies heavily on self-reports of behaviour, rather than examining action in any direct fashion, and in consequence the impact on decision-making of competence, whether real or perceived, has largely tended to be ignored. In the present context, there are specific, cogent reasons for examining these influences, but in fact it seems likely that ability or perceived ability typically has a bearing more generally on whether or not individuals choose to perform an action.

1.3 Aims of the present project

The primary aim of the present project was to investigate the influence of each of these seven factors on the pedestrian decision-making of adolescents in the age range 11–15 years. The use of the TPB as an orienting framework had the advantage of establishing at the outset a conceptual and methodological approach which would allow the **relative** importance of these factors to be assessed across this age range, rather than the research focusing simply on the description of their influence in isolation from each other. It was considered that the ability to do this was essential to the process of informing judgements about potential interventions in a balanced fashion.

This aim was addressed by means of two studies. The objective of **Study 1** was to provide an initial test of the hypothesis of the emergence of a discrepancy between actual and perceived pedestrian skill in the period following transition to secondary school. The key goals were therefore to:

1. assess the **actual** pedestrian skills of adolescents aged 11–15 years;
2. compare these to measures of their **perceived** pedestrian skills;
3. consider how the relationship between actual and perceived skill changes, especially across the transition from primary to secondary school; and
4. examine how this relationship compares to that found amongst adults.

Study 2 was intended to address the central objective of assessing the relative impact of the cognitive and social factors outlined above on adolescent pedestrian decision-making, and in particular to test the hypotheses regarding the role of misperceptions of ability and peer-group influence. To do this, data were collected on attitudes, subjective and peer norms, self-identity, perceived behavioural control, and actual and perceived skill from a sample of adolescents in the first three years of secondary school, along with measures of behavioural intention with respect to safe road crossing, and of actual behaviour (i.e. performance, as opposed to competence). These data were analysed using regression techniques to examine the relative contribution of skill, attitude and identity variables on pedestrian decision-making (i.e. intentions) and thence behaviour.

2 STUDY 1

2.1 Issues for investigation

Study 1 was designed to test the hypothesis of the emergence of a discrepancy between perceived and actual pedestrian skills following the transition to secondary school. A sample of children and young adolescents from the last year of primary school (Primary 7 (P7) in Scotland, i.e. 11- to 12-year-olds) and the first three years of secondary school (Secondary 1 to 3 (S1 to S3), i.e. 12- to 13-year-olds, 13- to 14-year-olds and 14- to 15-year-olds respectively) were assessed via computer-based tasks on four areas of pedestrian skill:

- safe route planning;
- visual timing of crossing judgements;
- use of designated crossings; and
- the perception of drivers' intentions.

In view of the possibility that previous assessments had overestimated older children's pedestrian skills by focusing on more basic situations, the items in each skill area were designed to include a number of more complex and challenging problems, of the kind that adolescents in urban areas would be more likely to face.

As well as gauging actual performance, the computer tasks required participants to make periodic judgements of the perceived difficulty of the problems they had to solve, both before and after having completed them. This made it possible to compare relative perceptions of difficulty to relative levels of performance, and examine how far these perceptions were adjusted in the light of the feedback generated by experience. Data were also collected from an adult sample using the same tasks in order to establish how close to mature levels adolescent performance was in terms of both skill and perceptions of relative difficulty.

Past research (e.g. Tolmie *et al.*, 2005; Tolmie *et al.*, 2002; Chinn *et al.*, 2004b) has established the effectiveness of computer simulations for both training and assessing pedestrian performance in a controlled fashion. However, to permit further cross-validation of measures in the present context, data on selected skills were also collected at the roadside from a sub-sample of Primary 7 (P7), Secondary 2 (S2) and adult participants.

If the emergent discrepancy hypothesis is correct, participants from S1, S2 and S3 (i.e. post-transition) would be expected to regard decisions in all skill areas as easier relative to their actual performance than either P7 children or adults. Since this discrepancy was hypothesised to be sustained by lower levels of attention to feedback, the S1 to S3 participants should also show a tendency not to revise their estimates of difficulty after completing problems to the same extent as the P7 children and adults, even where they perform poorly. Finally, since the discrepancy hypothesis is founded on the notion that adolescents assume their performance is better than it actually is, it was expected that the S1 to S3 participants would show skill levels which were clearly poorer than those shown by adults.

2.2 Method

2.2.1 Design

Data collection was completed in two separate blocks. Computerised assessment took place during the first block of testing, within which four key skill areas were examined in five age groups, P7, S1, S2, S3 and adults. The sequence in which each skill was tested was varied systematically between participants in order to minimise order effects. Roadside assessment was conducted during the second block of testing.

Since roadside testing is time-consuming, and its primary purpose in the present context was the cross-validation of the data collected by the computer software, it was not deemed necessary to test all five age-groups. Thus, samples from three age-groups were assessed: children from P7, adolescents from S2 and an adult sample. The P7 and adult groups provided important reference points against which the adolescent skill levels could be benchmarked. As roadside testing of perceptions of drivers' intentions is extremely difficult to standardise (see Tolmie *et al*., 2002; Foot *et al.*, in press), this was excluded from consideration in this block. Of the remaining skills, no more than two were assessed for any given individual, and the order of these was again systematically varied. The first block was completed at least four weeks before the second started, to avoid contamination of the roadside data by memory of the computer test materials.

The perceived difficulty of test items was systematically assessed before and after performance on the computer materials relating to all four skill areas, but not at the roadside. Computer and roadside performance was subsequently correlated in order to assess the extent to which characteristics of the first reflected actual road-crossing skills. Computer performance was then examined for changes with age in skill profile, and the relationship of skill to perceived level of difficulty in each age group.

2.2.2 Participants

A total of 169 participants took part in the study. They were drawn from five different age groups, and seven different educational institutions in west central Scotland. The first four groups' age range was between 11 and 15 years, corresponding to classes P7, S1, S2, and S3. They were drawn from secondary and feeder primary schools in each of two areas, Clydebank and Dumbarton. These schools were contacted through the Road Safety Department of West Dunbartonshire Council. The last group, the adult sample, was drawn from postgraduate students at Strathclyde, Glasgow and Stirling Universities, and was aged between 21 and 47 years. All child and adolescent participants took part with the permission of the local authority, their head teacher, and their parents. All members of the research team had Scottish Criminal Record Office clearance, and the research had received university ethical approval.

Table 2.1: Study 1 – number of participants, by age group and gender

	M	F	Total
P7	20	19	39
S1	14	17	31
S2	22	18	40
S3	16	15	31
Adults	9	19	28
Total	**81**	**88**	**169**

A breakdown of the sample is shown in Table 2.1. Taken overall, the sample was approximately balanced for gender and was representative of a range of socio-economic status and school ability. The exact age was known for a total of 161 participants; date of birth information was withheld in the remaining eight cases. Of those for whom age was known, the mean of the 38 P7 pupils at the date of first testing was 11 years, 5 months; of the 29 S1 pupils it was 12 years, 5 months; of the 40 S2 pupils it was 13 years, 5 months; of the 29 S3 pupils it was 14 years, 5 months, and of the 25 adults it was 27 years, 3 months.

2.2.3 Materials

The study was designed to assess skill and perceived level of difficulty within four broad and related areas of pedestrian competence:

- **safe route planning** – the perception of dangers posed by aspects of the road layout and the adjustment of crossing routes to deal with these;
- **visual timing** – co-ordinating road crossing with vehicle movement;
- **use of designated crossings** – the perception of cues from traffic and crossing type and the crossing strategy employed; and
- **perception of drivers' intentions** – an awareness of cues to drivers' future actions, and the need to adjust road-crossing decisions to fit.

All four skills were assessed via computer-based tests, and the first three were also assessed at the roadside.

2.2.3.1 Computer assessment measures

The pedestrian skills assessment software contained four separate modules of simulation materials, each assessing one of the four pedestrian skills in an imaginary town environment, within which a set of problems of varying levels of complexity had to be solved. Each module, apart from visual timing, addressed a total of 12 different problem scenarios; visual timing involved multiple decisions within each of six different scenarios. The problems all required participants to carry out a specific pedestrian judgement on behalf of an on-screen character. The degree of difficulty of the problems systematically increased within each module, allowing assessment under both more straightforward and more challenging conditions.

The software was also designed to probe perceived levels of difficulty. The method employed was the same in all modules and involved participants estimating the difficulty of completing specific problems, before and again after performance, in the light of the feedback they had received from the experience of making judgements. Estimates were made by clicking the mouse on a continuum similar in appearance to a thermometer, with markers of very easy to very hard at either end (see Appendix 1). Each participant was asked to make this estimate before and after six matched pairs of problem scenarios in each of the four modules, with the exception of visual timing. Here these judgements were made before and after performance at each of the six test locations. In each case, the participant was presented with a preview of the scenario s/he was about to work on, and asked to estimate how difficult s/he thought it would be to complete the problem, given what they had seen. They then made the judgements relevant to that pair or set of problems. Once they had done so, they made an estimate of how hard they actually found the problems to be. This enabled **reaction** to perceived performance to be assessed relative to actual skill level, as well as initial perceptions of problem difficulty.

All software was authored using Macromedia Director 6.0 on the PC platform. This allowed the creation of a realistic 3D environment featuring high-quality animation routines and some degree of interactivity. Examples of the simulated environments for all four modules are included in Appendix 1. More detailed descriptions of the assessment software for each skill area are given below.

2.2.3.1.1 Safe route planning

Identifying a safe location from which to cross is as important as the crossing task itself. Routes that minimise (a) the exposure to traffic (e.g. crossing directly rather than diagonally), (b) blocking of both pedestrians' and drivers' views (e.g. parked cars, blind/sharp bends, hills), and (c) the number of stimuli in the traffic environment to be considered by the pedestrian (e.g. intersections where traffic arrives from several directions) are considered safe.

This module contained 12 problem scenarios of varying levels of difficulty, which presented participants with an elevated view of a street containing parked vehicles and other obstacles obscuring the view, plus junctions and blind bends, etc. Although each scenario contained more than one type of feature to be dealt with, the focus of the first set of four scenarios was on junction crossings, the second set of four scenarios on blind bends, and the last four scenarios on parked vehicles and other obstructions. The central character was seen standing on one side of the road and the participant was asked to select the safest route possible to a designated spot on the other side of the street. The starting point was always a dangerous location, i.e. very close to parked cars, or on a blind bend or near a junction, so that simply walking across from that point was not a safe option. The destination was marked with an arrow. Participants had to decide what the view of the online character was from the point s/he was standing, and to make judgements about safe crossing routes accordingly.

Once the route had been decided upon, they were able to mark it on the screen by clicking where the character would have to walk in order to enact the selected route. They were also required to justify this route ('Why did you choose that route?'). The software allowed movements to be rescinded, in case participants changed their mind and wanted to select a different route.

Estimation of difficulty. The scenarios were presented in six sets of two, paired by location, problem type and level of difficulty. Estimates of perceived difficulty bars appeared before and after each of the six pairs. The participants were asked to make pre-judgements as soon as the first scenario in each pair came up on screen, but before the exact destination of the online character had been indicated. Post-judgements were made once they had completed the crossing for the second problem of each pair.

2.2.3.1.2 Visual timing

The aim of this task was to evaluate the ability to recognise when a sufficiently large gap between vehicles is available to enable a safe crossing to be made. A gap refers to time rather than distance, and factors such as road characteristics (e.g. width) and personal characteristic (e.g. walking speed) may influence the size of the required gap for safe crossing. Thus, certain judgements need to be made for a safe crossing to be completed, including:

- the distances and speed of vehicles (often approaching from more than one direction), including those further away as well as those close to the point of crossing;
- the gaps between those vehicles that might present a crossing opportunity (the time available);
- the time that the pedestrian would need to cross the road in question, given its width and the intended speed of movement (the time required); and
- the time that these vehicles will take to reach the intended crossing point.

This module presented six problem scenarios of varying levels of difficulty. Each location was shown from a bird's eye view, which made the surrounding roads and traffic visible. The traffic flow was continuous in each case, with safe gaps appearing from time to time. The six locations differed in terms of the volume, speed and direction of traffic, width of roads and number of possible gaps available to make a safe crossing. The animated sequence for each problem location was of a fixed length, and designed to loop three times to create animations of sufficient duration to conduct the task, with vehicle characteristics being altered on each successive run-through. In practice, it was very difficult to perceive the repetition. A practice trial of three crossings was included at the beginning of the module, to help participants familiarise themselves with the task.

In each scenario an on-screen character was shown, whom participants had to help make up to six crossings between moving traffic from the specific point s/he was standing at, while imagining that s/he was walking at normal speed. Participants had to estimate how long it would take to make a crossing under the circumstances depicted. In order to help them make that decision, and to give them some indication as to how fast the online character and the traffic was moving, a short movie was presented for around 30 seconds prior to the start of testing for each location, showing the online character crossing the road and walking along the pavement until taking up his or her position on the kerb, as well as showing the traffic moving.

The participant then had to watch the traffic carefully and press an on-screen 'Start' button to signal the start of each crossing that they thought was safe. The character took one step forward onto the road to indicate the start of crossing. As participants did not actually see the crossing completed, they had to make estimations about how long it would take the character to get to the other side of the road. When they thought s/he was at the other side, they pressed on a 'Stop' button, to indicate that the character had completed the crossing. Participants continued with the next crossing whenever they felt it was safe to cross, without waiting for the tester to indicate the beginning of the next attempt. Testing at each location was completed when (a) participants had performed six crossings or (b) after five minutes had passed, whichever took less time.

Estimation of difficulty. Estimation of difficulty bars were presented before and after each of the six scenarios. After the short movie at the beginning of each scenario, traffic was frozen for a while, and the bar appeared at the bottom of the screen. Participants made their pre-trial judgement about how difficult it would be to make the character cross the road safely, according to what they had seen so far. The post-trial judgements were made after having completed a maximum of six crossings at each location, at which point the traffic flow froze again and the post-bar appeared.

2.2.3.1.3 Use of designated crossings

Designated crossings may facilitate pedestrians' attempts to traverse the road, but they require certain behaviours to be carried out in a particular sequence for these crossings to be safe, for example: move to the appropriate position, press a request button, check the pedestrian light, look for traffic both right and left, check for ongoing traffic when the green man appears, and check both lanes for traffic during the crossing (see Tolmie *et al*., 2003). Behaviours when using pelicans, zebras and junctions with pedestrian-called crossing phase were assessed by this module.

The module contained 12 problem scenarios, which presented participants with a street level view of 12 different designated crossings, four zebras, four pelicans and four light-controlled junctions. The participants were instructed to make the on-screen character cross the road at the designated crossing in the safest possible way.

The 12 crossings were presented in six predefined pairs. Pairing was based on the arrangement of crossings on six maps which participants were presented with prior to being tested. Each map depicted an environment containing two different types of designated crossings within the same area:

- the first and fifth maps contained a zebra and pelican crossing;
- the second and the fourth map contained a junction and a pelican crossing; and
- the third and the sixth maps contained a junction and a zebra crossing.

For each pair of crossings, participants were first presented with an elevated view of the relevant map, and the two designated crossings were pointed out to them. Next, they were presented with a street level view of the first designated crossing. An on-screen character was seen standing on one side of the road and the participant was asked to decide and describe what the character should do in order to cross in the safest possible way. The starting point was close but not immediately next to the designated crossing. Once they had been shown how to make the character perform the behaviours they had described, they proceeded to complete the crossing and moved on to the second of the pair.

In each scenario, traffic approached from various directions, obeying standard traffic rules. Stepping into the road before checking for traffic or before pressing for the green man was therefore not a safe option. The software allowed for a variety of behaviours to be performed, such as walking in any direction, looking right, left and behind, and pressing for the green man (where applicable). For example, by clicking anywhere on the screen, the on-screen character would walk to that point; or by clicking on the right or left side of the screen, either when stationary or when crossing the road, the character would look right or left, respectively, the screen changing to display what they would see. Once the crossing had been completed and the character was across the road, an arrow appeared at the bottom of the screen allowing the participant to proceed to the next scenario.

Estimation of difficulty. Pre-assessment estimations of difficulty were made while participants were presented with the elevated view of each of the six maps. Post-estimations were made on the same maps, which were presented after crossings at both designated sites had been completed.

2.2.3.1.4 Perceptions of drivers' intentions

Pedestrian skills would be limited if they were based on the assumption that vehicle movements are entirely regulated by and predictable from the road infrastructure and conventional usage of it. In practice, drivers use the infrastructure in different ways, and vary in their goals and in their control of their vehicles. They may also, on occasion, disregard convention altogether. To deal with this additional complexity, pedestrians need to recognise that the traffic environment is populated by agents with different intentions and objectives, and be able to read the cues available both from vehicles and from the infrastructure to interpret drivers' likely intentions and thus anticipate future vehicle movements.

This module assessed the ability to read and interpret such cues. It contained a total of 12 problem scenarios, each presenting the participant with an elevated view of a street where a pedestrian was attempting to make a crossing and where various vehicles were moving. Scenarios were presented in six sets of two, paired by difficulty level. In each case, participants had to predict the future movement of specific vehicles on the road on the basis of the information provided by the vehicle, other road users or the road environment, such as:

- the vehicle indicating (left or right);
- changes of the vehicle's speed (accelerating or slowing down);
- the vehicle changing road position;
- the vehicle braking (and slowing down or stopping);
- the presence of reverse lights;
- engine noise;
- drivers getting into the car;
- other pedestrians' behaviours (e.g. hailing a taxi);
- traffic lights, and
- the presence of a designated crossing.

Some scenarios depicted incorrect driving behaviours, for example, a vehicle indicating too early before the corner it was intended to turn into, or a car overtaking after the traffic light changed to amber at a junction and the car in front had stopped.

For each scenario, participants had to carefully view a short sequence (3 to 5 seconds) providing cues of this type as to what would happen next. At the end of the sequence, the image froze. Participants were asked to make their predictions about the vehicles in question, identify what cues there were to support their predictions, state what alternative possibilities there might be, and decide whether it would be safe for the pedestrian to cross at that moment. After that, a concluding sequence was presented, showing what the vehicles actually did. This was provided to generate performance feedback equivalent to that yielded by enacting behaviours in the other three areas of skill assessment, and thus a similar basis for making post-estimations of difficulty.

Estimation of difficulty. Perceived estimations of difficulty bars appeared before and after each of the six pairs of problem scenarios. Participants were asked to make a pre-judgement once they were presented with the first scenario in each pair, after having viewed the initial sequence, but before giving their prediction. The post-judgements were made after they had watched the concluding sequence of the second scenario of each pair.

2.2.3.2 Roadside assessment measures

Assessments at the roadside provided measures of pedestrian skill in three of the four areas used in the computer-based testing, namely safe route planning, visual timing and use of designated crossings. No estimates of difficulty were collected during the roadside testing. Detailed descriptions of the methods used to assess skill in each of the three areas that were tested are given below.

2.2.3.2.1 Safe route planning

Comparable locations of three different types (near parked cars, near a junction and near a blind bend) were identified in the vicinity of each of the participating schools. All selected sites were in residential areas, with minimal moving traffic. Participants were taken to each site in turn, and asked to imagine that they were alone and wanted to cross to a destination point located a short distance along the pavement and across the road. The start point was always a dangerous location, i.e. very close to the parked cars, on the blind bend or at the junction. The destination point (an identifiable object such as a doorway) was chosen so that simply walking across to it from the start point was not a safe option. Participants were asked to select and point out their preferred route to the destination (but not actually cross the road), and explain why they would use this route. Data relating to four crossings (two start points x two destinations) were collected at each of the three locations types, giving 12 sets of responses in all.

2.2.3.2.2 Visual timing

Suitable sites for the assessment of visual timing skills were only available in one of the two areas in which participating schools were located, and testing was therefore restricted to children from those schools. The same sites were utilised for both primary and secondary school participants. The first part of the task required a fairly quiet road. Standing at the kerbside, participants made judgements of the time it would take them to cross the road if they were walking at normal speed, by envisaging themselves crossing following a start signal and shouting 'now' when they imagined they would have reached the opposite kerb. After four separate judgements of this kind, and under close supervision by the researchers, participants were asked to physically cross the same stretch of road four separate times, at normal walking speed, in order to obtain a measure of their actual crossing time. The road where this task was completed was similar in width to the road where the second part of the timing task was carried out.

For the second part of the task, a fairly busy road, with no traffic calming measures or traffic lights or parked cars, was used. Participants were taken to the site and took up position at the kerbside, with a clear view of traffic in both lanes' traffic. A video camera was located behind them. They were then asked to raise their hand as soon as they thought it was a safe time to cross the road, putting it down whenever they thought they would have been at the other side of the road, had they actually carried out the crossing. Data were collected from up to 10 such trials within a maximum 20-minute period.

2.2.3.2.3 Use of designated crossings

Suitable sites for the assessment of designated crossing skills were only available in the area which lacked sites for the testing of visual timing. The testing of designated crossings was therefore restricted to children from the schools in that area, the same sites again being utilised for both primary and secondary school participants. Within this area, no zebra crossings were available (these being rare in the west of Scotland), and behaviour was thus assessed only at pelicans and junctions with pedestrian-called crossing phase. Two different pelican and two different junction crossings within a short distance of each other were used, and participants completed two crossings at each by crossing from one side to the other, then back again. Thus eight separate attempts were observed in total, four of each type. After taking up position at the kerbside, near but not immediately next to the designated crossing, participants were asked simply to cross the road using the crossing, while being closely followed by one researcher to ensure safety.

2.2.4 *Procedure*

As noted previously, testing was completed in two separate blocks. The first, which took place within schools, focused on the computer-based assessments; the second concentrated on roadside testing in the areas immediately surrounding schools. Each test session lasted no more than 50 minutes (the duration of a school period), with participants proceeding at their own pace.

2.2.4.1 Computer assessment

Computer-based testing of children and adolescents took place in their respective schools, with four to five participants at a time working on a one-to-one basis with a researcher. Each school provided an empty classroom, where four to five laptops could be set up in such a way that participants did not overlook one another. The assessment of adults took place at the University of Strathclyde, in computer booths located in the Department of Psychology. The adults were tested on an individual basis, also working one-to-one with a researcher.

Each participant was seated in front of a laptop computer with a tester seated alongside him/her. The tester welcomed the participant and instructed him/her to fill in their details (name of school, year group, date of birth and name) on the initial display screen, and then click on the 'OK' button to begin the session. The order in which the assessment modules were completed was systematically varied across participants according to a pre-arranged schedule. At the outset of each task guidance was provided in the use of the relevant software and, where appropriate, how to make the on-screen character carry out the desired actions. For the visual timing module, participants also had the opportunity to complete a practice trial of three crossings, to familiarise themselves with what would be required from them in that task.

Once the participant understood what they had to do, testing for that skill began. Much of the data was recorded automatically by the computer, reducing potential bias and minimising missing data, as the software would not move on until each trial had been completed. The role of the researcher was primarily to guide the participant through the on-screen instructions, to provide them with help and clarification if requested, and to prompt full consideration of the problems being addressed. They did, however, collect qualitative data on separate coding sheets for some of the modules. Thus, for safe route planning, the chosen route for each problem was automatically recorded by the computer with a red line and was available for subsequent scoring, but the explanations/justifications were written down by the tester on a coding pro-forma. Similarly, for use of designated crossings, the presence or absence of target elements that should be exhibited by a safe crossing were noted on a pro-forma checklist (the list of behaviours is described in the scoring section below); the sequence of actions performed by the on-screen character was not recorded by the computer. For perceptions of drivers' intentions also, responses as to what the vehicle would do and why were recorded on a pro-forma response sheet. Data collection for visual timing was fully automated, as was progression through the task. If fewer than six crossings were made at the end of the five minutes, the software would proceed to the next scenario, and would record and calculate the data based on the number of crossings that were actually made up to that point. No feedback on the adequacy of the decision and the safety of the behaviour performed was provided to the participants by the researcher at any point during or after testing.

Perceived difficulty estimations were obtained at the points indicated in the preceding section. Pre-estimation of difficulty responses were obtained by asking 'How easy or difficult do you think it will be for the character to cross the road safely/to predict what the cars will do next?', and getting participants to respond using the estimation bars on-screen. Post-test estimation of difficulty similarly followed the question: 'How easy or difficult was it for the character to cross the road safely/to predict what the cars actually did?' Only after all problem scenarios for a module had been completed, and pre- and post-estimations of difficulty had been made, could participants proceed to the next module.

2.2.4.2 Assignment of participants to roadside testing

In total, 96 of the 169 participants were tested at the roadside, although none were tested on more than two of the three skills, primarily because of constraints on the availability of test sites for visual timing and use of designated crossings. As far as possible, the roadside sample was balanced for gender. Thus, within each skill type, a sub-sample of approximately 20 pupils from P7, 20 from S2, and 10 adults completed the roadside assessment. The area in which each skill was tested was decided on the basis of the surrounding traffic environment. Thus, pelican and junction crossing tests were carried out in Clydebank. Visual timing tests took place in Dumbarton. Safe places tests were conducted in areas around all four schools.

Table 2.2: Roadside test sample – number of participants by skill tested, gender and age group

Skill	*Age group*			**Total**
	P7	**S2**	**Adults**	
Visual timing	17 (8M/9F)	20 (10M/10F)	10 (2M/8F)	**47**
Designated crossings (junctions/pelicans)	19 (12M/7F)	20 (10M/10F)	10 (3M/7F)	**49**
Safe route planning	20 (10M/10F)	20 (9M/11F)	9 (3M/6F)	**49**

The sub-sample of children and adolescents was drawn from the schools in the areas that provided test environments for each skill. Thus, the whole sub-sample of 37 pupils (no data were available for three participants) for visual timing came from the Dumbarton schools. Half of them (20) were also tested on safe route planning. Similarly, 39 pupils from the Clydebank schools were tested on the use of designated crossings, with half of these (20) also being tested on safe route planning. The sub-sample of adults consisted of 20 individuals split between the Dumbarton and Clydebank sites, this determining whether they were tested on visual timing or the use of designated crossings. Approximately half of the individuals in each section of the sub-sample (there were no data for one person) also completed testing on safe route planning in the same area. This arrangement yielded roadside data from approximately 50 participants in three age groups for each of the three skills tested. Table 2.2 presents the number of participants tested at the roadside, broken down by skill, gender and age group.

2.2.4.3 Roadside assessment

The roadside assessment took the form of a 'traffic trail' through streets adjacent to the schools, during which each participant was assessed in up to two skills. Testing took the equivalent of one school period in each case. To ensure their safety, participants were accompanied by members of the research team at all times, and were all wearing fluorescent yellow reflective jackets. Where participants were asked to actually cross roads (i.e. on the first part of visual timing and for the use of designated crossings), they were very closely supervised by a researcher.

Accompanied by a team of researchers, younger participants were taken from their classroom along the traffic trail for their school in groups of four to five. All testing took place individually, and researchers were available to supervise participants while others were being tested. Adults were tested on the same traffic trails as the younger participants, being taken out by car to these trails in small groups. Again, all testing was conducted individually. No feedback was provided to the participants at any time during or after the assessments.

The data recording was largely manual. Thus for safe route planning, participants' preferred route for each problem was recorded on a schematic drawing by the researcher carrying out the testing, along with their explanations for choosing that route. For visual timing, estimated and actual crossing times were recorded by the researcher on a stopwatch and noted on a pro-forma. Crossing judgements were recorded on videotape and subsequently scored directly from this medium. For the use of designated crossings, crossing behaviours were noted on a pro-forma, as for the computer-based assessment, by a researcher standing at the other side of the crossing.

2.2.5 Scoring

Performance in each skill area was scored according to predetermined criteria derived from past research (see Thomson and Whelan, 1997; Tolmie *et al*., 2002; Tolmie *et al*., 2003). Details of the scoring systems employed for the computer-based assessment and, where appropriate, roadside assessment, are given in separate sections below. Scoring for estimations of difficulty, which was conducted in the same fashion in each skill area, is outlined in a further section following these.

2.2.5.1 Safe route planning

Participants' skill was assessed in terms of behavioural performance, according to the route they had chosen, and conceptual understanding according to the reasons they reported for choosing a specific route.

2.2.5.1.1 Behavioural performance

The routes chosen by the participants in the 12 different scenarios/locations were coded according to the index shown in Table 2.3. As a check on the reliability of coding, data for 28 participants or 16.5% of the sample were scored independently by two researchers. Inter-rater reliability was 93.3%.

Table 2.3: Safe route planning – behavioural scoring

Score		
Unsafe	A	A direct route from the start point to the destination, usually involving crossing the road diagonally
	B	Does not move away from the starting point to cross, but crosses straight across the road and then to the destination, or moves from the starting point only in order to be opposite the destination point
Safe	C	Moves away from the dangers of the starting point but ends up too close to some other danger, or an otherwise D route but crosses the road diagonally
	D	Moves away from all dangers before crossing the road straight across

The number of **safe routes** taken was calculated by adding up the number of routes coded as C or D, and the number of **unsafe routes** by adding up the number of routes coded as A or B. These numbers were then converted to percentages of the overall number of routes described.

2.2.5.1.2 Conceptual performance

A participant's explanations for the choice of each route were coded according to the index shown in Table 2.4. As for behavioural performance, the reliability of coding was checked via independent scoring by two researchers of data for 28 participants (16.5% of the sample). Inter-rater reliability was 88.3%.

Table 2.4: Safe route planning – conceptual scoring

Score	
0	Gives no response, or says 'I don't know'
1	Answer does not include anything relevant to road safety
2	Answer is related to road safety but is irrelevant or untrue in this context
3	Identifies feature that is dangerous but not why it is dangerous, or says 'can see' but can't
4	Identifies what the dangerous feature is and why, or explains why the new position is superior in terms of being able to see better

The responses for individual routes were then collapsed by averaging scores across these to create one variable which represented **conceptual understanding**.

2.2.5.1.3 Roadside assessment

The variables and method of data scoring were the same as those used in the computer assessment.

2.2.5.2 Visual timing

This task required only behavioural responses, which were all recorded and scored automatically by the computer. The start and stop decision points of every crossing made by each participant (i.e. the moment the on-screen character was made to step forward and the moment s/he was supposed to reach the kerb across the road) were recorded along with information regarding the movement of the traffic, the width of the road, and the time the character needed to cross each road. These data were then used by the computer to automatically calculate the variables shown in Table 2.5 (final variables represent averages or totals as appropriate across the maximum six individual crossings made at each location, i.e. up to 36 crossings in total).

2.2.5.2.1 Roadside assessment

The variables used were essentially the same as those used for the computer assessment. The time from the moment participants stepped forward until the moment they judged they would be on the kerb across the road was recorded from videotape for each trial and used to determine any differences from the estimated and actual crossing times recorded during the first part of the task. Participants' signals indicating the start of each trial provided the bases for the measure of starting delay and effective gap size for that trial. Measures for the accepted gap size (between vehicles) were derived from the continuous video recording of the traffic. Missed opportunities and tights fits were based on the time each participant would require to cross the road (i.e. their actual crossing time), and were calculated as described in Table 2.5. No measure of splats was needed for roadside testing. Final scores were based on the performance across a maximum of 10 trials.

2.2.5.3 Use of designated crossings

Participants' skill was measured in terms of the behaviours performed. A predefined set of elements that should be present in a safe crossing (see Tolmie *et al*., 2003) was used to calculate behavioural scores. Table 2.6 presents these elements. Since the occurrence or non-occurrence of each behaviour was clear and objective, no check on the reliability of scoring was deemed necessary. In order to derive overall values, the occurrence of each element was scored in terms of the percentage of occasions it was present across all attempts for a given type of crossing (zebra, pelican and junction).

2.2.5.3.1 Roadside assessment

Variables and method of data scoring were the same as those used in the computer assessment for junctions and pelicans.

Table 2.5: Visual timing variables – description and calculation

Variable	Description	Calculation
Accepted gap size	The temporal size of any gap nominated by the participant as safe	The number of frames, converted to seconds, between two vehicles passing the projected crossing point: From frame of vehicle preceding 'start' click until frame of vehicle following 'stop' click
Effective gap size	Since there is usually a delay stepping into a gap, there is a mismatch between the true size of the gap and its actual effective size (defined by the time that remains between actually stepping out and the next vehicle arriving)	The accepted gap size less the delay (number of frames, converted to seconds): From frame of 'start' click until frame of following vehicle
Starting delay	The time the character takes after a vehicle has passed before stepping into the ensuing gap. The full size of the gap can be exploited by making the character step out smartly once the lead vehicle has passed, thereby maximising the gap's effective size. Alternatively, a perfectly safe gap could get squandered by procrastinating before making the character step out, thereby reducing the size of the useable part of the gap (and possibly making it unsafe)	The number of frames, converted to seconds, between a vehicle passing the projected crossing point and the click to start walking: From frame of preceding car until frame of 'start' click
Estimated crossing time	The time participants estimated it would take the on-screen character to cross the road	Frame of 'stop' click minus frame of 'start' click, converted to seconds
Total missed opportunities	A possible safe gap which the participant did not use to make a crossing	The time needed to cross was calculated based on the width of each road and the time it would take the character to walk across at a fixed pace. Any gap more than one and a half times the number of frames it took to cross a road, irrespective of whether the next car is nearside or far side, was counted as a missed opportunity if not selected. Missed opportunities were calculated as a total across trials
Total tight fits	Tight fits represented 'close calls'. The definition of a tight gap varied according to whether the approaching vehicle was in the near lane, far lane, or middle lane (in the case of the three-lane dual carriageway used at the last scenario).	Total number of crossings made in each location which fitted the following criteria: The size of splats and tight fits, in frames, depends on whether the next car is nearside or far side. If nearside, then a splat occurs if the effective gap size is smaller than the number of frames needed for the on-screen character to reach the centre of the road and a tight fit occurs if the gap size is larger than this but smaller that the time taken to complete the crossing. If the next car is far side, then a splat occurs if the effective gap size is smaller than the time taken to cross the road and a tight fit occurs if the gap size is larger than this but smaller than the size of a missed opportunity
Total splats	Any crossing which, if attempted, would not give enough time to reach the other side of the road without being struck	
Crossing attempts	Number of crossing attempts	Number of crossings made by a participant at each location (participants should have made six crossings at each location but for some the loop of traffic ran out before they had made all six crossings, i.e. they were timed out)

Table 2.6: **Designated crossings elements – description by type of crossing and crossing phase (P = preparatory behaviour, L = looking whilst assessing when to cross, C = behaviour during crossing)**

Pelican (13 elements)	Junction (12 elements)	Zebra (10 elements)
• Looks at pedestrian light (P)	• Looks at pedestrian light (P)	• Takes up position between road markings (P)
• Presses button (P)	• Presses button (P)	• Stands of pavement close to (but not on) kerb (P)
• Stands between markings **or** close to kerb (P)	• Stands between markings **or** close to kerb (P)	• Looks right for vehicles stopping – all lanes (L)
• Crosses on green (C)	• Crosses on green (C)	• Looks left for vehicles stopping – all lanes (L)
• Looks right (L)	• Looks right and left and behind (L)	• Looks right to double check (L)
• Looks left (L)	• Looks right to double check (L)	• Steps out promptly (i.e. without hesitation) (C)
• Looks right to double check (L)	• Checks signal before crossing (L)	• Looks right and left when crossing (C)
• Checks signal before crossing (L)	• Steps out promptly (i.e. without hesitation) (C)	• Remains on crossing whilst walking (C)
• Steps out promptly (i.e. without hesitation) (C)	• Looks right and left when crossing (C)	• Mounts pavement (C)
• Looks right and left when crossing (C)	• Remains on crossing whilst walking (C)	• Moves to inside of kerb to continue (C)
• Remains on crossing whilst walking (C)	• Mounts pavement (C)	
• Mounts pavement (C)	• Moves to inside of kerb to continue (C)	
• Moves to inside of kerb to continue (C)		

2.2.5.4 Perception of drivers' intentions

Participants' performance was scored in terms of correctness of prediction and the cues used to make this prediction.

2.2.5.4.1 Correctness of prediction

The information recorded on the coding sheet allowed the coder to determine whether the participant had made the correct prediction or not with respect to each of the focal vehicles in the scenario, and also whether the correct prediction was the first or second prediction made. As a check on reliability of coding, data from 27 participants (15.9% of the sample) were scored independently by two researchers. Inter-rater reliability was 96%. An overall score for a participant's performance was derived by totalling the number of correct predictions for each focal vehicle given across the 12 items (maximum = 17), regardless of whether this was given first or second.

2.2.5.4.2 Number of cues used to make prediction

The valid cues present in each scene were defined before the coding of participants' responses began. The participant was given one point for each cue correctly identified. This variable was scored independently of whether the participant made a correct or incorrect prediction, or whether the cue was identified as part of the first or second prediction. Independent coding of data from the same 27 participants as for correct predictions produced inter-rater reliability of 88%. Overall scores were derived by totalling the number of valid cues correctly identified across trials (maximum = 52).

2.2.5.5 Estimations of difficulty

The pre- and post-assessment estimations of difficulty were determined automatically by the computer from the position of the marker that the participants had placed on the estimation bar, with the underlying scale taken to be 0 (very easy) to 100 (very difficult). Pre- and post-estimations were averaged separately across all six pairs of problems or locations for each skill.

2.3 Results

2.3.1 Comparison of computer and roadside performance

Before proceeding to full analysis of the skills and difficulty estimation data, an examination was made of the relationship between performance on the computer and roadside tasks. Data for safe route planning, visual timing and use of designated crossings amongst the sub-samples who had been tested in both locations were checked for correlation between corresponding variables across the two contexts. The assumption was that, whilst overall scores might differ due to variation in setting and available information, **relative** levels of performance should be roughly equivalent under the two conditions if the computer tasks were accurately estimating roadside skills.

For **safe route planning**, Pearson correlations (i.e. taking into account the precise values of individual data points) were computed for the percentage of unsafe routes, the percentage of safe routes and conceptual understanding. Significant values were obtained in all three cases ($r = 0.45$, $P = 0.001$ for unsafe routes; $r = 0.45$, $P = 0.001$ for safe routes; $r = 0.52$, $P < 0.001$ for conceptual understanding; $n = 49$, one-tailed probabilities in each case). As far as more specific elements of participants' responses were concerned, particularly strong relationships were noted for the percentage of D routes, the most safe ($r = 0.60$, $P < 0.001$), and for the frequency of the highest level of conceptual response, that scoring 4 ($r = 0.44$, $P = 0.001$). In general, then, the computer scores appeared to map satisfactorily onto roadside performance, and to do so increasingly well as performance reached higher levels.

The pattern of relationships was somewhat more complex for **visual timing**, in part because of the greater number of variables involved. Using Pearson correlations, of the six variables with direct correspondence across computer and roadside testing, only starting delay and missed opportunities were found to be significantly correlated across the two contexts. However, starting delay on the computer was also correlated in the appropriate direction with all other roadside variables except estimated crossing time and missed opportunities. Similarly, missed opportunities on the computer were significantly correlated with all other roadside variables except estimated crossing time and tight fits. In addition, both variables were significantly correlated with all other computer variables (except estimated crossing time for missed opportunities). The same picture emerged even more strongly using Spearman's rho, which only takes into account the rank order of cases, not the precise values of variables: the values of the correlations were in general higher, missed opportunities on the computer were now correlated with roadside tight fits as well, and accepted gap size was now correlated across computer and roadside testing. The values of both sets of correlations are shown in Table 2.7.

The conclusion seems clear. Some variables were measured less well on the computer than others, especially at the level of precise numerical value rather than relative adequacy of performance. However, computer performance on two crucial variables, starting delay (a measure of the ability to look ahead and anticipate gaps) and missed opportunities (the ability to judge the timing of movements to available gaps) was well-related to all important aspects of performance at the roadside. Within bounds, then, the relationship was good, although the data suggest that it would be best to focus attention on these two particular aspects of computer performance.

Table 2.7: Correlation of computer measures of starting delay and missed opportunities to (a) roadside measures and (b) other computer measures (Pearson correlations in bold, Spearman's rho in italics; *P < 0.05, **P < 0.01)

	Accepted gap size	*Effective gap size*	*Starting delay*	*Estimated crossing time*	*Missed opportunities*	*Tight fits*
(a) Roadside measures ($n = 47$)						
Computer starting delay	0.28* 0.36**	0.28* 0.32*	0.26* 0.27*	-0.05 0.04	0.18 0.33*	-0.29* -0.30*
Computer missed opportunities	0.33* 0.48**	0.31* 0.40**	0.29* 0.26*	0.04 0.08	0.28* 0.44**	-0.22 -0.30*
(b) Computer measures ($n = 166$)						
Computer starting delay	0.13* 0.26**	-0.70** -0.67**	-	-0.25** -0.33**	0.53** 0.38**	0.15* 0.19**
Computer missed opportunities	0.27** 0.36**	-0.22** -0.12	0.53** 0.38**	0.11 0.20**	-	0.19** 0.27**

For **use of designated crossings**, roadside data were only available for pelicans and junctions. Since the number of variables was even larger than for visual timing, comparison here focused on correspondences between the performance profiles on the computer and at the roadside. Figures 2.1 and 2.2 show the mean presence of the target elements of behaviour in the two contexts for pelicans and junctions respectively. As can be seen, other than perhaps a slight tendency for the computer to underestimate looking behaviours and movement to the inside of the pavement at the end of the sequence, the relative incidence of the different elements is strikingly similar for computer and roadside tests. As confirmation of this, the correlation between the relative mean occurrence of the different elements was 0.93 for pelicans ($n = 13$, $P < 0.001$, one-tailed), and 0.96 for junctions ($n = 12$, $P < 0.001$, one-tailed). Overall, then, the degree of relationship between computer and roadside performance appeared to be high.

Figure 2.1: Mean presence of target elements of behaviour on computer and at roadside – pelican crossings

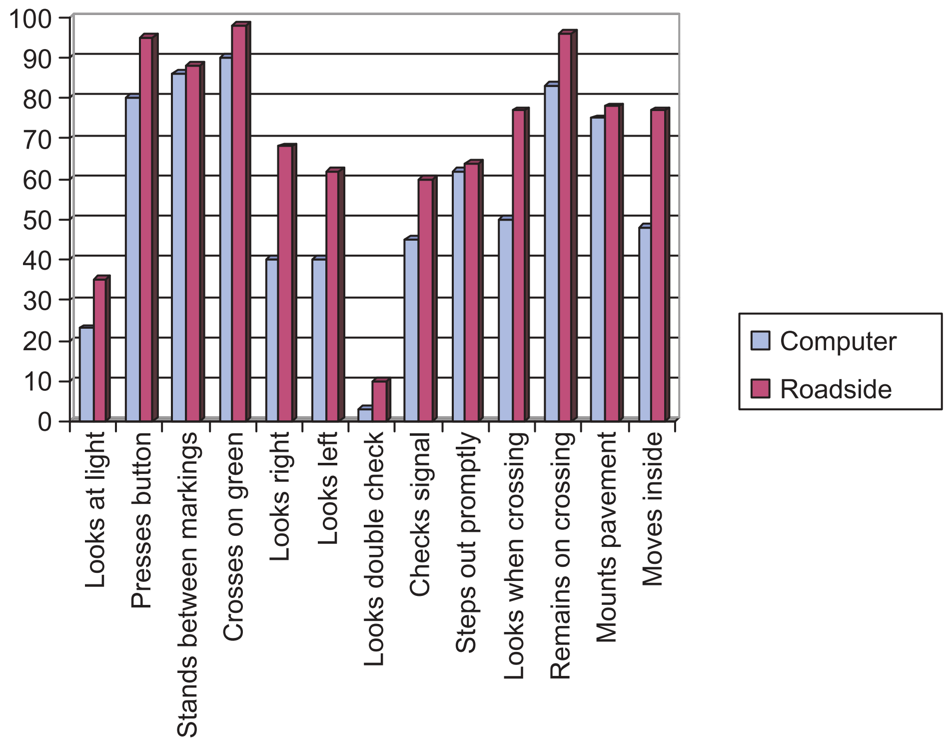
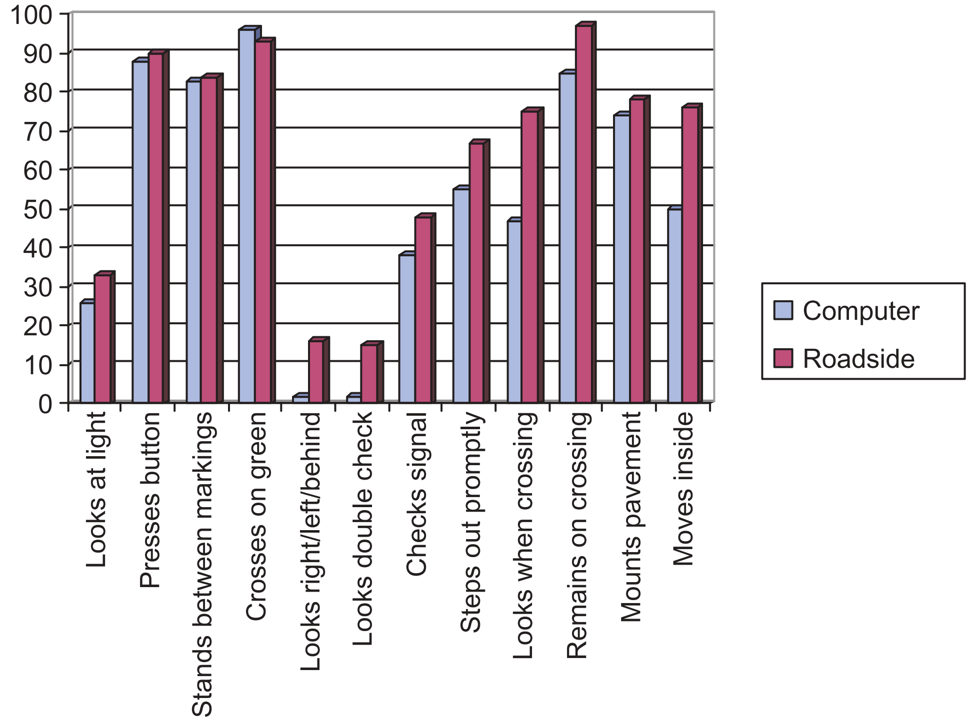


Figure 2.2: Mean presence of target elements of behaviour on computer and at roadside – junction crossings



2.3.2 *Age-related change in skills*

Having established that the computer scores provided an accurate measure of participants' skill levels, attention turned to the extent to which participants exhibited improvements in skill with increasing age, and how far adolescents' performance was comparable to that of adults. Data relating to this are laid out by skill area below. Preliminary analyses established that there were no effects of gender on any aspects of the measured skills, and this factor is consequently discounted from further consideration in what follows.

2.3.2.1 Safe route planning

Since the percentage of unsafe routes (A + B) reflected the number of crossing judgements **not** coded as safe (C + D), the two measures were perfectly negatively correlated. As far as behavioural performance is concerned, therefore, attention will be restricted here to the percentage of safe routes. The analysis of conceptual understanding focused on the mean score across routes. Table 2.8 shows the means and standard deviations on these two measures, broken down by age group.

Table 2.8: Performance on safe route planning (computer testing) – mean percentage of safe routes and mean score for conceptual understanding (maximum = 4), by age group (standard deviations in italics)

	P7	S1	S2	S3	Adults
Percentage of safe routes	57.8 *32.7*	75.7 *22.2*	62.1 *29.0*	65.5 *26.4*	80.9 *23.6*
Conceptual understanding	2.51 *0.81*	3.11 *0.70*	2.75 *0.77*	2.88 *0.78*	3.20 *0.53*

As can be seen, there was a gradual increase with age in the incidence of safe routes across the school sample, and a corresponding reduction in the variability of individual performance; in other words, as participants became older and performed better, they also became more consistent. The only exception to this age trend was the S1 sample, which performed at a higher level than the other pupil groups, with lower variance. The reasons for this apparent boost in performance at this age are unclear. This age group aside, there was a rather greater jump in performance moving from the school to the adult sample, and a further reduction in variance, though it should be noted that even adults made unsafe choices on nearly 20% of occasions. The analysis of variance revealed that the apparent effect of age was significant ($F(4,147) = 3.20$, $P = 0.015$), although this was not a strong trend (effect size using partial eta-squared = 0.08), and follow-up tests found significant differences between the P7 and adult age groups only ($P = 0.05$).

Scores for conceptual understanding exhibited a very similar pattern, unsurprisingly, since the percentage of safe routes was strongly correlated with understanding ($r = 0.84$, $n = 157$, $P < 0.001$, one-tailed; cf. Tolmie *et al*., 2005, on the importance of conceptual understanding for generalisation of behavioural strategies across contexts). Analysis of variance again found a significant effect of age ($F(4,147) = 3.99$, P =.004; effect size = .10). Follow-up tests identified significant differences between the P7 and S1 pupils ($P = 0.013$) and between the P7 pupils and adults ($P = 0.019$).

2.3.2.2 Visual timing

In the light of the relationships between computer and roadside variables noted above, the analysis of the visual timing data focused primarily on the measures of starting delay and missed opportunities, although scores on the remaining variables are reported in Table 2.9 to provide a full picture of performance. For starting delay, there was a fairly clear pattern of decrease in delay across the secondary school age groups, indicating better anticipation of gaps, coupled once more with reducing variance in performance. On this measure, the S1 pupils were unremarkable, performing little differently from the P7 children. There was a further decrease in delay amongst the adults, with the shift between S3 and adults approximately the same as that between P7 and S3. The analysis of variance showed that the age effect was again significant ($F(4,156) = 5.18$, $P = 0.001$, effect size = 0.12), with reliable differences being identified between the P7 pupils and adults ($P = 0.004$) and between the S1 pupils and adults ($P = 0.002$).

Table 2.9: Mean scores on measures of visual timing performance (computer testing), by age group (standard deviations in italics)

	P7	S1	S2	S3	Adults
Starting delay (secs)	1.37	1.41	1.25	1.20	1.06
	0.31	*0.43*	*0.37*	*0.28*	*0.27*
Total missed opportunities	5.53	6.43	4.95	4.06	3.67
	5.11	*5.64*	*4.77*	*2.85*	*2.88*
Accepted gap size (secs)	6.50	6.49	6.56	6.54	6.52
	0.32	*0.43*	*0.29*	*0.32*	*0.22*
Effective gap size (secs)	5.12	5.08	5.31	5.34	5.45
	0.40	*0.59*	*0.39*	*0.39*	*0.35*
Estimated crossing time (secs)	3.38	3.73	3.72	3.85	3.81
	1.56	*1.23*	*1.12*	*1.44*	*0.84*
Total tight fits	15.37	14.97	14.58	13.81	14.59
	3.28	*2.77*	*2.27*	*2.83*	*2.37*
Total splats	4.18	4.50	4.00	3.94	2.48
	3.64	*3.81*	*3.36*	*3.57*	*2.67*

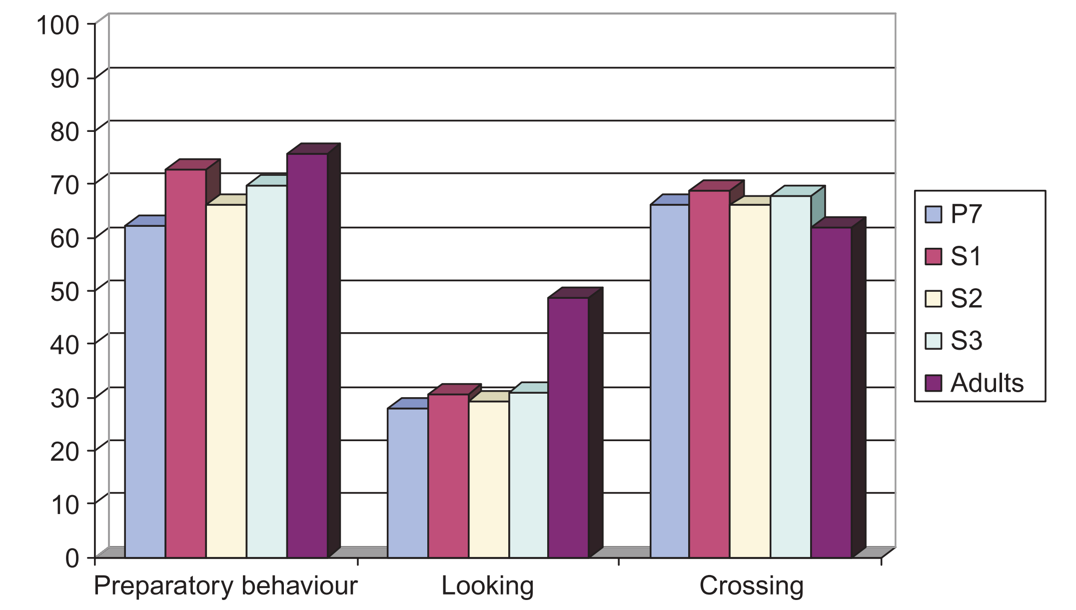
Missed opportunities also showed a decline with age, especially after S1, coupled with diminishing variance in performance. The overall levels of performance for all age groups were quite good, however, bearing in mind that these are totals across 36 trials for most participants. In addition, the degree of variance was fairly high relative to these small means. As a result, analysis of variance found no significant effects.

As far as the remaining variables were concerned, accepted gap size was stable across age groups. **Effective** gap size increased significantly, however ($F(4,156) = 3.71$, $P = 0.007$, effect size = 0.09), reflecting the decrease in starting delay, to which it was strongly related (see Table 2.7b), and the more efficient use of the chosen gaps resulting from better anticipation. Estimated crossing time showed some tendency to increase with age, perhaps due to the more realistic assessment of the likely time needed to cross, but this effect was not significant. The high numbers of tight fits and splats tend to confirm that participants found it in fact relatively hard to judge the precise time needed to cross, though the slight decline in splats amongst the adults suggests that they at least may have been beginning to adjust to this better.

2.3.2.3 Use of designated crossings

In order to simplify analysis, the designated crossings variables were collapsed into three overall variables for each type of crossing, as in Tolmie *et al*. (2003). These were defined as the mean incidence of target elements relating to (a) behaviour during the preparatory phase, (b) looking behaviours whilst assessing when to cross, and (c) actual crossing behaviour. Cronbach's alpha was calculated for each phase for each type of crossing as a check on the internal consistency of the responses making up each resulting score. For pelicans, the values were 0.60, 0.82 and 0.90 respectively, the first being acceptable and the remaining two good. For junctions, the corresponding values were 0.59, 0.69 and 0.89, and for zebras, 0.79, 0.89 and 0.92. The precise set of elements used to derive scores for each phase for pelicans, junctions and zebras is indicated in Table 2.6. Figures 2.3 to 2.5 show the profile of performance within the three phases for each crossing type in turn, broken down by age group.

Figure 2.3: Mean presence of target behaviours (computer testing) in each of three phases, by age group – pelican crossings



As can be seen from Figure 2.3, there was a gradual increase with age in the incidence of target preparatory behaviours for pelican crossings, albeit with the S1 pupils once more showing more precocious levels of performance. This trend was borne out by analysis of variance, which identified a significant effect of age ($F(4,164) = 4.40$, $P = 0.002$, effect size = 0.10), with differences located between the P7 and S1 pupils ($P = 0.028$), and between the P7 pupils and adults ($P = 0.003$). As reported in past research (Tolmie *et al*., 2003), the performance on looking behaviours was generally much poorer, with little improvement across the school sample. Adults did substantially better, though they were still well short of ideal levels of performance. The analysis of variance once again found a significant effect of age ($F(4,164) = 5.18$, $P = 0.001$, effect size = 0.11), with differences located between the adults and each of the pupils' groups (for P7, $P = 0.001$; for S1, $P = 0.01$; for S2, $P = 0.002$; for S3, $P = 0.011$). The performance on crossing behaviours was at levels comparable to those for the preparatory phase, and flat across age groups.

Figure 2.4: **Mean presence of target behaviours (computer testing) in each of three phases, by age group – junction crossings**

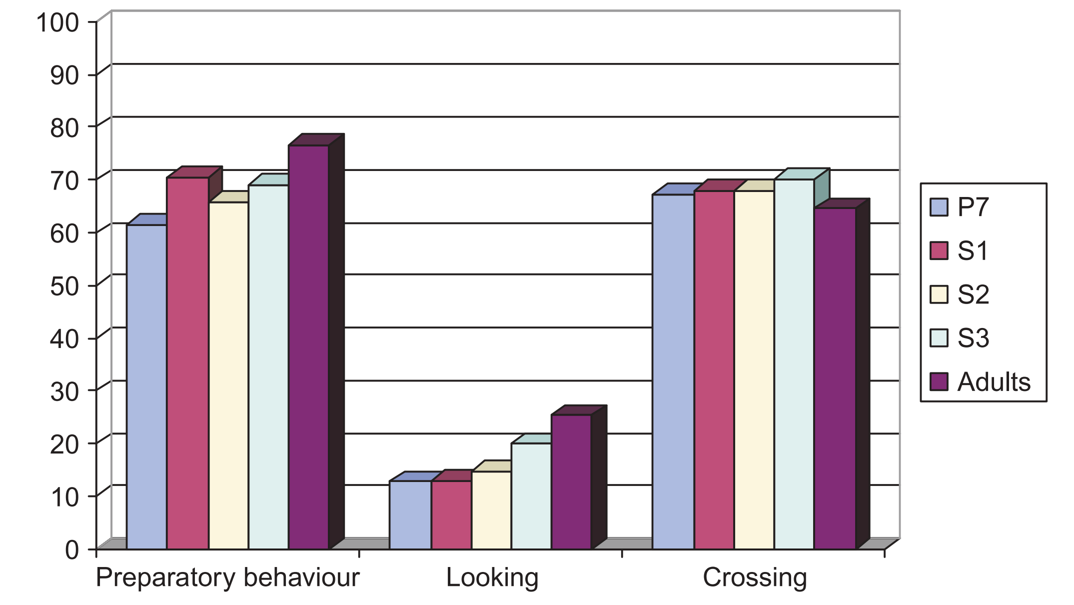
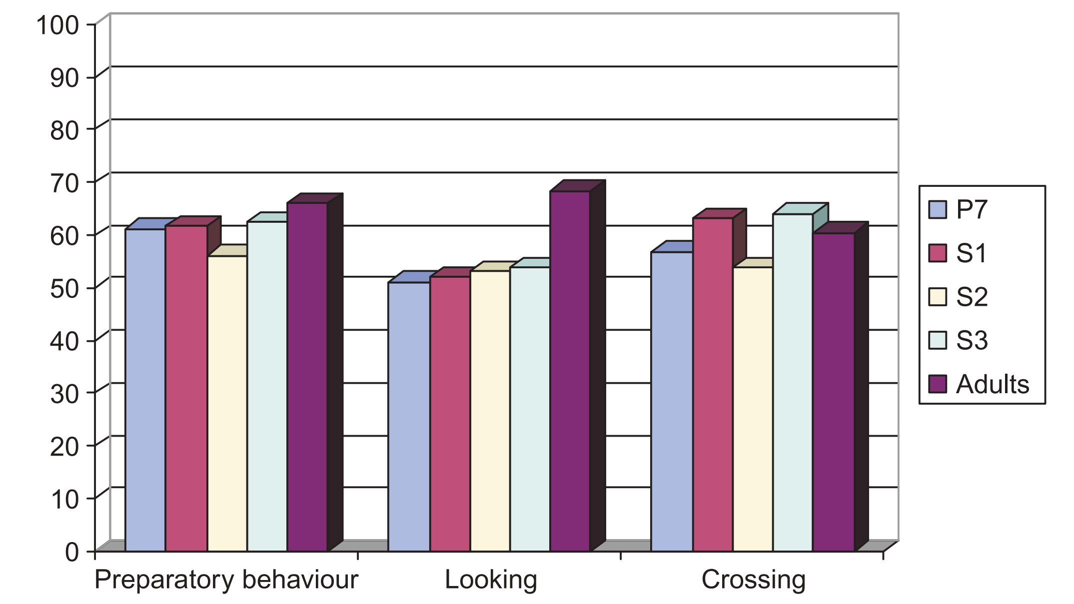


Figure 2.5: **Mean presence of target behaviours (computer testing) in each of three phases, by age group – zebra crossings**



The pattern of performance was very similar for junction crossings, as can be seen from Figure 2.4. A significant effect of age was again found for preparatory behaviour ($F(4,161) = 4.27$, $P = 0.003$, effect size = 0.10), with differences located between the P7 pupils and adults ($P = 0.002$). Looking behaviour was even poorer here than on pelican crossings, but adults once more did rather better, generating a significant effect of age ($F(4,163) = 3.97$, $P = 0.004$, effect size = 0.09), with differences located between the adults and each of the pupils groups bar S3 (for P7,

$P = 0.01$; for S1, $P = 0.02$; for S2, $P = 0.047$). No age effect was present for the crossing phase.

For zebras (see Figure 2.5), preparatory and crossing behaviours were at similar levels to those for pelicans and junctions, but with a somewhat flatter age profile for the preparatory phase, and in this case no effects of age. With the absence of automated signals to control crossings, looking behaviours were substantially more frequent (cf. Tolmie *et al*., 2003), but there was still a tendency for adults to do rather better, though this effect was not quite statistically significant ($F(4,164) = 2.29$, $P = 0.062$).

2.3.2.4 Perception of drivers' intentions

Table 2.10 presents the mean number of correct predictions and valid cues identified by participants in each age group. As can be seen, for correct predictions, there was some tendency for performance to improve with age across the school sample and for variation in performance to decrease, though, in the former respect, the S3 pupils fell back somewhat relative to the S2 pupils. There was a bigger gap in performance between the school sample and the adults, as in safe route planning and aspects of the use of designated crossings. The analysis of variance identified a significant effect of age on scores ($F(4,157) = 3.82$, $P = 0.005$, effect size = 0.09), with reliable differences between the adults and the P7 pupils ($P = 0.003$), the S1 pupils ($P = 0.011$) and the S3 pupils ($P = 0.042$), but not the S2 pupils.

Table 2.10: Performance on perception of drivers' intentions – number of correct predictions (maximum = 17) and number of valid cues identified (maximum = 52); standard deviations in italics

	P7	S1	S2	S3	Adults
Correct predictions	11.32 *2.34*	11.43 *2.58*	12.05 *2.04*	11.68 *2.06*	13.32 *1.56*
Number of cues	14.76 *5.40*	17.00 *3.96*	16.23 *4.47*	17.03 *4.30*	18.89 *4.21*

With regard to the number of valid cues identified, it should be noted first of all that, whilst the mean scores appear in general to be low relative to the maximum possible total of 52, the picture is not quite as bad as it seems. The cues occurred in sufficiently rapid sequence to stretch attentional demands, and in many instances simply provided convergent evidence: it was not necessary to spot every cue to generate a correct prediction, as the rather higher relative values attained on that index confirm. This said, some differences in the pattern of performance on this measure were apparent. There was a rather larger improvement in performance between the primary and secondary school participants, but variance tended to remain fairly high and the S2 pupils did less well on this than the S1 and S3 pupils. There was a further, slightly smaller increase in scores amongst the adults. The analysis of variance again found a significant effect of age ($F(4,157) = 3.86$,

$P = 0.005$, effect size = 0.09), but with reliable differences here restricted to those between the adults and the P7 children. The data suggest that the secondary school sample improved relative to the primary children in their ability to identify valid cues, without improving similarly in their ability to use these cues to arrive at correct predictions. The implication is that they were becoming more aware of significant events in the traffic environment without necessarily being able to interpret these as yet.

2.3.2.5 Summary of age changes in skill profiles

Taken overall, the pattern of age-related change in skill levels varied across area, but the general trend might reasonably be characterised as one of modest improvement from 11 to 15 years, and a greater shift between adolescents and adults. This trend is clear if differences between the adolescents and the adults versus those between the adolescents and the P7 children are enumerated. As far as the first is concerned, the adults did not differ significantly from any of the secondary school groups for safe route planning, and only did so with respect to the S1 pupils for visual timing. However, they differed from at least two of S1, S2 and S3 for pelican and junction looking behaviours (the area where poorest performance was observed), and for drivers' intentions predictions. In contrast, the secondary school sample did not in general differ significantly from the P7 pupils in any of the four skill areas, doing so at all only where the S1 pupils showed apparently precocious performance, i.e. on safe route planning concepts and pelican preparatory behaviours.

2.3.3 Perceived difficulty

In at least two of the four skill areas under investigation, the secondary school sample performed significantly less well than the adult sample, and in none of the four areas did they perform in general significantly better than the P7 pupils. With this skill profile in mind, it was possible to examine how far the perception of problem difficulty mirrored performance, both before and especially after completion of problems, when feedback from experience was available.

Figures 2.6 to 2.9 present the profile of difficulty ratings for each of the four skill areas in turn, broken down by age group. It should be noted that the ratings exhibited a fairly high degree of variability across individuals (overall standard deviations ranged between 16 and 21 percentage points), with little difference between age groups in this respect. This probably reflected a degree of difference in the calibration of the precise meaning of the rating scale. Regardless of this, though, a number of systematic effects emerged from the data, with analysis of variance identifying effects of skill area ($F(3,477) = 108.48$, $P < 0.001$, effect size = 0.40) and pre- versus post-performance estimation ($F(1,159) = 132.59$, $P < 0.001$, effect size = 0.45), plus interaction effects between these, both on their own ($F(3,477) = 33.84$, $P < 0.001$, effect size = 0.17) and in conjunction with age ($F(12,477) = 1.87$, $P = 0.038$, effect size = 0.04).

Figure 2.6: Mean estimates of perceived difficulty pre- and post-problem completion for safe route planning, by age group

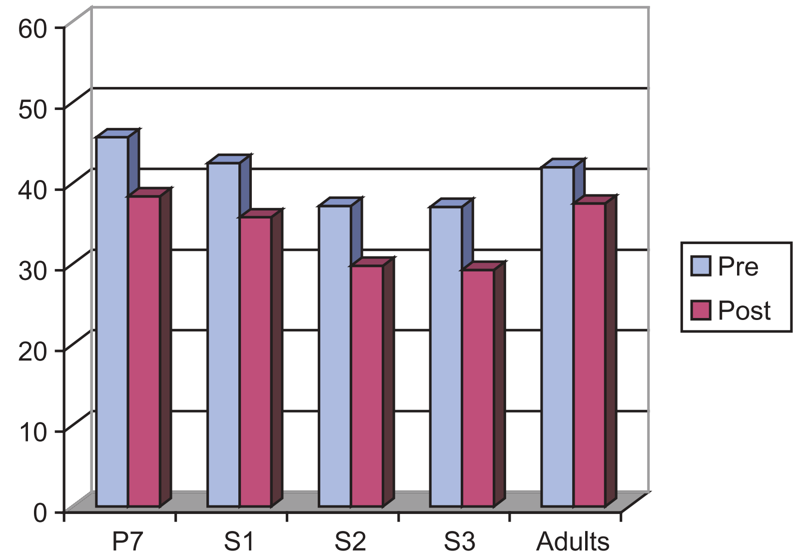


Figure 2.7: Mean estimates of perceived difficulty pre- and post-problem completion for visual timing, by age group

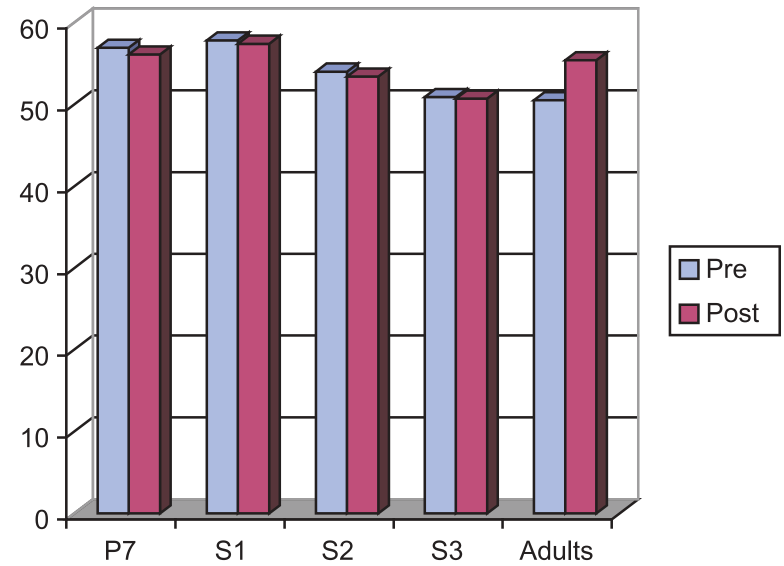


Figure 2.8: Mean estimates of perceived difficulty pre- and post-problem completion for use of designated crossings, by age group

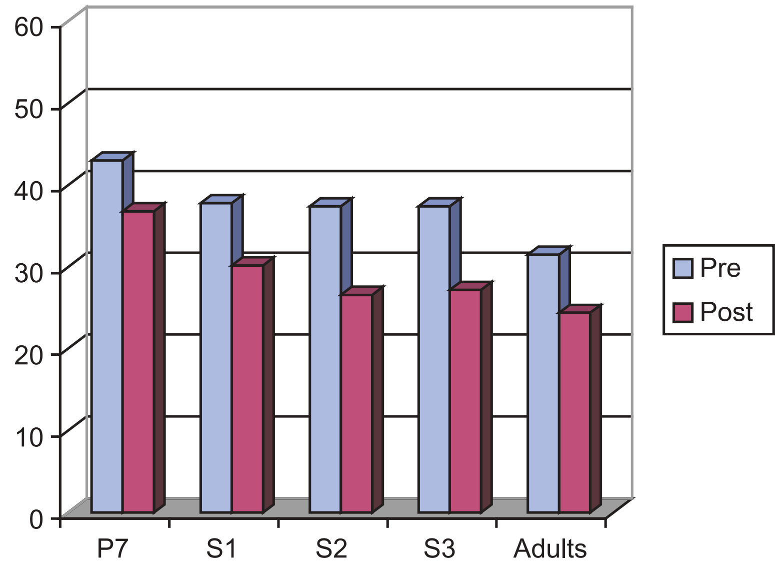
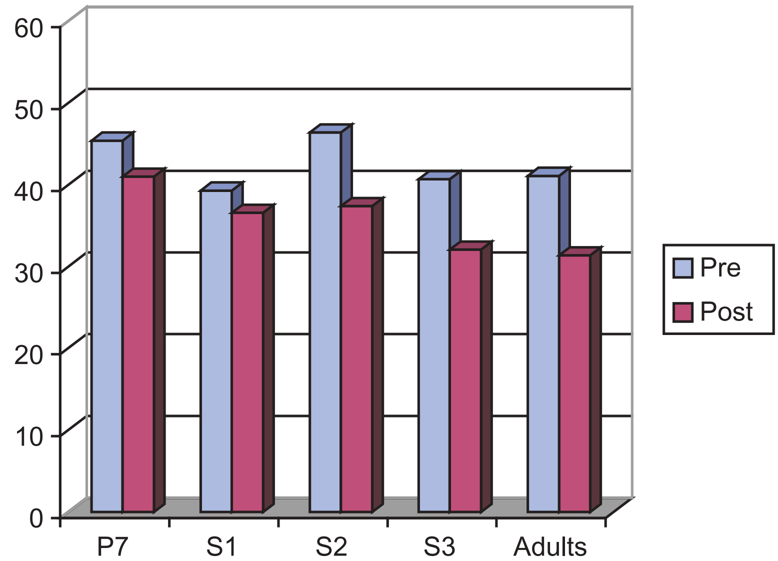


Figure 2.9: Mean estimates of perceived difficulty pre- and post-problem completion for perception of drivers' intentions, by age group



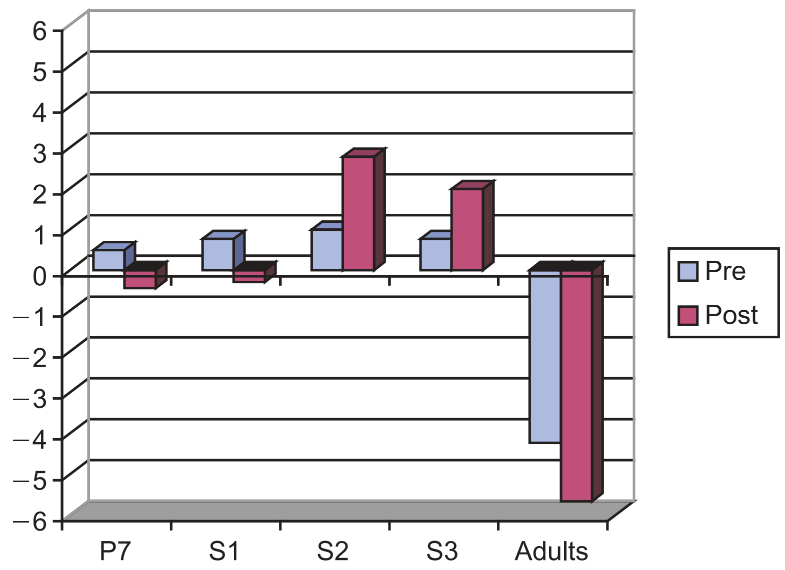
With regard to the effect of skill area, as comparison across Figures 2.6 to 2.9 makes plain, the perceived difficulty of the different tasks varied substantially, with visual timing being seen by all age groups as the hardest task (mean = 54.53), safe route planning and perception of drivers' intentions being held to be of approximately equivalent difficulty in the next rank down (mean = 37.16 and 39.43 respectively), and use of designated crossings being seen as the easiest task (mean = 33.46). It should be noted that these judgements did not particularly reflect actual relative performance levels, the worst aspect of which was unquestionably looking behaviour on designated crossings (as previously found in roadside testing by Tolmie *et al*., 2003). As far as pre- versus post-estimation differences were concerned, there was a clear tendency for post-performance estimates of difficulty (mean = 38.46) to be lower than pre-performance (mean = 43.84), though again these changes were not necessarily merited given that errors were relatively prevalent in all skill areas. This effect was absent for visual timing, though, hence the interaction between skill area and pre/post-estimation. The further interaction with age was attributable to the fact that the adults revised their difficulty estimate upwards post-performance for visual timing, and that the S2 and S3 pupils tended to exhibit larger pre/post drops in estimation of difficulty on average than the other age groups (mean = 6.93 and 6.69 for S2 and S3 respectively, against 4.82, 4.10 and 3.69 for P7, S1 and adults). This was especially the case for designated crossings and, relative to the younger age groups, perception of drivers' intentions.

What was strikingly absent from the data, given its near-ubiquitous presence with respect to performance, was any overall effect of age on difficulty ratings. Indeed, closer inspection shows that differentiation between the age groups was, in general, surprisingly low. Bearing in mind the hypothesised tendency for adolescents to overestimate their skill levels, it may be noted that for safe route planning the S2 and S3 pupils (though not the S1 pupils) tended to rate the problems as marginally easier than the adults both before and after completion (see Figure 2.6), despite the fact that their performance was if anything worse. Similarly, for visual timing (see Figure 2.7), the S3 pre-performance ratings were nearly the same as those given by the adults, even though adults tended to show better anticipation of traffic gaps, as indexed by their smaller mean starting delay and larger effective gap size. Moreover, as already noted, the adults increased their difficulty ratings for this skill post-performance, whereas the S3 ratings were static.

For the use of designated crossings (see Figure 2.8), the secondary sample's pre-performance ratings were rather more in keeping with their poorer skill levels relative to those of the adults, especially as regards looking behaviours. However, they rated the task as easier than the P7 pupils, despite the fact that they performed no better than them. Post-performance, the larger drop in the S2 and S3 estimates brought these down, inappropriately, to a level comparable to the adults. For the perception of drivers' intentions (see Figure 2.9), pre-performance estimates were somewhat haphazard, but post-performance, the S1 and S2 estimates were lower than those given by the P7 pupils, who showed similar skill levels, whilst the S3 pupils gave ratings comparable to the adults, who out-performed them.

Overall, then, as hypothesised, secondary school pupils (the 13- to 15-year-olds in particular) tended to rate the problems in all four skill areas as easier, relative to their actual skill levels, than either 11-year-olds or adults, and only adults showed any sign of revising their estimates of difficulty upwards post-performance. An even clearer picture of mismatches between performance and difficulty rating emerges when these two indices are compared more directly. If the scale on which a given performance variable is reversed (where necessary) so that higher scores equate with poorer levels of performance, and the observed scores are then transformed so that they have the same mean and variance as the equivalent difficulty rating, this effectively provides a measure of what that difficulty rating **should** have been for individuals' relative skill levels. It is then possible to look at the discrepancy between this predicted difficulty rating and that which was actually given, by subtracting the second from the first. Positive discrepancies would indicate an underestimate of difficulty (the actual rating was less than the predicted), and negative differences an overestimate.

Figure 2.10: Mean discrepancy between predicted and actual difficulty ratings, pre- and post-performance, by age group



This procedure was carried out relative to both pre- and post-performance difficulty estimates for the key behavioural variables in each of the four skill areas:

- percentage safe routes;
- number of missed opportunities and mean starting delay;
- the mean presence of target behaviours in preparatory, looking and crossing phases; and
- the number of correct predictions and valid cues identified.

Means of the discrepancies between predicted and actual difficulty ratings across these variables were then calculated for each age group. The outcome is displayed in Figure 2.10. As can be seen, relative to their performance level, adults substantially overestimated the difficulty of the problems in comparison to the younger age groups, indicating a considerable degree of caution on their part about their competence. Discrepancies hovered around zero for the P7 and S1 age groups, but shifted towards overestimates of difficulty post-performance, suggesting that, on balance, they had some awareness of their skill levels. In contrast, the S2 and S3 age groups consistently underestimated problem difficulty relative to their performance, and they were, moreover, the only groups to show a shift towards **greater** underestimation post-performance.

2.4 Conclusions from Study 1

Study 1 was designed to test three predictions derived from the hypothesis of an emergent discrepancy between perceived and actual skills post-transition to secondary school:

1. that skill levels amongst adolescents would still be noticeably poorer than those shown by adults;
2. that adolescents would regard decisions in all skill areas as easier relative to their actual performance than either P7 children or adults; and
3. that adolescents would show a tendency not to revise their estimates of difficulty post-performance.

As far as the first prediction is concerned, on balance the data indicate that, whilst skill levels in adolescence may be marginally higher than in late primary age children, they are not at adult levels of competence. Certainly, on the vast majority of indices used in Study 1, performance in the S2 age group was closer to that observed among P7 children than that found in adults. The performance of the S3 age group was more finely balanced midway between P7 and adult levels, but it was still significantly poorer than that of the adults on several measures. The trend of gradually improving competence towards adult levels through the secondary age range was disrupted to some extent by the seemingly precocious performance of the S1 age group on safe route planning, the preparatory phase of designated crossings, and, to a lesser degree, the identification of valid cues in perception of drivers' intentions. However, this age group still performed at a lower level than the adults in terms of starting delay, the looking phase of designated crossings, and making correct predictions about vehicle movements.

The data are rather clearer with regard to the second prediction. Quite simply, as Figure 2.10 shows, adolescents in the S2 and S3 age groups were much more likely than adults or P7 children to underestimate the difficulty of problems relative to their actual performance levels, and thus tacitly overestimate their competence. The picture was not completely uniform in this respect, admittedly, but on more than 50% of measures the S2 and S3 participants rated the problems as easier relative to their performance than both the P7 children **and** the adults, and they did so in comparison to at least one of these groups on all the key behavioural measures.

This pattern did not, however, extend to the S1 participants. Whilst they generally rated the problems as easier than the adults, this was not consistently the case, and even where it was, the differences were often marginal in character. They also rated the problems as more difficult relative to their skill levels than the P7 participants on nearly half of the key behavioural variables. The outcome was a profile not dissimilar to that of the P7 age group, as Figure 2.10 shows.

A similar separation between the S1 age group on the one hand and the S2 and S3 groups on the other is evident in the data relating to the third prediction. Given the opportunity to reassess the test problems in the light of experience, rather than failing to revise their estimates of difficulty, the older adolescent groups were in fact even **more** likely to underestimate problem difficulty relative to their ability levels. In contrast, the S1 participants also tended to revise their estimates post-performance, but in an upwards rather than a downwards direction, suggesting that they at least were attending to feedback to some extent.

Taken overall, then, the data are consistent with the presence of misperceptions of ability and failure to attend to performance feedback exclusively among adolescents, as hypothesised. However, this effect seems to be restricted to 13- to 15-year-olds, which strongly suggests that it is not a function of the transition to secondary school per se, but is instead related to assumptions of ability and a decline in the priority attached to pedestrian skills. The implication is that this is the consequence of a shift in perceptions that takes place some time **after** going to secondary school.

3 STUDY 2

3.1 Issues for investigation

Study 1 confirmed that 13- to 15-year-old adolescents overestimate their abilities and pay inadequate attention to their performance as pedestrians compared with younger children and adults. Moreover, whilst these effects were found under test conditions, such circumstances might tend, if anything, to promote **increased** rather reduced concentration. It seems possible, therefore, that the real-world performance of this age group might actually be worse than that observed. The Study 1 data do not demonstrate, however, that this overestimation of ability and lack of attention actively lead to hazardous behaviour. For instance, adolescents might be capable of making strategic decisions about road-crossing which are good enough to protect themselves from the consequences of their lack of reflection at the point of enacting crossings (e.g. by choosing less demanding routes when they have to make journeys on foot through familiar environments, or by otherwise avoiding obviously risky situations).

Whether the observed discrepancies between perceived difficulty and skill level are in fact related to the incidence of riskier crossing decisions remains a key question to be addressed, therefore. To examine this, what is needed is a study that measures these variables within a single sample. In addition, though, the emergence of perceived difficulty/skill discrepancies in the second year of secondary school suggests that they have their origin in **social** factors that come into operation early in the secondary age range. The power of such a study would therefore be substantially increased if the nature of these influences were also examined, by measuring within the same single sample the variables most likely to have an impact (see Section 1.2):

- attitudes to safe and risky crossing decisions;
- peer-group attitudes and behaviour (and the potentially countervailing attitudes and behaviour of parents); and
- self-perceptions and self-identity, including wider propensities for risk-taking.

This would allow the nature of the changes taking place to be investigated in more detail, and also enable the **relative** impact of skill, attitudinal and identity variables on pedestrian decision-making to be assessed. This would, in turn, facilitate judgements about where attempts at intervention might best focus their efforts.

Study 2 was designed, with these points in mind, to collect data from a single sample of secondary school participants on perceived difficulty and pedestrian skill, attitudes, peer and parent norms, and self-identity; and to examine the relationships between these measures and subsequent self-reports of roadside behaviour. The test materials used in the study followed the format of those used in research on the Theory of Planned Behaviour (TPB), outlined in Section 1.2, which links attitudinal, normative, control and (in this case) identity and skill variables to behaviour via their effect on behavioural **intention**. This framework allowed the resulting data to be interpreted in terms of the extent to which intention predicted behaviour (indicating that it was deliberate), and how far in turn intention was predicted by social and skill-related measures. Data were also collected on major demographic variables (age, gender and socio-economic status) and on participants' self-reported history of accidents and near misses, to enable the extent to which the TPB measures related to a wider frame of reference to be established. In particular, the demographic variables would be expected to affect intentions and behaviour through their impact on attitudes, norms and self-identity, whilst reports of hazardous crossing behaviour should tend to be associated with accidents and near misses if they are reliable.

In view of the injunction of TPB theorists (e.g. see Ajzen and Madden, 1986) to focus investigation on concrete behaviour, data on the social and skill-related variables were collected with reference to the intention and performance of eight specific and three more global behaviours, differing in level of hazard from cautious to very risky. The relationship between variables was then examined via separate statistical models for each of these 11 behaviours, in order to identify general patterns. In view of the differences found in Study 1 between pupils in the first versus second and third years of secondary school, the sample recruited for Study 2 was drawn in equal numbers from each of these age groups, since these encompassed the period during which significant shifts appeared to occur.

3.2 Method

3.2.1 Design

The study employed a prospective design, with data being collected in three blocks, each corresponding to a separate test session:

1. measures of skill and perceived difficulty;
2. measures of attitudes, norms, identity and intentions; and
3. measures of self-reported recent behaviour, demographics and accident history.

Data in Blocks 1 and 2 were collected as close to each other in time as possible; Block 3 data were collected a minimum of two weeks after Block 2 data, in order to allow the extent to which skill and social factors predicted **subsequent** behaviour to be assessed. The data were all collected online, with participants from three year groups (Secondary 1 to 3 (S1 to S3)) being tested individually on each block. Block order remained constant across participants, but the sequence in which measures were taken within each block was systematically varied, with some limited exceptions necessitated by practical considerations (see Section 3.2.4 below). The relationship of Block 1 and Block 2 measures to behavioural intentions, and thence to self-reported behaviour, was subsequently examined using multiple regression techniques, with demographic and accident history variables being included at appropriate points in these analyses. Since the regression procedure required data on every variable, only cases for which there was a complete record from all three test sessions were examined.

3.2.2 *Participants*

The total number of participants tested was 331, but, of these, complete data were only available for 307. This attrition was mostly due to pupils being absent at the time of one or more test sessions, but in two instances it was the result of online data records becoming unrecoverable. The final 307 participants were drawn from the first three years of four secondary schools in West Dumbartonshire, who were contacted through the Road Safety Department of West Dunbartonshire Council. All participants took part with the permission of the local authority, their head teacher and their parents. All members of the research team had Scottish Criminal Record Office clearance, and the research had received university ethical approval.

Details of the composition of the sample are laid out in Table 3.1. As can be seen, it was made up of similarly-sized cohorts from the three age groups and was roughly balanced in terms of gender. The mean age of the 104 S1 pupils was 12 years, 7 months, of the 107 S2 pupils it was 13 years, 7 months, and of the 96 S3 pupils it was 14 years, 7 months. The sample also comprised varying levels of socio-economic status (SES). The area in which the participating schools were located was relatively deprived but their catchment area was more varied. By asking participants to give their postcode, it was possible to draw individual ACORN profiles and to assign each pupil to one of five broad SES categories, with category 1 representing the wealthiest and 5 the most deprived (see www.caci.co.uk/acorn). Across the sample, 8.8% were in category 1 (wealthy achievers), 4.9% were in category 2 (urban prosperity), 20.2% were in category 3 (comfortably off), 15.6% were in category 4 (moderate means), and 48.2% were in category 5 (hard-pressed) (numbers do not sum to 100 due to missing data for seven participants). Thus the full range of SES was covered, although it was somewhat skewed towards the lower end, with category 1 in particular under-represented relative to the UK total and category 5 over-represented (25.1% and 22.4% of the population respectively fall into these two categories). Given that the prevalence of accidents is similarly skewed (Roberts *et al.*, 1998), this was considered to be not inappropriate.

Table 3.1: Study 2 – number of participants, by age group and gender

	M	F	Total
S1	49	55	**104**
S2	53	54	**107**
S3	50	46	**96**
Total	**152**	**155**	**307**

3.2.3 Materials

As noted above, all data were collected online, in three separate blocks:

1. skills and perceived difficulty;
2. attitudes, norms, identity and intentions; and
3. self-reported behaviour, demographics and accident history.

The materials employed for each block are described below.

3.2.3.1 Block 1: skills and perceived difficulty

Pedestrian skills were assessed using a version of the computer software developed for Study 1, shortened in order to reduce the test load. The same four skill areas were examined, using the same procedures, except that only 8 problem contexts were now employed out of the original 12 for safe route planning and perception of drivers' intentions, 9 out of 12 for use of designated crossings, and 4 out of 6 for visual timing. The problems used in each skill area were determined primarily on the basis of their reliability and, where data were available, correlation with the roadside measures in Study 1. Essentially, the set of problems of the requisite size which had the highest internal consistency and best correlation to roadside performance was the one used, except where considerations regarding the range of events covered necessitated some adjustment. For safe route planning, this procedure led to the retention of three problems relating to junctions, two to blind bends, and three to parked vehicles and other obstructions. For visual timing, the selected contexts were the three less demanding ones, plus the medium context out of the three that were more demanding. For the use of designated crossings, three instances of each crossing type (junctions, pelicans and zebras) were retained, with, in each case, the crossing that was most complex being excluded. For the perception of drivers' intentions, all problems were retained, except three simple car indicator items and one of the two traffic light items.

This reduction in the number of problems to be completed meant that it was now possible to provide a practice item in all four skill areas, as well as the instruction in the task and use of the software that had been given in Study 1. Slight modifications were also made with regard to the process of obtaining participants' estimations of difficulty within each skill area. Rather than pairing scenarios as in Study 1, and requesting estimations before and after each pair, for safe route planning, use of designated crossings and perception of drivers' intentions, bars for difficulty estimation appeared before and after each alternate problem, starting with the first (second for designated crossings), until four problems had been assessed in this way. For visual timing, estimates were made before and after trials at each location, as in Study 1. In all four skills, a final difficulty estimate was also now requested after all items had been completed, based on participants' judgements of the overall difficulty of the problems in that specific area. The procedure for making difficulty estimates was included in the practice trials for each skill area. As in Study 1, the sequence in which skills were tested was systematically varied across participants.

3.2.3.2 Block 2: attitudes, norms, identity and intentions

Block 2 data collection utilised an extended TPB questionnaire. The content of this was informed by focus group discussion between pupils not subsequently involved in Study 2, but of the same age and living in the same locality. Four groups were employed, two male only and two female only; single-gender groups were used due to the typically stilted nature of cross-gender interaction among young adolescents (see Tolmie and Howe, 1993). Discussion centred on the activity of walking under different circumstances (e.g. to school, to see friends), the problems encountered, the range of behaviours witnessed, and the influences on these behaviours. Data from the focus groups were used to generate and refine items for the questionnaire, particularly as regards the behaviours the questions were to address. Once drafted, the questionnaire was piloted for ease of use on a sample of 20 participants drawn from the pool of S1, S2 and S3 pupils who had taken part in Study 1. A final version was then compiled, correcting for a small number of comprehension difficulties that had emerged.

The questionnaire focused on a range of eight specific and three more global road-crossing behaviours, with participants being asked to make essentially the same set of judgements in relation to each. The use of a number of specific behaviours and a smaller range of more general ones was designed to meet the ‘multiple act criterion’ for measuring broad attitudes outlined by Ajzen and Madden (1986). Of the three global behaviours, one was selected as cautious in character, and the other two as hazardous. The eight specific behaviours covered a slightly more refined range, with three chosen to represent different degrees of caution, a further three different degrees of risk, and two the kind of behaviour exhibited by skilled adult pedestrians, but which might be seen as risky by less skilled respondents. The 11 ‘scenarios’ arrived at in this way, together with their corresponding degree of risk, are laid out in Table 3.2.

The final version of the questionnaire included items measuring all components of the extended TPB model outlined in Section 1.2, apart from skill and perceived difficulty, which were addressed in Block 1, and actual behaviour, which was addressed in Block 3. Thus, for each of the 11 scenarios, ratings were made in relation to attitude, subjective norm, perceived behavioural control, and intention. In addition, ratings of self-identity and parental and peer norms were made for the eight specific scenarios only. Alternative methods were used to arrive at identity variables for the global scenarios, via measures of global self-identity and risk-taking, in order to provide triangulating data on this less established component of the TPB framework. Ratings of peer and parent norms for the global behaviours were derived by calculating a composite of those made for the specific behaviours, since it was felt that participants would find it harder to make accurate direct ratings of norms for general classes of behaviour. Finally, due to its theoretical significance in moderating the impact of peer-group norms (see Terry *et al*., 1999), participants were also asked to complete ratings on the strength of their identification with their peer group. More specific detail on the measures used for each component is given below.

Table 3.2: The global and specific scenarios employed in Study 2, together with their associated degree of risk

Type of scenario	*Degree of risk*	*Scenario item number and description*
Global	**Cautious**	1 Acting cautiously when crossing the road
	Risky	2 Taking chances when crossing the road
		3 Messing about when crossing the road
Specific	**Cautious**	1 Waiting for the green man before crossing, even when there is no traffic in sight
		2 Looking in all directions for traffic (including behind you) when crossing at a junction
		3 Waiting for a large gap in the traffic to give myself time to cross
	Risky	4 Jumping a barrier at the roadside to avoid going out of my way
		5 Running to cross the road through a tight gap between cars
		6 Crossing the road slowly enough to force vehicles to slow down
	Skilled	7 Stepping out into the road before cars have fully passed me
		8 Stopping in the middle of the road until the far side is clear to cross

3.2.3.2.1 Attitudes

Participants were asked to evaluate each behaviour, both specific and global, on eight semantic differential scales. These consisted of pairs of bipolar adjectives, together with a rating scale (1 to 7) used to indicate which pole the behaviour was considered to be closer to, and in what degree. The adjective pairs were chosen to cover a range of affective (bad versus good, unsatisfying versus satisfying, unenjoyable versus enjoyable) and cognitive dimensions (stupid versus sensible, inconsiderate versus considerate, unskilful versus skilful, inefficient versus efficient), plus an overall evaluation (negative versus positive). The scales were presented as a set, always in the same sequence, with the negative pole to the left and associated with lower values on the rating scale, as was the case for all the questionnaire items involving ratings of this kind. Ratings could be made by clicking on the numbered point that corresponded with the participant's judgement.

3.2.3.2.2 Subjective norm

Subjective norms are personal judgements about whether significant others would approve or disapprove of the performance of the behaviour by the respondent. These were measured by a single item for each behaviour, comprising the statement ‘Most people who are important to me would approve of me doing this’, rated on a 7-point scale for agreement (1= strongly disagree, 7 = strongly agree).

3.2.3.2.3 Perceived behavioural control

The degree of control participants subjectively perceived themselves to have over performance of each behaviour was also assessed via responses to a single statement for each instance. For the specific scenarios, this was ‘If I wanted to do this I could’, and for the global scenarios it took the form ‘When going somewhere, if I wanted to [e.g. take chances when crossing the road] I could’. These statements were rated for agreement in the same way as for the subjective norm items.

3.2.3.2.4 Behavioural intentions

Intention to perform each behaviour was assessed via ratings of a single statement, ‘I expect to do this in the future’ for the specific scenarios, or ‘When going somewhere I expect to [e.g. take chances when crossing the road]’ for the global scenarios. The rating scales again ranged from 1 (definitely will not for the specific scenarios; strongly disagree for the global scenarios) to 7 (definitely will or strongly agree, respectively).

3.2.3.2.5 Parental and peer norms

Parental norms (i.e. observed patterns of actual behaviour on the part of parents, as opposed to perceptions of their approval for a behaviour being performed by the respondent) were obtained for the specific scenarios only. This was done by asking for each behaviour ‘How often do your parents [e.g. wait for the green man before crossing, even when there is no traffic in sight]’, participants responding on a 7-point scale from 1 (never) to 7 (all the time). Peer norms were measured in exactly the same way, save that the referent group was the respondent’s friends (‘How often do your friends . . .’).

3.2.3.2.6 Peer group identification

As a measure of strength of identification with their peer group, respondents were asked three questions which they answered via ratings on a scale from 1 to 7:

- ‘How well do you fit in with your friends?’ (1 = not at all, 7 = extremely well);
- ‘Do you spend a lot of time with your friends?’ (1 = not much time, 7 = a great deal of time); and
- ‘How close do you feel to your group of friends?’ (1 = not close, 7 = extremely close).

3.2.3.2.7 Self-identity

Measures of self-identity were taken in relation to the specific scenarios via a single item ‘I see myself as the type of person who would do this’, rated for agreement using the 7-point response scale which was employed for subjective norms and perceived behavioural control.

A more ‘global’ measure of self-identity was derived from respondents’ ratings of 40 adjectives, presented one at a time, on a scale from 1 (very unlike me) to 7 (very like me). These adjectives were chosen for this task because they were either directly appropriate to descriptions of behaviour in a road safety context or carried fairly obvious implications for such behaviour. Given their number, respondents rated them using a Q-sort method rather than checking a point on a scale for each, as they did with the other Block 2 items. As each word appeared, participants dragged it into a box at the bottom of the computer screen according to the degree to which they felt it was an appropriate term to describe themselves. The layout and instructions that they saw are illustrated in Figure 3.1.

Figure 3.1: Measure of self-identity derived from respondents’ ratings of 40 adjectives (presented one at a time)

Drag the word below in to the most appropriate box depending on how much you consider the word to be like you or unlike you.

(adjective)

Very <u>un</u>like me | Very like me

1	2	3	4	5	6	7

The contents of each box (i.e. the adjectives rated up to that point) could be viewed at any time via a drop-down list that appeared when the box was clicked on. A set definition for all adjectives was also available, in case respondents required any clarification about meaning. The full set of adjectives used is presented in Table 3.3:

Table 3.3: List of adjectives used for global self-identity assessment (in order of presentation)

1. Careless	11. Overcautious	21. Anxious	31. Talkative
2. Cautious	12. Unpredictable	22. Optimistic	32. Selfish
3. Easily distracted	13. Responsible	23. Funny	33. Easily influenced
4. Observant	14. Disciplined	24. Friendly	34. Short-tempered
5. Considerate	15. Independent	25. Likeable	35. Lazy
6. Polite	16. Hesitant	26. Honest	36. Shy
7. Aggressive	17. Wild	27. Disobedient	37. Smart
8. Reliable	18. Confident	28. Determined	38. Cool
9. Sensible	19. Experienced	29. Conforming	39. Daft
10. Reckless	20. Patient	30. Adventurous	40. Uncertain

Note: The words were always presented in this specific order, but were not numbered when presented to the participant.

3.2.3.2.8 Risk-taking

Six items, all prefaced in the same way, were used to assess general risk-taking. These items comprised three statements reflecting a tendency to behave in a safe manner ('Thinking about my everyday life, I always prefer to be on the safe side'; 'I am cautious before doing anything'; 'I am rather cautious in unusual or unpredictable situations') and three reflecting unsafe tendencies ('I don't think about the possible unpleasant outcomes of my actions'; 'I would do almost anything just for a dare'; 'In general I quite enjoy taking risks'). Respondents were asked to rate each for agreement on a 7-point scale (1 = strongly disagree, 7 = strongly agree). The wording of these six items was based on elements of the Attitudes Towards Risks Questionnaire (Franken *et al.*, 1992), but with various modifications introduced after piloting to aid comprehension for a Scottish sample.

Presentation sequence. The questionnaire items were presented in a random sequence generated by the computer at the start of each individual session, except that certain items were grouped together within this sequence to facilitate task comprehension. Thus the items for each of the eight specific scenarios relating to attitude, subjective norm, perceived behavioural control, self-identification and intention were always presented in a single set, and in that order, although the sequence in which the set relating to each behaviour appeared was randomised. In each case, the scenario was presented at the top of the screen, with the question and response boxes for each variable underneath. An illustrative example of the layout is provided in Figure 3.2, showing only the attitude and subjective norm questions for the first specific scenario.

Figure 3.2: Example of layout for scenario, with the question and response boxes for attitude and subjective norm questions

WAITING FOR THE GREEN MAN BEFORE CROSSING, EVEN WHEN THERE IS NO TRAFFIC IN SIGHT IS

Bad	1	2	3	4	5	6	7	Good
Stupid	1	2	3	4	5	6	7	Sensible
Unsatisfying	1	2	3	4	5	6	7	Satisfying
Inconsiderate	1	2	3	4	5	6	7	Considerate
Unenjoyable	1	2	3	4	5	6	7	Enjoyable
Unskilful	1	2	3	4	5	6	7	Skilful
Inefficient	1	2	3	4	5	6	7	Efficient
Negative	1	2	3	4	5	6	7	Positive

Most people who are important to me would approve of me doing this

Strongly disagree	1	2	3	4	5	6	7	Strongly agree

Similarly, the questions regarding parental norms for the eight specific behaviours were presented as a single set, as were those relating to peer norms. In both instances, the basic question (i.e. 'How often do your parents [peers] . . . ?') was presented at the top of the screen, with the eight behaviours and corresponding rating scales laid out underneath in the order indicated in Table 3.2. Finally, the items relating to global self-identity were always presented as a single set as the last element of the questionnaire, since the response format was different from that used elsewhere. All the remaining items were shown singly, in full randomised order, interspersed among the sets for the specific behaviours and norms described above.

3.2.3.3 Block 3: self-reported behaviour, demographics and accident history

Data collection for Block 3 employed an online questionnaire similar in format to that used for Block 2, developed and piloted as part of the same procedures. The Block 3 questionnaire comprised items relating to the remaining component of the TPB model, actual behaviour, as well as exposure, accident/near-miss history, and past road safety training. Demographic information relating to SES was also collected during this session, via initial questions on date of birth, gender, the name of the street where participants lived, and their postcode (information regarding name and school year was entered as a case identifier for computer data files at the start of sessions for each block). Further detail on the main Block 3 questionnaire items is given below.

3.2.3.3.1 Self-reported behaviour

Data on self-reported behaviour was collected in relation to each of the three global and eight specific scenarios utilised for the TPB items in Block 2. The focus here was on the frequency with which each behaviour had been performed in the period after completion of the Block 2 questionnaire, in order to test the extent to which the earlier measures genuinely predicted subsequent behaviour. The items relating to this element were presented as a single set in the order shown in Table 3.2, at the start of the Block 3 questionnaire. This set was headed with the question 'How often in the last 2 weeks have you . . . ?', followed by the description of each scenario. Each was accompanied by a 7-point rating scale for responses (1 = never, 7 = very often).[1]

[1] In order to explore the possibility of obtaining direct measures of pedestrian behaviour, the final part of the third session was devoted to two on-screen map tasks, which required participants to mark the route that they would take from a start point to a destination a number of streets away. In the event, the data from these tasks proved to be less reliable than hoped for. Since there were, however, sufficient points of interest to suggest that a more refined version of these tasks might serve as a useful assessment tool, brief details on materials and data relating to them are provided in Appendix 2.

3.2.3.3.2 Exposure

Exposure to traffic was assessed via four items regarding the frequency with which participants walked to school and from school on their own, and as part of a group. Responses were made using a 4-point scale for each item, keyed as shown in Figure 3.3.

Figure 3.3: Example of item assessing exposure to traffic

How often do you walk TO school on your own?

Never	Less than once a week	1–2 days a week	3–5 days a week

3.2.3.3.3 Accident/near-miss history

Self-reported pedestrian accident history (a) in the past six months and (b) longer ago was requested by two items: ‘In the last six months, have you been hit by a vehicle when out walking?’ and ‘Have you been hit by a vehicle **more** than six months ago when you were out walking?’. Near-miss history in the past six months was assessed by one item: ‘In the last six months, have you come **close** to being hit by a vehicle when you were out walking?’. The six-month cut-off was used as a period within which memory was more likely to be accurate. For all three questions, participants were given the opportunity to report how many times and what kind of vehicle they had been hit (or nearly hit) by. An example of the question layout is provided in Figure 3.4.

Figure 3.4: Example of item assessing near-miss history

In the last six months, have you been hit by a vehicle when out walking?

No	Yes, once	Yes, twice	Yes, three or more times

(The following question only appeared if the participant responded ‘yes’ to the first question)

What were you hit by?

Car	*Lorry/van*	*Bus*	*Motorbike*	*Bike*	*Something else*

Click on as many boxes as apply

3.2.3.3.4 Past road safety training

Previous pedestrian and cycling training was examined via two items: 'Have you ever been taught road safety?' and 'Have you ever had cycle training?'. Those responding positively could choose different options to indicate the type of training they had had (see Figure 3.5).

Figure 3.5: Item assessing past road safety training

Have you ever been taught road safety?

No	Yes, in the classroom	Yes, in the playground/gym	Yes, at the roadside

Click on as many boxes as apply

3.2.4 Procedure

All testing took place within schools, in three separate sessions, one for each of the blocks of measures described above. An empty classroom was used in each case, with sufficient space to comfortably accommodate four to five laptops and the same number of participants and researchers, each participant working on a one-to-one basis with a researcher. Sessions took between 20 and 50 minutes to complete (the first session was the longest), with participants proceeding through the materials at their own pace, after having received guidance on what they were required to do. As well as being provided with practice items for the Block 1 measures in each skill area, participants were presented with online instructions and a practice page before attempting the actual questionnaires for Blocks 2 and 3. In addition, the researchers stood ready to give any further clarification that was required before or during testing. All data were collected and stored online, with the exception of the Block 1 conceptual responses for safe route planning, answers to questions for perception of drivers' intentions, and the profile of target behaviours performed for designated crossings. As in Study 1, these data were recorded on pro-formas by the researcher working with the participant. For the questionnaire measures, responses were not recorded by the computer until participants clicked to indicate that they were ready to proceed to the next question. Up to this point they were able to change their answers by clicking a second time to deselect an option, and then choosing again.

Testing in each school began at slightly different times of the same school year (between February and April 2004), but it was common to each school that the first two sessions were completed within a week of each other, and that the third did not take place until a minimum of 14 days after the second, to allow testing of predictive relations.

3.2.5 Scoring and data reduction

The scoring procedures for each block of measures are outlined below. In view of the large number of items on which data were collected, values were collapsed across items where it was appropriate to do so. This served to reduce the number of variables to manageable proportions both for identification of trends and for use as predictors of intentions and behaviour in subsequent regression analyses. The methods of data reduction employed are described as part of the outline of the scoring system.

3.2.5.1 Block 1 measures

3.2.5.1.1 Skill variables

Behavioural performance on **safe route planning** was scored in the same way as for Study 1 (see Section 2.2.5.1), and values derived as before for the percentage of safe and unsafe routes. Conceptual performance was also scored according to the criteria used previously, but instead of reducing this to an average across problems, greater differentiation between low- and high-level responses was made by computing two indices, the percentage of responses in categories 0 to 2 (i.e. which mentioned nothing pertinent to the problem), and the percentage of responses in category 4 (i.e. which gave full and relevant answers).

As in Study 1, **visual timing** responses were scored automatically by the computer, but some adjustments were made to the variables that were derived. Accepted gap size, effective gap size and starting delay were scored as before (see Section 2.2.5.2), as were estimated crossing time and total crossing attempts, but the latter two were discounted from consideration except for the purposes of calculating other measures. Missed opportunities were redefined to take into account whether the next car of a potential gap was in the nearside or far side lane, as is more common elsewhere in the literature. In addition, the splats variable was dropped, tight fits were redefined to specify crossings that were more obviously hazardous, and a new variable, riskier crossings, was introduced to cover instances that were neither safe crossings nor tight fits. The new definitions are summarised in Table 3.4.

One further change introduced was that missed opportunities were now computed as a percentage of all possible gaps that were not used, averaged over locations. This provided a standardised index across individuals which took into account the fact that exposure to the task varied depending on how quickly crossing judgements were made. Similarly, safe and riskier crossings and tight fits were all now computed as a percentage of the total number of crossings attempted, again averaged over locations, since the number of attempts could also vary across individuals due to some being timed out.

Table 3.4: Revised scoring of visual timing variables for Study 2

Variable	***Definition and calculation***
Missed opportunities	Total number of possible gaps presented which the participant did not use to make a crossing Possible gaps: If next car on nearside – any gap greater than crossing time If next car on far side – any gap greater than 1.5 x crossing time In the case of a nearside car, the next-but-one car must also be considered. If the next-but-one car is a nearside, no adjustment is needed but if the car is a far side car then the combined size of the gap must fit the criteria for a far side crossing (Crossing time = 4s for locations 1 and 2, and 4.67s for locations 3 and 4)
Riskier crossings	Total number of crossings made in each location which fitted the following criteria: If next car on nearside: effective gap size <= crossing time If next car on far side: effective gap size <= 1.5 x crossing time
Tight fits	Total number of crossings made in each location which fitted the following criteria: If next car on nearside: effective gap size <= 0.5 x crossing time If next car on far side: effective gap size <= crossing time
Safe Crossings	Crossings made that were considered safe calculated by the following formula: Number of Crossing Attempts minus (Tight Fits + Riskier Crossings)

For **use of designated crossings**, in order to simplify scoring and collapse over crossing type, the checklist of behaviours employed in Study 1 was reduced to nine items, all of which applied to both the pelican and junction crossings, and five of which applied to the zebra crossings as well. The nine target behaviours were as follows:

- looks at pedestrian light (pelicans and junctions);
- presses button (pelicans and junctions);
- stands in correct position (all);
- number of times looks to check traffic (all);
- looks right to double check (all);
- checks signal before crossing (pelicans and junctions);
- crosses on green (pelicans and junctions);
- looks right and left whilst crossing (all); and
- ends crossing in correct position (all).

The first three of these behaviours correspond to the preparatory phase in Study 1, the next three to the looking phase, and the last three to the crossing phase. The incidence of each of these behaviours was scored as the percentage of crossings on which it was present out of all those to which it applied (i.e. six for behaviours applicable just to pelicans and junctions, nine for the remainder). The only exception to this was the number of times a participant looked to check traffic, which was scored in terms of the average number across the nine different crossing scenarios.

Responses for **perception of drivers' intentions** were scored in the same way as Study 1. However, in order to represent outcomes on slightly more meaningful scales than simple totals of correct responses and cues identified, performance was expressed as the percentage of vehicles for which correct predictions were made on the first attempt, on the second attempt, and overall; and the average number of cues identified per vehicle.

3.2.5.1.2 Data reduction for skills

The 24 variables outlined above were retained for purposes of examining change in performance levels across the three age groups, and, as appropriate, for comparison to the levels found in Study 1. However, their large number made them unwieldy for use in examining the relationship between skill, behavioural intentions and self-reported behaviour. To reduce them to a more manageable set, all except percentage of unsafe routes (since this was perfectly negatively correlated with **safe** routes) were subjected to a factor analysis (principal components with varimax rotation) with the objective of identifying a smaller number of underlying dimensions.

This analysis identified five clear factors accounting for 49.8% of the variance in the rotated solution, which mapped very strongly onto the different skill areas (see Table 3.5). The first factor identified a cluster of variables from visual timing centred on selected gap size. The second factor combined the performance and conceptual variables from safe route planning. The third factor related to first time and overall correct predictions from perception of drivers' intentions, together with the cues identified. The fourth factor combined the two variables from visual timing associated with hesitancy, i.e. starting delay and missed opportunities. Finally, the fifth factor combined the looking behaviours relating to traffic from use of designated crossings.

Leaving aside the striking and hitherto unreported implication that the pedestrian skills identified by Tolmie *et al*. (2002, 2003) are **independent** components (thus confirming the need for distinct training in each), this solution pointed to a simple strategy for data reduction. Since the loadings for the different variables in each of the five factors were almost uniformly high, as Table 3.5 makes plain, it was possible in four of the five instances to take one variable from each as representative of the whole factor. The selected variables were tight fits for factor 1, number of cues identified for factor 3, starting delay for factor 4, and number of times looked for factor 5. This strategy was deemed less appropriate for factor 2, due the mix of behavioural and conceptual variables, and an overall score for this factor (a weighted composite of those variables associated with it) was used instead.

Table 3.5: Summary of factor loadings from analysis of skill variables					
	Factor				
	1	***2***	***3***	***4***	***5***
VT effective gap size VT % tight fits VT % safe crossings VT accepted gap size	**0.861** **-0.857** **0.710** **0.701**				
SRP % safe routes SRP % 0–2 responses SRP % 4 responses		**0.902** **-0.880** **0.847**			
DI % predictions correct 1st time DI % predictions correct overall DI number of cues per vehicle			**0.935** **0.918** **0.740**		
VT starting delay VT % missed opportunities				**0.931** **0.852**	
DC number of times looked DC looks right and left crossing DC looks right to double check					**0.816** **0.716** **0.652**

VT = Visual timing.
SRP = Safe route planning.
DI = Drivers' intentions.
DC = Designated crossings.

3.2.5.1.3 Estimations of difficulty

As in Study 1, estimations of difficulty were derived directly from the computer as raw values on a scale from 0–100 for each judgement that was made. Three summary values were then computed from these for each of the four skill areas:

- the mean of the difficulty estimates made prior to completing problems (mean pre-estimate);
- the mean of the difficulty estimates made after completing problems (mean post-estimate); and
- the end estimate of difficulty.

In addition, measures of the discrepancy between perceived difficulty and actual performance on key behavioural variables were calculated using the procedure employed in Study 1 (see Section 2.3.3). These were computed for each of the five skill factors identified above, using tight fits, number of cues, starting delay, and number of times looked (reversed where appropriate, so that higher scores indicated poorer performance) as the performance measures for factors 1, 3, 4 and 5, and percentage unsafe routes as the comparable behavioural variable for factor 2, given that it was simply the obverse of percentage safe routes. Discrepancies were only calculated for the post-estimates of difficulty, since these had proved more indicative of poor monitoring of performance in Study 1.

3.2.5.1.4 Data reduction for difficulty estimates

As with the skill measures, whilst the 17 difficulty variables outlined above provided the basis for detailed analysis of performance, it was necessary to consider ways in which these might be reduced for the purposes of examining relations to intentions and behaviour. The start point for doing so was the observation that, despite fluctuations from one skill area to another in the **absolute** levels of difficulty measures of a particular type (see Section 3.3.1.2 below), individual values were strongly correlated (for pre-estimates, correlations between skill areas ranged from 0.57 to 0.64, for post-estimates, from 0.48 to 0.62, for end estimates from 0.45 to 0.60, and for the five discrepancy measures from 0.24 to 0.59; all correlations significant at $P < 0.001$, one-tailed).

Table 3.6: Summary of factor loadings from analysis of difficulty estimates

	Measure			
	Pre-estimates	***Post-estimates***	***End estimates***	***Discrepancies***
Safe route planning	**0.857**			
Visual timing	**0.835**			
Designated crossings	**0.837**			
Drivers' intentions	**0.852**			
Percentage of variance explained	*71.5%*			
Safe route planning		**0.834**		
Visual timing		**0.799**		
Designated crossings		**0.815**		
Drivers' intentions		**0.842**		
Percentage of variance explained		*67.7%*		
Safe route planning			**0.836**	
Visual timing			**0.810**	
Designated crossings			**0.782**	
Drivers' intentions			**0.786**	
Percentage of variance explained			*64.6%*	
Safe route planning				**0.704**
Visual timing – starting delay				**0.730**
Visual timing – tight fits				**0.723**
Designated crossings				**0.644**
Drivers' intentions				**0.701**
Percentage of variance explained				*49.1%*

The implication is that individual participants were highly consistent, relative to each other, in their perceptions of the level of difficulty of the different problems, some considering them as a set to be easier and some as more difficult. Factor analyses (principal components) for each of the four types of measure confirmed this picture. As can be seen in Table 3.6, values across skill area for a given measure loaded in each case onto a single factor which explained a high percentage of the variance. In contrast to actual performance in the different skill areas, then, perceptions of difficulty were substantially related. This relationship extended, moreover, to the different types of measure, with average pre-, post- and end estimates of difficulty across the four skill areas all strongly positively correlated to each other (values ranged from 0.85 to 0.95), and negatively correlated to a slightly lesser extent with discrepancies (-0.72 to -0.84; all values significant at $P < 0.001$, one-tailed). Since the overlap in variance was not total, however, for the purposes of data reduction, the decision was made to focus on two variables, one representing the positive pole, the average post-estimate of difficulty (given its importance in Study 1), and one the negative, the average discrepancy.

3.2.5.2 Block 2 measures

With the exception of global self-identity, risk-taking and peer-group identification, separate measures of every Block 2 variable were derived for the three global and eight specific scenarios, in order to permit distinct models of the relationship between variables to be constructed for each of the behaviours they described. The precise manner in which these measures were arrived at is outlined below, followed by a description of the scoring system employed for the remaining variables.

3.2.5.2.1 Attitudes

The eight semantic differential scales employed to measure attitudes showed high internal consistency for each of the 11 scenarios (values of Cronbach's alpha ranged between 0.86 and 0.94, with a mean of 0.90). The ratings that participants made across the eight scales were therefore averaged in order to give one single measure of attitude for each scenario. Lower scores on this measure indicated a negative attitude towards the behaviour in question, whilst higher scores indicated a positive one.

3.2.5.2.2 Subjective norm, perceived behavioural control and behavioural intentions

For each of the 11 scenarios, participants rated single items for subjective norm, for perceived behavioural control, and for behavioural intentions. These ratings were used without modification as the measure of these variables in each case, with higher values indicating respectively greater perceived approval of the behaviour in question, greater control over its performance, and a higher perceived expectation of actually performing it.

3.2.5.2.3 Parental/peer norms and specific self-identity

The frequency with which parents and friends performed each behaviour were also assessed via single items, as was the extent to which respondents saw themselves as the kind of person who behaved in that way, but in this case only for the eight specific scenarios. The ratings for these items were used without modification as the measures of parental norms, peer norms and self-identity for those behaviours, higher values indicating more frequent performance of a behaviour and greater perceived typicality. For the three global behaviours, measures of parental and peer norms were derived by calculating composites of the ratings for the specific behaviours. Once values for the three risky and two skilled scenarios (see Table 3.2) had been reversed to yield the same underlying polarity as the cautious behaviours, it was possible to check that the ratings for parents and peers exhibited sufficient internal consistency to construct valid composites. Values were good for peer norms, and acceptable for parental norms (alpha = 0.79 and 0.62 respectively), and averages across the eight ratings were therefore computed for both. The same composite scores were used for each of the global behaviours, with higher values on these indicating more cautious normative behaviour. Measures of self-identity for the global behaviours were derived from the global rating task, as described below.

3.2.5.2.4 Peer group identification

The three questions on strength of identification with friends showed good internal consistency (alpha = 0.77), and these were therefore simply averaged to provide a single measure of this variable.

3.2.5.2.5 Global self-identity

Factor analysis (principal components with varimax rotation) was used to analyse the ratings given for the 40 adjectives, to reduce these to a smaller set of dimensions. This identified a five-factor solution explaining 42.4% of the variance among responses. Of these five factors, the first two accounted for 23.4% of the variance, and produced clearly meaningful groupings covering 19 of the 40 adjectives. These two groupings were therefore used in subsequent analyses as separate global self-identity scales, labelled ‘cautiousness/sensitivity’ and ‘carelessness/unpredictability’ respectively. The adjectives comprising these two scales, together with their factor loadings, are shown in Table 3.7. Since both scales had good internal consistency (alpha = 0.82 for cautiousness/sensitivity and 0.81 for carelessness/unpredictability), scores on each were computed simply as averages across ratings on the relevant items. Higher scores on cautiousness/sensitivity indicated that the participants perceived themselves as more careful individuals, whilst higher scores on carelessness/unpredictability suggested perceptions of the self as more reckless.

Table 3.7: Summary of factor loadings for global self-identity ratings		
Item	***Factor***	
	1: Cautiousness/sensitivity	***2: Carelessness/unpredictability***
Responsible	**0.714**	
Sensible	**0.671**	
Reliable	**0.604**	
Polite	**0.597**	
Considerate	**0.548**	
Honest	**0.535**	
Patient	**0.521**	
Conforming	**0.505**	
Overcautious	**0.468**	
Cautious	**0.451**	
Disciplined	**0.352**	
Unpredictable		**0.682**
Reckless		**0.646**
Wild		**0.576**
Aggressive		**0.558**
Daft		**0.558**
Careless		**0.556**
Short-tempered		**0.516**
Easily distracted		**0.512**

3.2.5.2.6 Risk-taking

Respondents' ratings of the three 'safe' risk-taking items was automatically reversed by the computer so that all six items had the same underlying polarity. In order to check that the resulting scores related to a single coherent scale, they were subjected to factor analysis (principal components with varimax rotation). This identified one factor accounting for 39.6% variance (see Table 3.8 for loadings). Internal consistency was also found to be reasonable (alpha = 0.68). A single measure of risk-taking was therefore derived by averaging across ratings with common polarity applied. Higher scores on this measure indicated more risk-taking.

Table 3.8: Summary of factor loadings for risk-taking items	
	Loadings
I always prefer to be on the safe side	0.695
I am cautious before doing anything	0.720
I am rather cautious in unusual or unpredictable situations	0.592
I don't think about the possible unpleasant outcomes of my actions	0.399
I would do almost anything just for a dare	0.596
In general I quite enjoy taking risks	0.712

3.2.5.3 Block 3 measures

3.2.5.3.1 Self-reported behaviour

As with the Block 2 data, separate measures of self-reported behaviour were derived for each of the three global and eight specific scenarios, to be used as final outcome variables (i.e. those to be predicted) in models of relationships between factors. The simple rating of the frequency with which each behaviour had been performed in the previous fortnight was used for this purpose. Higher values indicated more frequent performance of the behaviour.

3.2.5.3.2 Exposure

In order to examine exposure patterns, simple counts were made for each the four journey types (walking to school alone, from school alone, to school in a group, and from school in a group) of the number of participants who said they did this (a) never, (b) less than once a week, (c) 1–2 days a week, and (d) 3–5 days a week. For the purposes of investigating the relationship of exposure to intention and self-reported behaviour, however, it was necessary to recast the exposure data into a form compatible with the ratings employed for these measures. To do this, values were computed for two indices, individual exposure and group exposure. These were derived by taking the average of ratings made for journeys to and from school alone, and then again as part of a group, scoring responses of ‘never’ as 1 and ‘3–5 days a week’ as 4. In both cases, the relevant items had high internal consistency when scored on this scale (alpha = 0.82 for individual and 0.81 for group journeys).

3.2.5.3.3 Accident/near-miss history

As might be anticipated, reported accidents, both within the preceding six months and prior to that, were low in frequency across the sample, two being the highest number recorded for any individual. Since values for these items correlated significantly, if weakly ($r = +0.20$, $P < 0.001$), a simple total across the two was computed to provide a single measure with a greater degree of variance. Reported near-misses (0 to 3) were retained as a further, separate measure. For the purposes of scoring, no account was taken of the vehicle(s) involved in either accidents or near-misses.

3.2.5.3.4 Past road safety training

Reports of road safety and cycle training were scored as two separate variables, in both cases as a simple dichotomy between having received training and not having done so. No account was taken of the stated context of training for the purposes of scoring, since participants tended to indicate experience in all three stated contexts.

3.3 Results

The study generated both cross-sectional and correlational data, details of which are presented below in two sections. The first focuses primarily on the profile of outcomes across the three age groups on the measures of skill, perceived difficulty, attitudes, norms, self-identity and reported behaviour. This section also deals with the comparability of the Study 1 and Study 2 samples with respect to skills and estimates of difficulty. The second section reports regression analyses examining relationships of social and skill variables to intention and behaviour for the 11 focal scenarios. This section addresses the key questions of what influences hazardous behaviour, and of whether social or skill variables are of greater importance. A final section outlines the conclusions that emerge from the data.

3.3.1 Profile analyses

3.3.1.1 Skill measures

3.3.1.1.1 Safe route planning

Table 3.9 shows the mean percentage of safe routes, and both low-level and high-level conceptual responses, broken down by age group. As can be seen, there was a small increase with age in the frequency of safe routes, but this was not statistically significant. High-level conceptual responses increased from S1 to S2, although they declined slightly again at S3, and there was a corresponding decrease with age in the incidence of low-level conceptual responses. Change with age in high-level responses, but not low-level, was sufficient to achieve statistical significance ($F(2,304) = 3.15$, $P = 0.044$), although the effect size was small (partial eta-squared = 0.02) and only the difference between S1 and S2 was reliable.

Table 3.9: Performance on safe route planning (Study 2) – mean percentage of safe routes, low-level and high-level conceptual responses, by age group (standard deviations in italics)

	S1	S2	S3
Percentage of safe routes	67.0	71.5	72.0
	28.1	*29.1*	*26.6*
Percentage of low-level conceptual responses	11.3	8.5	8.1
	10.9	*11.1*	*8.8*
Percentage of high-level conceptual responses	32.0	43.2	38.5
	32.2	*33.7*	*31.8*

Behavioural performance was broadly comparable to that in Study 1 (see Table 2.8 in Section 2.3.2.1). Although the percentage of safe routes for the S1 participants was somewhat lower here, and that for those in S2 and S3 higher, the variance was much the same as in Study 1, and the discrepancies in means were well within the margin of error. Conceptual performance across the two studies could not be directly compared due to the change in indices. However, conceptual and behavioural performance in the present study were correlated to much the same degree as in Study 1 (for percentage of safe routes and percentage of high-level responses, $r = 0.70$, $n = 307$, $P < 0.001$, one-tailed), suggesting that behavioural performance reflected conceptual grasp in similar fashion. As in Study 1, neither behaviour nor conceptual understanding were close to ceiling, and the degree of individual variability in performance was high. For low-level conceptual responses, this variability was to an extent associated with gender, since girls gave nearly a third more responses at this level than boys ($F(1,299) = 4.22$, $P = 0.041$, effect size = 0.01). This effect was not evident in Study 1, but its marginal nature would have made it hard to detect with the smaller sample size employed there.

3.3.1.1.2 Visual timing

Performance on the seven measures used to assess visual timing is shown in Table 3.10. Although minor fluctuations in all these indices are apparent across the age groups, only the decline with age in the percentage of missed opportunities was statistically significant ($F(2,304) = 3.13$, $P = 0.045$), and this effect was marginal (effect size = 0.02, reliable difference present only for S1 versus S3). In general, the three age groups showed remarkably similar performance profiles.

Table 3.10: Mean scores on measures of visual timing performance (Study 2), by age group (standard deviations in italics)

	S1	S2	S3
Starting delay (secs)	1.02 *0.36*	0.98 *0.30*	0.94 *0.34*
Percentage of missed opportunities	35.3 *19.4*	33.1 *16.8*	29.0 *17.6*
Accepted gap size (secs)	6.29 *0.34*	6.23 *0.32*	6.22 *0.35*
Effective gap size (secs)	5.28 *0.37*	5.26 *0.33*	5.29 *0.34*
Percentage safe crossings	58.45 *11.0*	57.2 *10.9*	58.2 *11.3*
Percentage riskier crossings	32.4 *11.6*	32.2 *11.4*	29.9 *11.7*
Percentage tight fits	9.1 *11.3*	10.6 *10.4*	11.8 *13.1*

In this respect, they were comparable to the Study 1 sample, where no significant differences were identified between the three secondary school age groups on any measure – although, as here, there were apparent declines in starting delay and missed opportunities (see Table 2.9 in Section 2.3.2.2). Some minor differences between the samples were evident: starting delays were systematically smaller among the present participants, as were accepted gap sizes, whilst effective gap sizes were comparable, but failed to show the increase with age identified in Study 1. These differences are explicable to some extent, however, in terms of the use of a subset of items weighted towards the easier scenarios for Study 2. The use of a greater number of demanding scenarios in Study 1 may have increased values for starting delay and accepted gap size, particularly amongst the younger participants, due to a perceived need for greater caution on such items.

The samples are similar in two other ways. First, among the current participants, significant effects of gender were found for starting delay ($F(1,299) = 7.65$, $P = 0.006$, effect size = 0.02), for missed opportunities ($F(1,299) = 11.63$, $P = 0.001$, effect size = 0.04), and for accepted gap size ($F(1,299) = 9.05$, $P = 0.003$, effect size = 0.03). In each case, girls tended towards greater caution, exhibiting longer delays, missing more opportunities (especially at S1) and choosing larger gaps than boys. None of these effects were significant among the smaller sample used in Study 1, but the same trends were apparent in the means. The other point of similarity is that, as for safe route planning, performance was far from ceiling in both samples, with the means masking a high degree of individual variability. Indeed, on the directly comparable measures, the standard deviations across the two samples were nearly identical.

3.3.1.1.3 Use of designated crossings

The percentage incidence of the nine target behaviours assessed for use of designated crossings (mean frequency in the case of number of looks to check traffic) is shown in Table 3.11. As for visual timing, few apparent variations across age group were reliable, with only the decline in looking right and left whilst crossing proving to be significant ($F(2,304) = 3.28$, $P = 0.039$, effect size = 0.02; S1 significantly different from S2). As in Study 1, looking behaviour was in fact very poor for all age groups, especially during the looking phase itself. This characteristic, the rather better performance on other aspects of the preparatory and crossing phases, and the general lack of significant age differences all indicate good levels of comparability between the two samples.

Table 3.11: Mean percentage of target behaviours (mean frequency for number of times looks to check traffic) for use of designated crossings (Study 2), by age group (standard deviations in italics)

	S1	S2	S3
Looks at pedestrian light	38.1% *47.0*	29.0% *43.9*	28.5% *43.0*
Presses button	98.2% *10.6*	97.0% *14.6*	97.6% *14.5*
Stands in correct position	80.9% *27.6*	78.6% *29.0*	83.6% *27.5*
Number of times looks to check traffic	1.52 *1.07*	1.31 *1.02*	1.42 *1.02*
Looks right to double check	5.0% *10.6*	6.1% *13.9*	4.6% *8.9*
Checks signal before crossing	53.2% *45.9*	50.6% *47.4*	49.6% *46.7*
Crosses on green	97.0% *11.3*	94.4% *17.6*	93.7% *15.5*
Looks right and left whilst crossing	35.4% *37.9*	22.5% *33.8*	28.4% *37.4*
Ends crossing in correct position	96.8% *9.2*	92.5% *20.7*	92.7% *20.6*

A further point of similarity is that the decrease in looking whilst crossing reflected a wider, if marginal, drift in performance between S1 and S2 in particular that was also apparent in Study 1 (see Figures 2.3 to 2.5 in Section 2.3.2.3). The older participants tended to look at the pedestrian light less, both at the outset and before crossing, and in addition to cross on green and end in the correct position less often. These trends were not significant due to the large underlying variance in performance observed for all three age groups, indicating that in each some participants did substantially worse than others. The slight tendency for the standard deviations to be higher among the older groups suggests this disparity grew larger with age if anything. This variation was again associated with gender to some extent, with girls looking to double check less often than boys ($F(1,299) = 5.68$, $P = 0.018$, effect size = 0.02), but crossing on green more often ($F(1,299) = 4.19$, $P = 0.042$). The gender effects were not evident in the Study 1 data, but the variation in performance found here was entirely consistent with the levels observed previously.

3.3.1.1.4 Perception of drivers' intentions

Table 3.12 shows the mean percentage of correct predictions of vehicle movements made at first and second attempt, and overall, together with the mean number of cues identified per vehicle. The profile of performance was again stable across the three age groups, as it was for the most part in Study 1 (see Table 2.10 in Section 2.3.2.4), and no significant differences were detected. As previously, performance in making correct predictions outstripped that in identification of cues, with most of the accurate predictions being made at the first attempt. Overall correct predictions were higher than in Study 1 (about 86%, as opposed to 12 out of 17, equivalent to around 70%). Variance in performance was more or less identical across the two samples, however (a standard deviation of 2 on a scale of 0–17 is equivalent to approximately 12% on the scale used here), and the difference in level is within the margin of error.

Table 3.12: Performance on perceptions of drivers' intentions (Study 2) – mean percentage of correct predictions of vehicle movements and mean number of cues identified per vehicle, by age group (standard deviations in italics)

	S1	S2	S3
Percentage of correct predictions – 1st attempt	80.8	80.7	83.0
	13.7	*12.9*	*12.8*
Percentage of correct predictions – 2nd attempt	5.0	4.1	4.0
	7.1	*6.5*	*6.3*
Percentage of correct predictions – overall	85.9	84.8	87.0
	13.5	*11.9*	*11.2*
Mean number of cues per vehicle	0.94	0.94	0.99
	0.27	*0.30*	*0.27*

As noted with regard to Study 1, not all cues necessarily needed to be picked up to infer likely future vehicle movement, so the poorer performance on this aspect of testing is not anomalous. There is nevertheless some cause for alarm in the fact that, on average, only one of the three or so cues available per vehicle was noticed, as the revised index makes clear. The implication is that attention may have been diverted once a first cue was noted, something that might lead to hazardous judgements under real world circumstances when cues are not convergent (as, for instance, with a driver continuing at speed down a road having forgotten to cancel his or her indicator from a previous manoeuvre). It should be noted that performance in this respect was no worse than that observed in Study 1, where the mean total of around 17 cues identified equates to more-or-less exactly one per vehicle.

As noted above for the other skill measures, the stability across age groups of the means masked a high level of underlying variability. This was again associated to an extent with gender differences. Girls made slightly fewer correct predictions than boys at the first attempt ($F(1,299) = 6.93$, $P = 0.009$, effect size = 0.02), but slightly more at the second ($F(1,299) = 4.39$, $P = 0.037$, effect size = 0.01). In addition to being somewhat tardier in interpreting what was happening, they were also nearly 10% poorer in identifying cues ($F(1,299) = 9.21$, $P = 0.003$, effect size = 0.03).

3.3.1.1.5 Summary for skill measures

Overall, then, as in Study 1, average levels of performance showed at best modest improvement across the three secondary school age groups in all four skill areas, and in general terms there was a high degree of comparability both between age groups and between samples. The profile of means across the various indices masked very high levels of variability within age groups, though, which were attributable only in part to known systematic factors such as gender.

3.3.1.2 Perceived difficulty

Perceived difficulty was examined first of all with regard to variation in pre-, post- and end estimates across skill area. Analysis then focused on discrepancies between individual post-estimates of perceived difficulty and actual performance level for each of the five skill components identified by factor analysis (see Section 3.2.5.1).

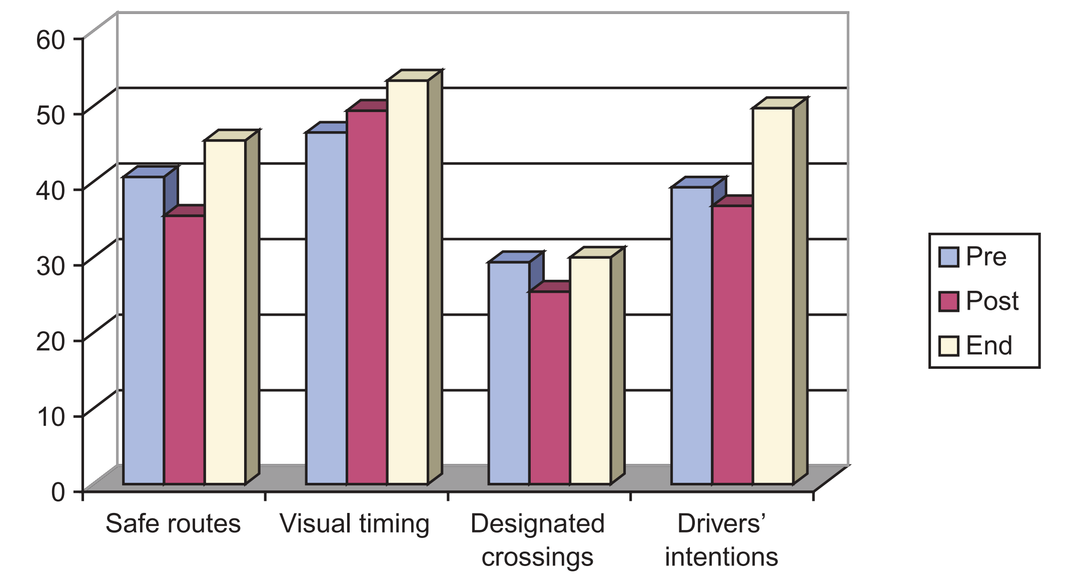
3.3.1.2.1 Pre-, post- and end estimates of difficulty

Analysis of pre-, post- and end estimates focused on comparison between the ratings made at these three time-points, both overall and within skill area. The relevant means are shown in Figure 3.6. Separate profiles for each age group are not presented, since no significant effects involving age were detected.

As Figure 3.6 indicates, the four skills differed substantially, and highly significantly, in their perceived level of difficulty ($F(3,912) = 157.38$, $P < 0.001$, effect size = 0.34), with the relative order identical to that found for Study 1. Visual timing was seen as being most difficult (mean = 49.8), perception of drivers' intentions (mean = 42.0) and safe route planning (mean = 40.6) as being of roughly equal moderate difficulty, and use of designated crossings (mean = 28.3) as being relatively easy. It should be noted that this systematic variation in the perceived difficulty of the different types of problem is in no ways at odds with the correlation across skill areas between individual ratings, detailed above with regard to the process of data reduction for difficulty estimates (see Section 3.2.5.1). Rather, it confirms that within their own personal frame of reference on the overall ease or difficulty of the test items, participants were in fact highly consistent in which they saw as more difficult, relatively speaking, and which as easier.

Cutting across these wider differences between skills, there was a consistent tendency within each skill area for post-estimates to be somewhat lower than pre-estimates, and for end estimates to be higher than both. This gave rise to a further highly significant effect of estimate time-point ($F(2,608) = 142.67$, $P < 0.001$, effect size = 0.32). The one exception to this pattern was that post-estimates were higher than pre-estimates for the skill seen as hardest, visual timing (for the interaction between skill and time-point, $F(6,1824) = 30.02$, $P < 0.001$, effect size = 0.09). Gender effects were identified, but these were small and limited to a tendency for girls to make higher estimates than boys ($F(1,299) = 5.74$, $P = 0.017$, effect size = 0.02).

Figure 3.6: Mean estimates of perceived difficulty pre- and post-problem completion and at the end of testing, by skill area



The pattern of ratings for the pre- and post-estimates was broadly the same as that in Study 1 among the S1 to S3 age groups. There, post-estimates were also lower than pre-estimates for safe route planning, use of designated crossings and perception of drivers' intentions, although they were static rather than higher for visual timing (see Figures 2.6 to 2.9 in Section 2.3.3). Unlike Study 1, there was no tendency for the S2 and S3 participants to exhibit greater drops in post-estimates than those in S1 (the mean difference was, in fact, identical across all three age groups). Nevertheless, though, there remained an apparently systematic bias towards reducing difficulty estimates post-performance that is hard to reconcile with the relatively poor level of that performance.

The implication is that across the age range young adolescents were once more failing to monitor their performance adequately – save that the high level of end estimates in each skill area seems inconsistent with this conclusion. However, the post-estimates were made shortly after the pre-estimates, and, unlike Study 1, for the very same items. It is hard to escape the inference that they were systematically lower because participants felt they had performed better than they expected, regardless of whether they had in fact done well. The general validity of this conclusion is supported by the fact that the exception to this pattern was restricted to the task seen as most difficult, visual timing. It is the end estimates that stand in need of further explanation, then, and the level of these is perhaps attributable to the harder items making greater impact on the cumulative impression of difficulty than the easier ones. There is certainly no evidence that it reflects a sudden, consensual shift back to more realistic assessment of performance at the end of each task.

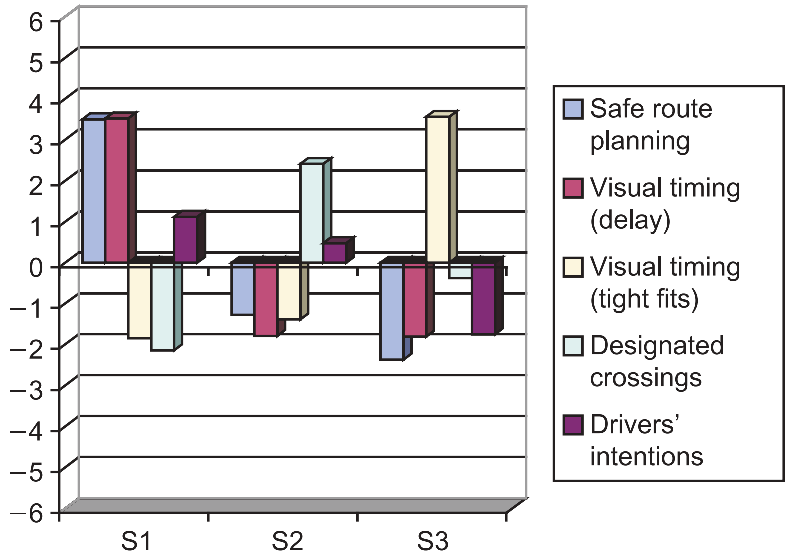
This said, there was one point of interest about the end estimates. Whilst, as noted, pre- and post-estimates differed overall by the same amount for each age group, there was a near-significant tendency for the difference between the level of these and the end estimate to become smaller with age ($F(4,608) = 2.33$, $P = 0.076$, effect size $= 0.01$): for S1, the mean difference was 8.4, for S2 it was 6.6, and for S3 it was 5.3. In this respect, then, there remained some sign that the older participants were more resistant to seeing the items as difficult, despite their performance being at comparable levels to the younger participants in most particulars.

3.3.1.2.2 Discrepancies between perceived difficulty and skill level

Figure 3.7 shows the mean discrepancies between predicted difficulty ratings based on objective scoring of observed skills and participants' own post-estimates of difficulty (i.e. those made once they had witnessed their own performance). Values are broken down by age group and are presented separately for each of the five skill components identified by the earlier factor analysis. It will be remembered that positive values indicate an underestimation of difficulty relative to skill level (actual is lower than predicted), and negative values an overestimation of difficulty (actual is higher).

As can be seen, all three age groups exhibited both underestimates and overestimates, with the direction of discrepancy fluctuating considerably across the skill component in each case. Unlike Study 1 (see Figure 2.10 in Section 2.3.3), there was no tendency for older adolescents to be more likely to underestimate difficulty than younger: no significant differences were found between the age groups for discrepancies on any of the five components, a not unexpected outcome given the lack of age differences in both skill levels and difficulty estimates.

Figure 3.7: Mean discrepancy between predicted and actual difficulty ratings, post-performance, for each of five skill components, by age group



As with the skill indices, however, the mean discrepancy values for each age group disguised a high level of individual variation. In all three groups, and for each of the five skill components, participants exhibited a full (and normally distributed) range of discrepancies from highly negative to highly positive. In contrast to the skill indices, little of this individual variation was explicable in terms of gender, the only identified effect being that boys were more likely to overestimate their ability with respect to making tight fits ($F(1,299) = 11.20$, $P = 0.001$, effect size $= 0.04$). It was, however, far from random, since, as noted in Section 3.2.5.1, discrepancies were highly correlated across the five skill areas. Individuals varied substantially in the extent to which they underestimated or overestimated difficulty, then, but they did so in consistent fashion from one skill area to another.

3.3.1.2.3 Summary for perceived difficulty

Overall, as with the skill measures, there was little difference between the age groups in the profile of difficulty ratings. There were, however, consistent differences between the skill area and between the time-point of estimate which were comparable to those found in this age range in Study 1. Differences from Study 1 were more evident with respect to discrepancies between skills and perceived difficulty, with older participants in this sample being no more likely than younger to underestimate difficulty relative to their skill levels. Such underestimates were nevertheless rife, occurring throughout the age range with a high degree of individual consistency. Despite differences in the pattern of data, the high level of variability between individuals within each age group tends, in fact, to confirm the conclusion drawn from Study 1 that such misperceptions are not a function of the transition to secondary school in itself. They would seem instead to reflect the effect of some other variable or set of variables which impacts in differential manner on individuals in this age range.

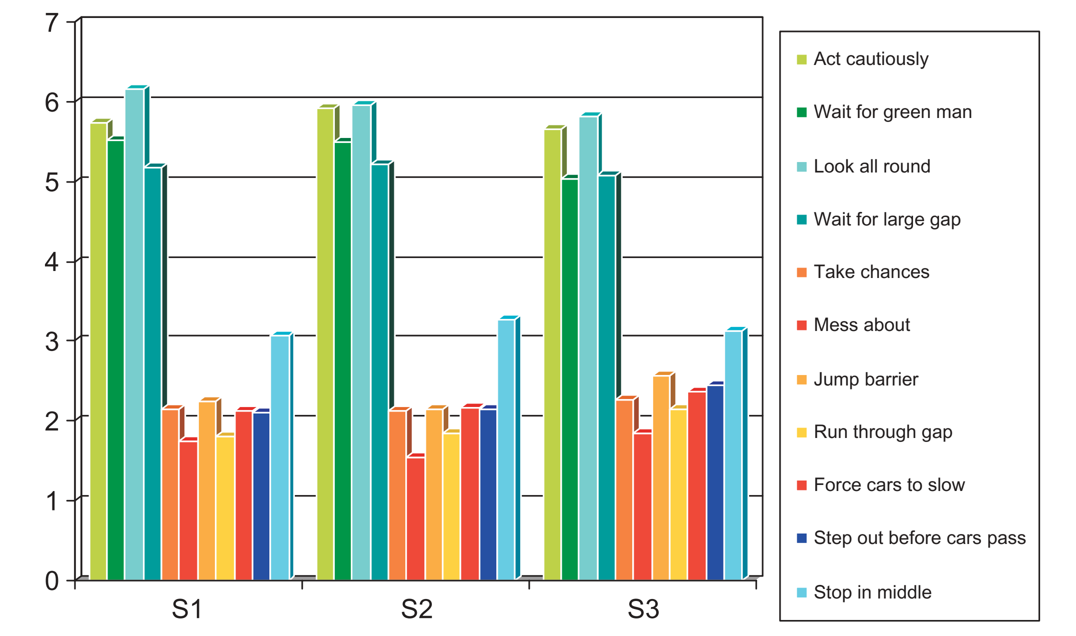
3.3.1.3 Attitudes, norms, identity and behaviour

Profile analyses for the Block 2 and Block 3 measures focused in turn on each aspect of the extended TPB model, i.e. attitudes, subjective norms, perceived behavioural control, parental norms, peer norms, self-identity and risk-taking, intentions, and self-reported behaviour. Similar analyses were carried out for the measures of exposure, accidents/near-misses, and past training. Results are reported below in this order, together with some preliminary consideration of the relationship between variables.

3.3.1.3.1 Attitudes

Figure 3.8 shows the mean attitude ratings on a scale of 0 to 7 for the three global and eight specific scenarios in each of the three age groups. As can be seen, irrespective of global versus specific differences, participants in all three age groups exhibited clear differentiation between their attitudes to cautious and risky behaviours, the former being seen as positive and the latter as negative. Although individuals varied to some extent in the degree to which they showed this differentiation, there was little overlap between ratings for the two types of behaviour (standard deviations were around 1.2 scale points on average, against a separation in means of approximately 3.5 scale points). Ratings were slightly more mixed for the second of the skilled scenarios (crossing to the middle of the road), but the net outcome was a substantial effect of scenario ($F(10,2990) = 657.40$, $P < 0.001$, effect size = 0.69). There was evidence of a modest change in ratings with age, the differentiation between cautious and risky/skilled behaviours becoming marginally less (for scenario by year, $F(20,2990) = 2.08$, $P = 0.02$, effect size = 0.01). There was also some minor variation with gender, girls tending to have a slightly more positive attitude to the cautious behaviours, and a slightly more negative attitude to the risky ones (for scenario by gender, $F(10,2990) = 4.36$, $P < 0.001$, effect size = 0.01). In general, though, adolescents in all three age groups were positive about cautious pedestrian behaviour, negative about risky behaviour, and somewhat less negative about skilled behaviour.

Figure 3.8: Mean attitude rating for four cautious, five risky and two skilled scenarios, by age group



3.3.1.3.2 Subjective norm

Ratings for the subjective norm ('most people who are important to me would approve of me doing this') exhibited a very similar profile to attitudes, as Figure 3.9 shows. Thus there was again clear differentiation between cautious and risky behaviours, the former being seen as approved of and the latter as disapproved of, with slightly more mixed perceptions of the feelings of others about the second of the skilled behaviours. As with attitudes, this gave rise to a sizeable effect of scenario ($F(10,2990) = 306.38$, $P < 0.001$, effect size = 0.51). Here, however, there was less sign of creep with age towards reduced differentiation, and no variation with gender. Variability in ratings at an **individual** level was nearly 50% higher than it was for attitudes, though (standard deviations averaged over 1.7), indicating there was less consensus on how performing the behaviours would be perceived by important others.

3.3.1.3.3 Perceived behavioural control

In general, participants apparently saw themselves as having substantial freedom to act as they chose, regardless of behaviour, with high ratings of perceived behavioural control ('if I wanted to do this I could') and much reduced differentiation between cautious, risky and skilled scenarios than was the case for attitudes and subjective norms (see Figure 3.10). There was still some tendency, however, to regard risky behaviours as less under personal control than cautious, and, in consequence, a weak effect of scenario, relatively speaking ($F(10,2990) = 31.28$, $P < 0.001$, effect size = 0.09). There was also some tendency for this effect to be slightly more marked among S1 participants than those from S2 or S3, and although this was not a significant trend, this was attributable in part to reasonably high levels of individual variability in ratings, as with subjective norms (standard deviations averaged just under 1.7).

Figure 3.9: Mean rating of subjective norm for four cautious, five risky and two skilled scenarios, by age group

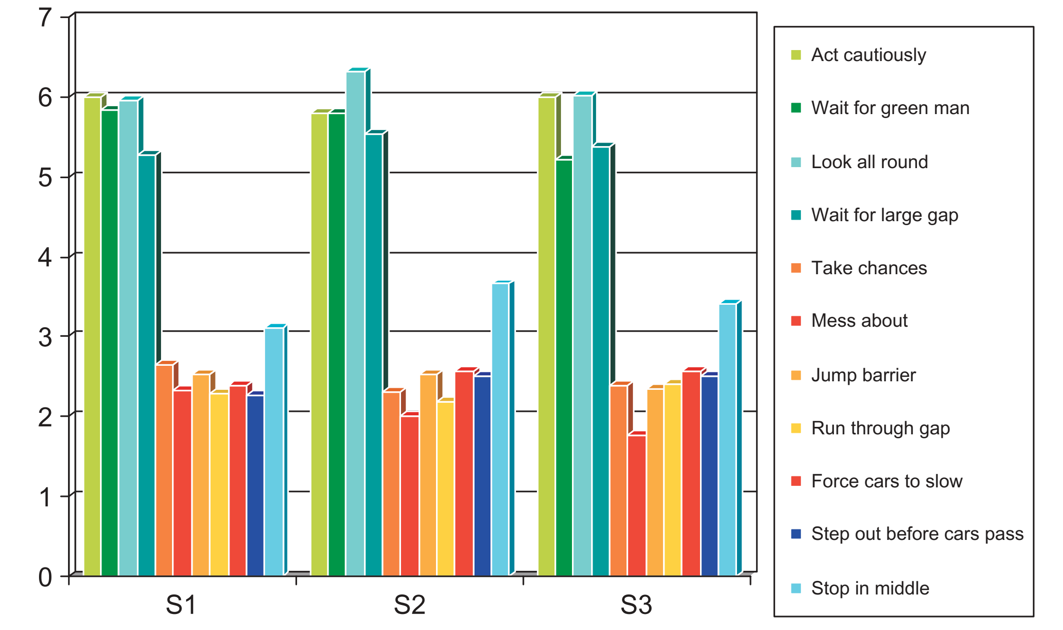
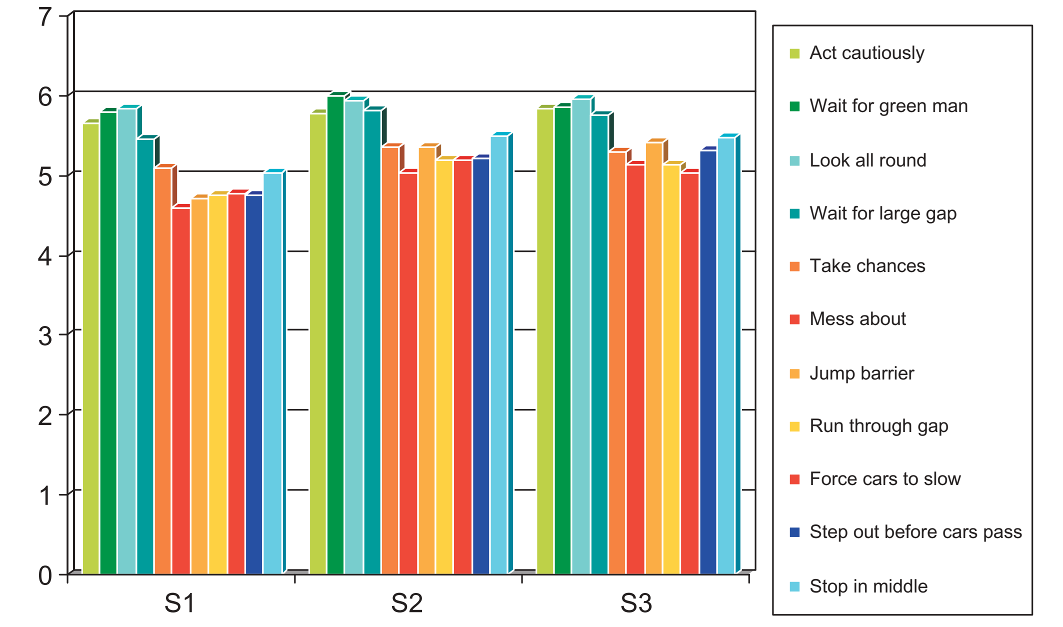


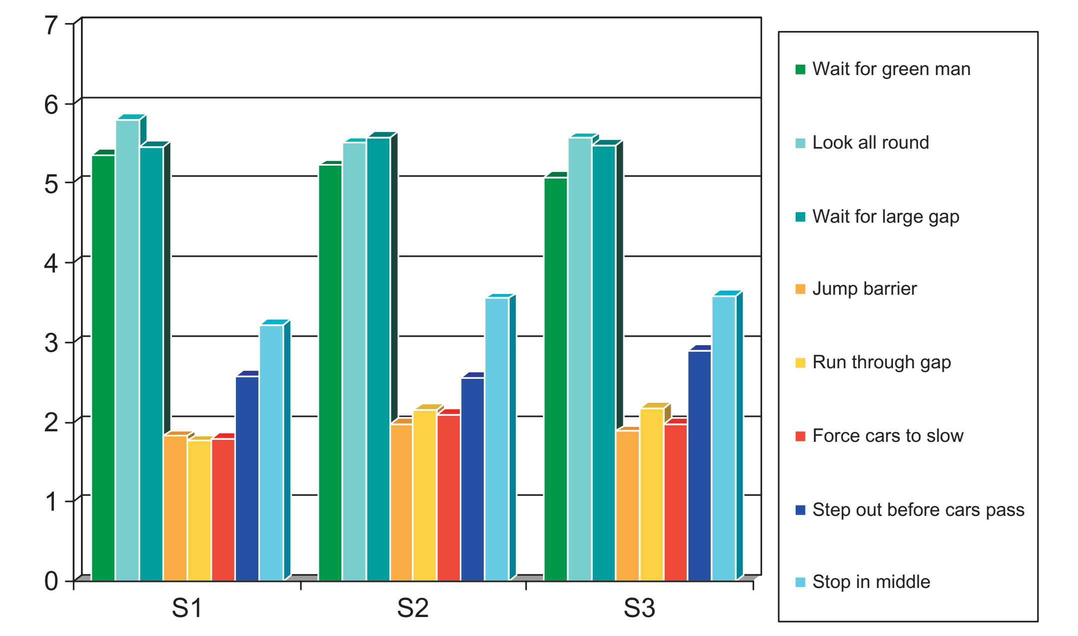
Figure 3.10: Mean rating of perceived behavioural control for four cautious, five risky and two skilled scenarios, by age group



3.3.1.3.4 Parental norms

Individual ratings for parental norms ('how often do your parents. . .?') were only available for the specific scenarios; the ratings used subsequently as predictors for global behaviours were simply composites of these. As far as the specific behaviours were concerned, there was once again clear differentiation between the three types (for the effect of scenario, $F(7{,}2093) = 382.05$, $P < 0.001$, effect size = 0.56), as Figure 3.11 shows. Parents were reported to engage in the cautious behaviours quite often, but not in the risky behaviours, and the skilled behaviours were reported to occur with moderate frequency. There were no effects of age or gender, as would also be expected, bearing in mind that the types of behaviour participants witnessed their parents engaging would not be particularly likely to vary as a function of such characteristics, at least in the adolescent age range. This, and the ratings for the skilled behaviours, confer good face validity on the data.

Figure 3.11: Mean rating of parental norms for three cautious, three risky and two skilled scenarios, by age group



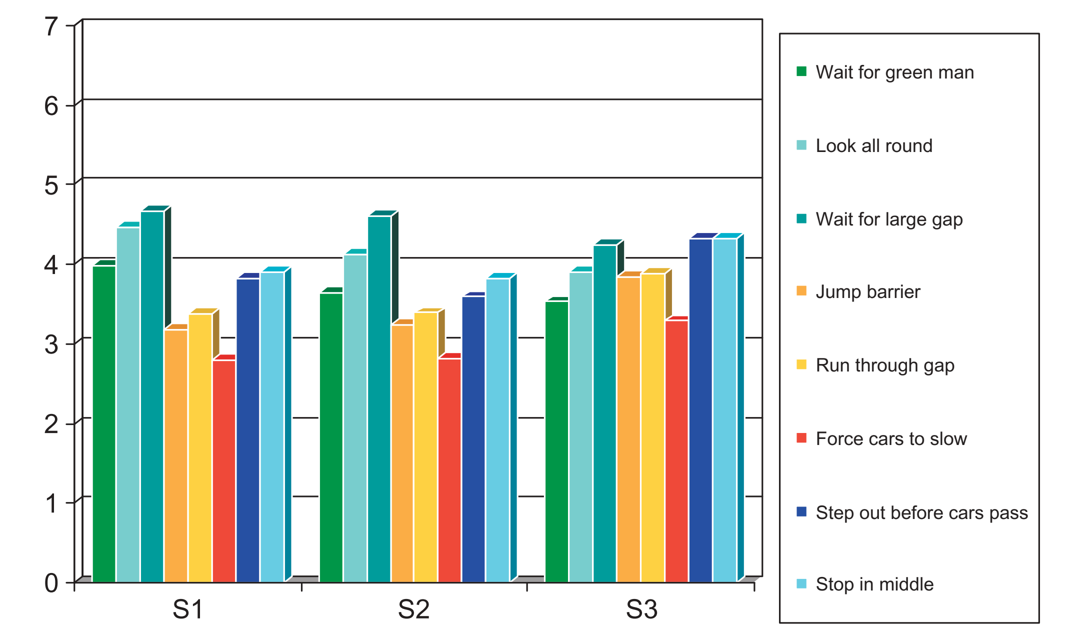
3.3.1.3.5 Peer norms

As with parental norms, participants only gave ratings of peer norms for the specific scenarios. As Figure 3.12 shows, there was still some differentiation between the three different types of scenario, but this effect was much weaker than it was for parental norms (for scenario, $F(7{,}2093) = 25.15$, $P < 0.011$, effect size = 0.08). In general, the profile was much flatter, with peers being reported to behave cautiously less often, and riskily more often than parents. There was also less difference in the reported incidence of risky and skilled behaviours. This flattening became more pronounced with age, leading to a net increase in the reported frequency with peers engaged in all of the eight behaviours, as well as significant variation in the profile (for year, $F(2{,}299) = 3.89$, $P = 0.022$, effect size = 0.02; for scenario by year,

$F(14,2093) = 2.90$, $P < 0.001$, effect size = 0.02). Within this broad pattern, there was some impact of gender, with girls reporting greater incidence of cautious behaviour and lower incidence of risky behaviour on the part of their peers, but little difference with respect to the skilled behaviours. This suggests that girls may perhaps differentiate between risky and skilled behaviours to a greater extent than boys (for scenario by gender, $F(7,2093) = 5.64$, $P < 0.001$, effect size = 0.02).

It should also be noted that the greater tendency towards riskier behavioural norms among peers was coupled with uniformly high levels of identification with them, regardless of age and gender (mean = 6.02 on a 7-point scale, with a standard deviation of 0.94). This is perhaps what might be expected in this age range, but it suggests that peer behaviour may well be a potentially important negative influence.

Figure 3.12: Mean rating of peer norms for three cautious, three risky and two skilled scenarios, by age group



3.3.1.3.6 Norms, perceived approval and perceived behavioural control

The two preceding sections reveal apparent signs of tension between parent and peer norms, with parents being reported as more likely to act cautiously and peers as more likely to carry out risky behaviours. Peers were also seen as slightly more likely to engage in the skilled behaviours, but without any real differentiation of these from risky behaviours. The presence of this tension gives rise to questions about:

- how far these different norms impact on perceived approval for different behaviours (i.e. the subjective norm); and
- how far in turn perceived approval led to feelings of being sanctioned to act in these ways if desired (i.e. perceived behavioural control).

Table 3.13: Relationships between perceived approval for behaviour (subjective norm) and parent versus peer norms (specific scenarios only); significant effects in bold type

Scenario	Proportion of explained variance (adjusted R^2)	Norm source	Beta	Significance
Wait for green man	0.028	Parents	0.110	ns
		Peers	**0.132**	**< 0.05**
Look all round	0.004	Parents	0.090	ns
		Peers	0.033	ns
Wait for large gap	0.064	**Parents**	**0.270**	**< 0.001**
		Peers	-0.107	ns
Jump barrier	0.050	**Parents**	**0.240**	**< 0.001**
		Peers	-0.049	ns
Run through gap	0.080	**Parents**	**0.271**	**< 0.001**
		Peers	0.060	ns
Force cars to slow	0.132	**Parents**	**0.350**	**< 0.001**
		Peers	0.064	ns
Step out before cars pass	0.046	**Parents**	**0.139**	**< 0.02**
		Peers	**0.141**	**< 0.02**
Stop in middle	0.152	**Parents**	**0.324**	**< 0.001**
		Peers	**0.126**	**< 0.05**

To examine the first question, regression analyses were carried out for each of the specific scenarios, taking individual ratings of the subjective norm for a given behaviour as the dependent variable, and the corresponding parent and peer norms as predictors. This approach allowed the relative strength of the two sources of influence on perceived approval to be established. The results of these analyses are shown in Table 3.13, with the beta values and their significance levels indicating the strength of relationship between perceived approval and the two norms for each behaviour. As can be seen, despite the implied averaging across significant others signalled by the phrasing of the subjective norm items ('most people who are important to me . . .'), and the strength of peer-group identification, parental norms were the stronger influence on perceived approval (though note the relatively low proportion of explained variance observed in each case indicates that factors beyond parental norms were at work too). The greater impact of parental norms was particularly evident for the risky behaviours. The positive relationships here indicate that if parents exhibited a low incidence of risky behaviours, as they characteristically (though by no means uniformly) did, adolescents were less likely to see these as acceptable. The influence of peer norms, in contrast, was restricted to perceived approval for waiting for the green man, and for the two skilled behaviours, where the influence was shared with parental norms.

Parental norms impacted in systematic and predictable fashion, then, on perceived approval for six of the eight specific target behaviours. In order to examine whether approval or disapproval was a significant influence in turn on perceptions of control over performing the different behaviours, correlations were computed between the ratings of subjective norm and perceived behavioural control for each. These were found to be positive and significant in all cases, with values ranging from 0.13 to 0.33, and a mean of 0.23. The perceived approval of a behaviour, as shaped in part by parental (and, more marginally, peer) norms, did tend therefore to lead participants to feel greater sanction to behave in that way themselves. This may go some way towards explaining the lower levels of perceived behavioural control reported for the risky behaviours: these were not likely to be seen as approved of (and therefore sanctioned) unless parents engaged in them, which on the whole they tended not to do. This suggests in turn that parental behaviour may be a potentially important restraining influence on risk-taking. There was little indication, however, that the behaviour of peers had a similar influence in the opposite direction, the strength of peer-group identification notwithstanding: the greater tendency of peers to engage in risky behaviours had no measurable impact on the perceived approval of these behaviours, and thus any sense that they were more sanctioned.

3.3.1.3.7 Self-identity and risk-taking

Figure 3.13 shows the mean ratings of self-identity with regard to each of the eight specific behaviours ('I see myself as the type of person who would do this'), measures of self-identity in relation to the global behaviours being derived instead from the Q-sort responses and the risk-taking questionnaire items. As can be seen, the general pattern of specific self-identity responses is somewhere between the reported parental and peer norms, with the tendency being to espouse cautious behaviours less than parents, and risky or skilled behaviours less than peers. The net result is somewhat less differentiation between behaviours than was the case for parental norms, but substantially more than for the peer norms (for scenario, $F(7,2093) = 132.79$, $P < 0.001$, effect size = 0.31). The extent of this differentiation reduced with age, however, with S3 participants tending to see cautious behaviours as slightly less typical of themselves, and both risky and skilled behaviours as substantially more so (for year, $F(2,299) = 3.85$, $P = 0.022$, effect size = 0.02; for scenario by year, $F(14,2093) = 2.27$, $P = 0.013$, effect size = 0.01). The differences were also moderated by gender, with girls slightly more likely to see cautious behaviours as part of their self-identity, and notably less likely to see risky or skilled behaviours as being so (for gender, $F(1,299) = 6.45$, $P = 0.012$, effect size = 0.02; for scenario by gender, $F(7,2093) = 6.53$, $P < 0.001$, effect size = 0.02).

The pattern for the two global self-identity factors derived from the Q-sort responses, cautiousness/sensitivity and carelessness/unpredictability, and for the general measure of risk-taking is very similar, as Figure 3.14 shows, with cautiousness declining slightly across the age groups, and carelessness and risk-taking increasing, although none of these effects was statistically significant. The three measures were in fact closely related, with risk-taking negatively correlated with cautiousness ($r = -0.59$) and positively correlated with carelessness ($r = 0.60$). Carelessness was in turn negatively correlated with cautiousness, and to a similar extent (-0.59). Factor analysis (principal components) confirmed that all three measures loaded onto a single factor which accounted for 72.9% of the variance in individual scores. Scores on this overall factor also showed a trend towards increasing carelessness and risk-taking with age, but this remained non-significant. There was, however, a clear effect of gender, with girls consistently typifying themselves as more cautious ($F(1,299) = 7.25$, $P = 0.008$, effect size = 0.02).

Figure 3.13: Mean rating of self-identity for three cautious, three risky and two skilled scenarios, by age group

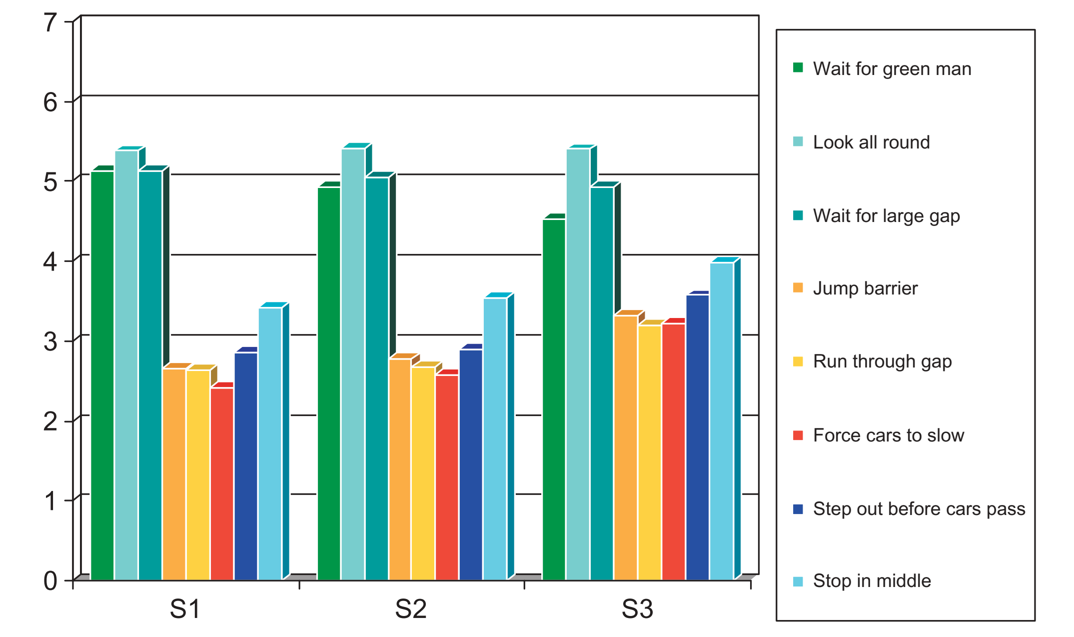
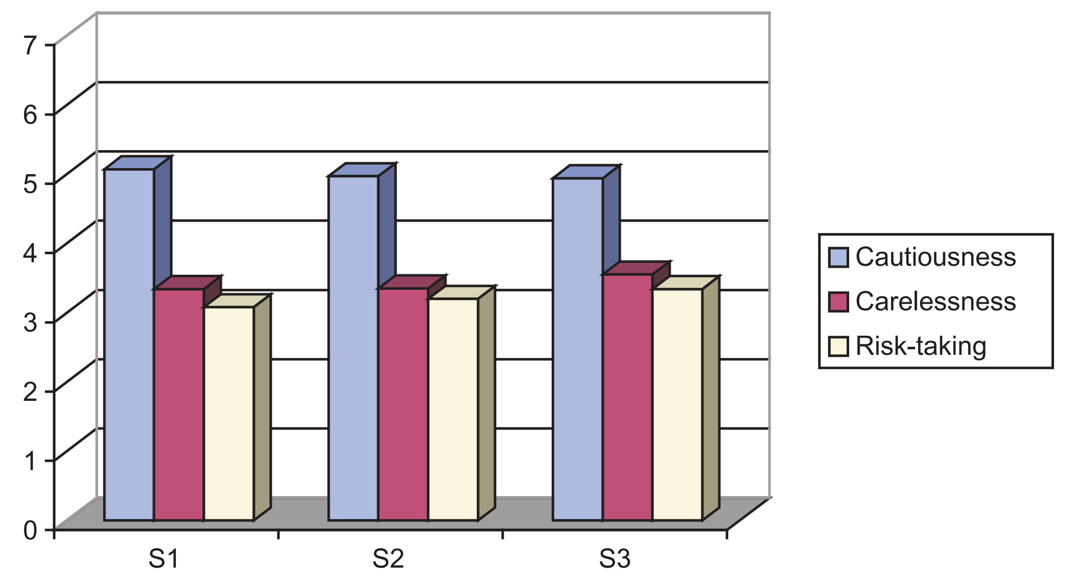


Figure 3.14: Mean scores on two global self-identity factors and measure of risk-taking, by age group



3.3.1.3.8 Self-identity and attitude

If participants' responses were internally consistent, it might reasonably be expected that expressed attitudes should reflect individuals' perception of their own identity ('as this kind of person, I have this particular attitude'), and that measures of the two should therefore be related. The extent to which overall carelessness/risk-taking and specific ratings of self-identity were associated with global and specific attitudes to cautious and risky behaviours was examined in order to establish whether this was the case. The carelessness/risk-taking measure was found to be significantly correlated with attitude to all three global scenarios, negatively in the case of acting cautiously (-0.23), positively with regard to taking chances (+0.48) and messing about (+0.44). It was also correlated with attitudes towards the specific scenarios in all but one instance, negatively in the case of the cautious behaviours, positively for the risky and skilled behaviours, the exception being crossing halfway. The average absolute value of these correlations was 0.28. Specific self-identity ratings were positively correlated with the corresponding attitude in all instances, and to an even stronger degree, the average correlation being +0.49. There was clear evidence, then, that attitudes were in large part simply a manifestation of underlying self-identity, those who saw themselves as more likely to take risks expressing more positive attitudes towards doing so, and more negative attitudes towards caution.

3.3.1.3.9 Self-identity and norms

Since participants' ratings of specific self-identity characteristics fell between peer and parental norms, it was pertinent to ask whether either of these were related to self-perceptions, producing a mediated influence on behaviour, via internalisation of norms. In order to examine this, regression analyses of the same form as reported above for the subjective norm (perceived approval) ratings were carried out, this time taking the self-identity rating for each specific behaviour as the dependent variable. Similar analyses were used to examine the relationship between the norm ratings for each behaviour and the global measure of carelessness and risk-taking, to ascertain how far perceived norms fed into this broader construct.

The outcomes of the analyses for the specific self-identity ratings are shown in Table 3.14. As can be seen, both peer and parent norms were positively related to self-identity, indicating that, in general, the more peers or parents exhibited a behaviour, the more participants saw it as part of their own identity. However, the nature of this relationship varied according to whether the behaviour in question was cautious or more risky. For the cautious behaviours, parental norms were plainly more influential, peer norms only emerging as a significant influence for one of the three scenarios. The proportion of variance explained by norms for these behaviours was relatively low, though, indicating that they were not particularly strong predictors in these instances. In contrast, for the risky/skilled behaviours, the proportion of explained variance was more than twice as much on average, and peer norms were now more influential than parental norms, with higher beta values in every instance.

Table 3.14: Relationships between self-identity and parent versus peer norms (specific scenarios only)

Scenario	Proportion of explained variance (adjusted R^2)	Norm source	Beta	Significance
Wait for green man	0.064	**Parents**	**0.175**	**< 0.005**
		Peers	**0.171**	**< 0.005**
Look all round	0.075	**Parents**	**0.252**	**< 0.001**
		Peers	0.079	ns
Wait for large gap	0.119	**Parents**	**0.311**	**< 0.001**
		Peers	0.108	ns
Jump barrier	0.161	**Parents**	**0.173**	**< 0.005**
		Peers	**0.342**	**< 0.001**
Run through gap	0.227	**Parents**	**0.259**	**< 0.001**
		Peers	**0.343**	**< 0.001**
Force cars to slow	0.246	**Parents**	**0.265**	**< 0.001**
		Peers	**0.366**	**< 0.001**
Step out before cars pass	0.203	**Parents**	**0.196**	**< 0.001**
		Peers	**0.352**	**< 0.001**
Stop in middle	0.289	**Parents**	**0.286**	**< 0.001**
		Peers	**0.349**	**< 0.001**

Peer and parent norms were also found to predict global carelessness and risk-taking, the relationship being negative where norms for the cautious behaviours were used as predictors, and positive where norms for the risky and skilled behaviours were used. However, peer norms again had more influence than parental norms, with higher beta values in every case bar one, where values were the same (average absolute beta value for peer norms = 0.26, against 0.12 for parental norms). Thus, the less cautious and more risky their peers' behaviour was perceived to be, the higher the participants' espousal not just of those behaviours but also of risk-taking more generally.

Put alongside the data on the relationship between norms and perceived approval, where, it will be remembered, peer norms had much less apparent influence than parental norms, an important point emerges. It would appear that parental norms have a limited effect on adolescents' self-identity, restricted primarily to specific cautious behaviours, and instead exercise their influence for the most part through the **external** mechanism of perceived disapproval for riskier behaviours. Peer norms, in contrast, appear to act **internally** for the most part, through their influence on self-identity, perhaps unsurprisingly in view of the strength of participants' identification with their peer group. This duality of mechanism would seem to be especially true for riskier behaviours.

3.3.1.3.10 Self-identity and perceived difficulty of road-crossing decisions

One further point of importance that should be noted here is that self-identity would appear to be at least one source of the individual variation in perceptions of difficulty of road-crossing decisions outlined in Section 3.3.1.2 and, more specifically, the tendency to underestimate difficulty. The global measure of carelessness and risk-taking was found to be negatively correlated with the average post-estimate of difficulty ($r = -0.15$, $P = 0.004$), and positively correlated with the average discrepancy between predicted and actual difficulty rating ($r = 0.14$, $P = 0.007$; both one-tailed, $n = 307$). Whilst neither relationship is strong, taken together they indicate consistently that the higher individuals scored on the risk-taking index, the less difficult they perceived the road-crossing problems to be after they had completed them, and the more positive the discrepancy they exhibited (i.e. the greater the underestimate of difficulty relative to actual performance). These data position self-identity as an important theoretical link between the effect reported in Study 1 and the social factors explored in Study 2.

3.3.1.3.11 Intentions

Ratings of intention to perform each of the global and specific behaviours are shown in Figure 3.15. For the eight specific scenarios, the profile is very similar to that observed for self-identity, except that the S1 and S2 participants exhibit slightly more intention to behave cautiously than their self-identity ratings would suggest. As a result, there is somewhat greater differentiation between the cautious and the risky or skilled scenarios ($F(10,3040) = 208.21$, $P < 0.001$, effect size = 0.41). As with self-identity, there was a definite shift with age towards an increase in intention to take risks (for year, $F(2,304) = 6.48$, $P = 0.002$, effect size = 0.04; for scenario *x* year, $F(20,3040) = 3.91$, $P < 0.001$, effect size = 0.02). Differences between scenarios were again moderated by gender, with girls somewhat more likely to intend to behave cautiously and less likely to intend to take risks (for scenario by gender, $F(10,2990) = 3.33$, $P = 0.002$, effect size = 0.01).

3.3.1.3.12 Self-reported behaviour

The profile for self-reported behaviour for the specific scenarios is also similar to that found for self-identity ratings, and thus in consequence it has a correspondingly high degree of similarity to intention, as can be seen in Figure 3.16. However, there was a tendency for cautious behaviours to have been performed slightly less often than intended, and for skilled behaviours to have been carried out a little more often, by S1 and S2 participants especially. As a result, there is somewhat less differentiation between scenarios than there was for intentions ($F(10,3040) = 166.25$, $P < 0.001$, effect size = 0.35), and the shift with age towards greater risk-taking was less pronounced also (for scenario by year, $F(20,3040) = 2.11$, $P = 0.025$, effect size = 0.01).

Figure 3.15: **Mean rating of intention for four cautious, five risky and two skilled scenarios, by age group**

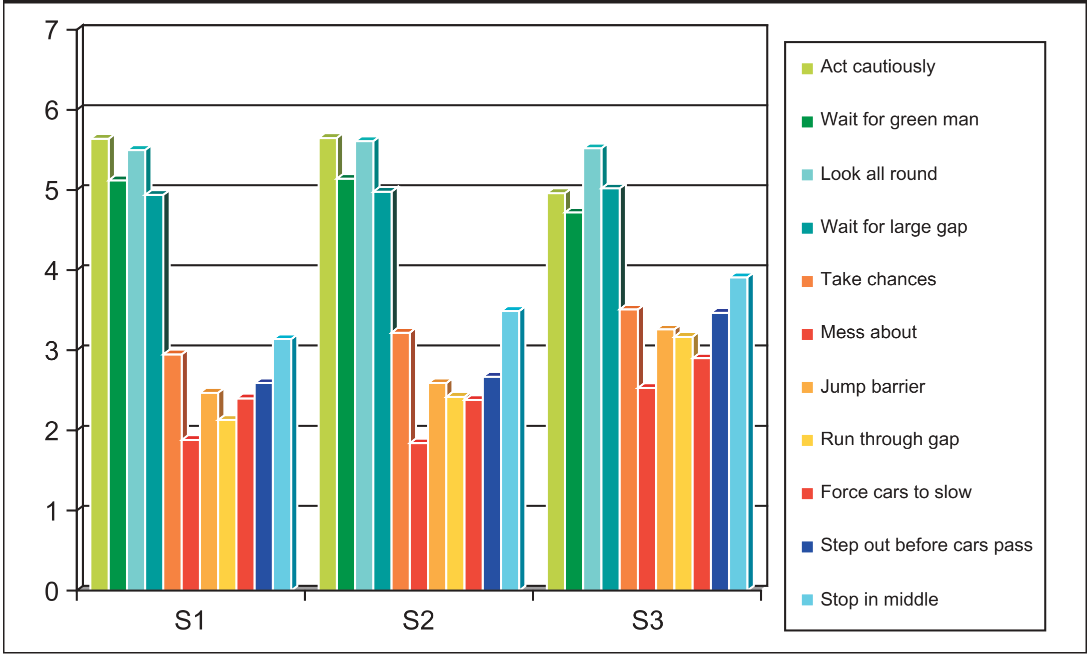
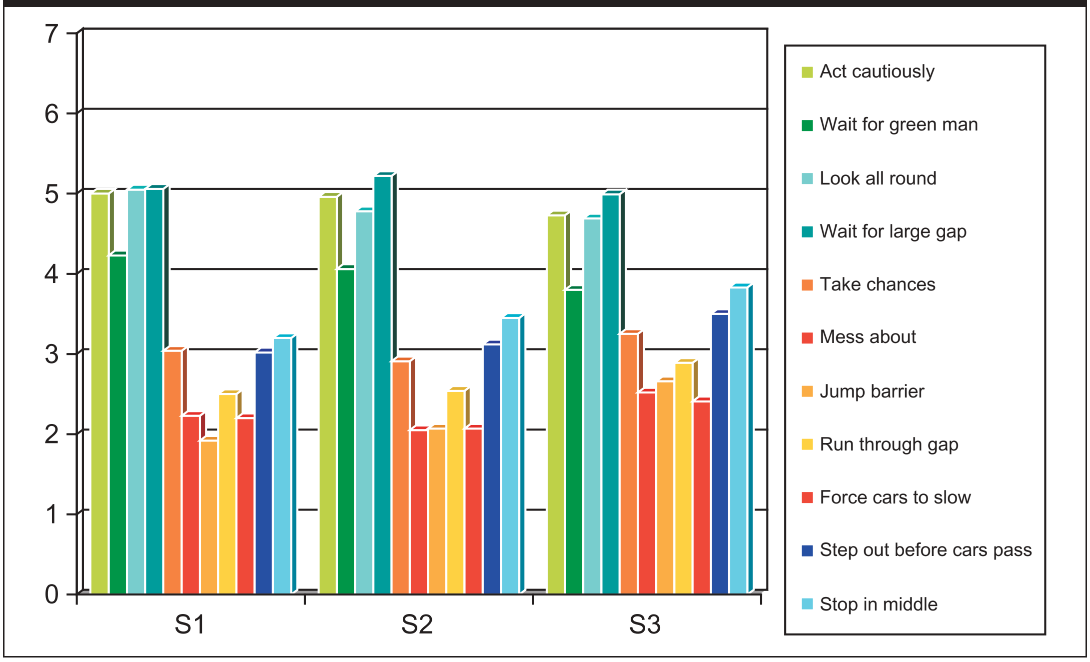


Figure 3.16: **Mean rating of frequency of behaviour for four cautious, five risky and two skilled scenarios, by age group**

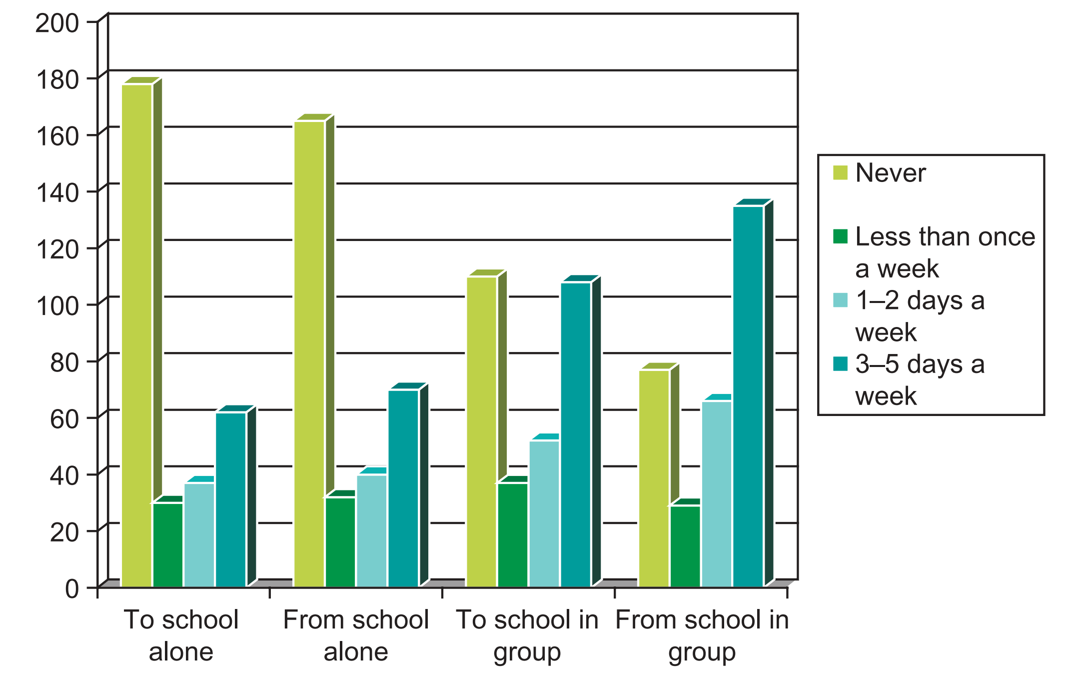


This reduced emphasis on caution, as far as actual behaviour is concerned, might serve in part to explain the relatively flat profile for peer norms. Since participants in the study must have made up some of the peer group reported on by other respondents, the difference between individuals' own apparent differentiation between caution and risk, and the reported lack of it among peers, is on the face of it something of a puzzle. However, the drift in behaviour towards incaution and taking more chances relative to **intention** may help to create an impression that everyone's behaviour is more risky than expected. Since this tendency might be less noticeable in oneself than in others, it would act to reinforce the notion that peers tend to take chances (note that in adults, a similar mechanism might underlie a tendency of individual drivers to see themselves as more considerate than others are; see Basford *et al.*, 2001). If this explanation is accurate, the effect would have been present regardless of gender: whilst there was significant variation in the reporting of behaviours by boys and girls (for scenario by gender, $F(10,2990) = 6.28$, $P < 0.001$, effect size = 0.02), the differences were restricted to girls being less likely to have jumped a barrier or run through a tight gap, and more likely to have waited for the green man. On balance, they too tended to have shown the same drift towards incaution as boys, with shifts in this direction being present for seven of the eleven scenarios, and more marked for the cautious and skilled behaviours as they were overall.

3.3.1.3.13 Exposure

Figure 3.17 shows the frequency with which participants across the three age groups walked to and from school alone and in a group. As can be seen, there was a strong tendency towards a bi-modal distribution of responses for each journey type, with the vast majority of participants indicating that they either never made a journey in that mode, or that they did so most of the time. In other words, then, there appeared, unsurprisingly, to be considerable day-to-day consistency in how school journeys were undertaken. Cutting across this, there was a clear pattern of journeys on foot being made more often as part of a group than alone, with all that this implies with respect to lowered levels of attention, and heightened opportunity for perceived peer norms to influence behaviour. Nearly half the sample walked home from school on a regular basis as part of a group.

Figure 3.17: **Frequency of walking to and from school alone and as part of a group (all age groups)**



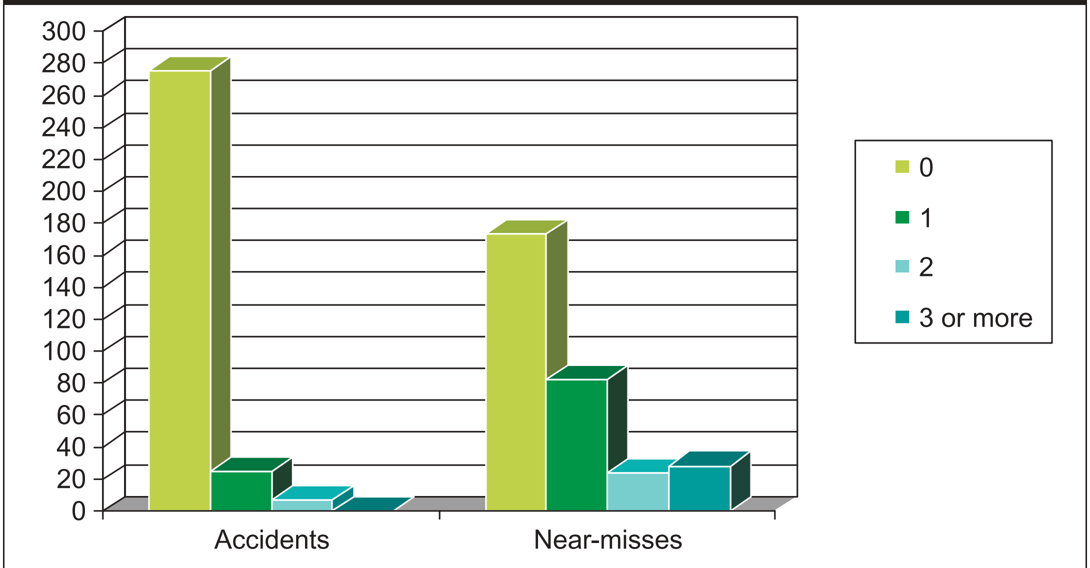
This said, despite the well-documented pressure for greater independence exerted by adolescents post-transition to secondary school (Platt *et al*., 2003), more than half the sample claimed never to make the journey either to or from school by walking on their own, and of these approximately 40% **also** claimed never to make the journey walking in a group. Thus, in total 20–25% of participants (depending on journey type) either never actually walked to or from school, or else must have done so accompanied by parents, siblings or solitary friends, conditions under which they would be better protected or more likely to act responsibly (Chinn *et al*., 2004; Lupton and Bayley, 2001). That instances of parental accompaniment, whether on foot or in a vehicle, made up a substantial proportion of these cases is indicated by the heightened incidence, relative to the journey to school, of walking both alone and in a group **from** school – at the time of day when parents would typically be less available. Perhaps surprisingly, the majority (55–60%) of the cases exhibiting this pattern were male, and there was little change with age. Only incidence of walking to school alone showed a significant association with age group (chi-square $= 17.35$, $df = 6$, $P = 0.008$), and this rested primarily on a shift with age from never making a journey in this mode to doing so less than once a week. The tendency towards consistency of journey mode was apparently not just day to day, therefore, but long term.

3.3.1.3.14 Accident/near-miss history

Figure 3.18 shows the frequency of self-reported pedestrian accidents (minor and more serious injuries) and near-misses. As indicated earlier, experience of actual accidents was relatively rare, though approximately 10% of the sample did report at least one such incident. No association with age was apparent in the frequency of these reports, but, as might be expected given the UK totals (Sentinella and Keigan, 2004), there was a significant association with gender (chi-square = 12.19, $df = 2$, $P = 0.002$), with 78% of all reports and 86% of double reports being made by boys.

Near-misses were substantially more common than accidents, 44% of participants reporting at least one incident, but the pattern of effects was similar, with frequency again being associated with gender (chi-square = 11.86, $df = 3$, $P = 0.008$), but not age. The impact of gender was more at the extremes in this case, though, with the number of single or double incidents more or less evenly divided between girls and boys, but 79% of reports of three or more incidents being made by boys. Reports of accidents were positively, though not especially strongly, associated with reports of near-misses ($r = +0.24$, $n = 307$, $P < 0.001$). They were also associated with one specific aspect of exposure: 69% of those reporting accidents walked home as part of a group on at least 1–2 days per week (chi-square = 16.60, $df = 6$, $P = 0.011$).

Figure 3.18: Frequency of reported pedestrian accidents and near-misses (all age groups)



3.3.1.3.15 Past road safety training

The vast majority of participants (96%) claimed to have received road safety training, and though there was an association between training and gender (chi-square = 4.18, $df = 1$, $P = 0.041$), the differences between boys and girls were marginal (93% versus 98%). Cycle training was reported less often, 63% of the sample claiming to have received this, but there was no association between such training and either gender or age. The general lack of variation in responses to these items meant that they had little predictive value in relation to other variables, and they were consequently excluded from further consideration.

3.3.1.3.16 Summary for attitudes, norms, identity and behaviour

To summarise, participants' attitudes were, on balance, positive towards cautious pedestrian behaviour, negative towards risky actions, and tended to neutrality towards skilled behaviours. Parental norms followed a similar profile, though they were reported to be a little less cautious and more likely to engage in skilled behaviours. Parental behaviour influenced perceived approval/disapproval of actions, as measured by the subjective norm, and thus how far participants felt they could choose for themselves whether to behave in this way. This influence held for the risky and skilled behaviours especially. Peers, in contrast, were seen as substantially less cautious and more likely to engage in risky behaviour than parents, and also as less likely to distinguish risky from skilled behaviours. Participants' self-identity and risk-taking profiles, which shaped their attitudes, lay between parent and peer norms, but were influenced more strongly by peer behaviour.

On these data, given the general character of parental and peer norms, the former seem likely to act as a **constraint** on risky behaviour, operating through the external mechanism of perceived disapproval, whilst peer norms generate pressure **towards** risky behaviour through strong identification with peers and internalisation of those norms. Consistent with this, whilst age differences in the present sample were limited, there was a systematic shift from S1 to S3 in favour of reduced caution and increased risk-taking on exactly the variables that the latter mechanism would link together, and only these, i.e. peer norms, self-identity, attitudes, intentions and behaviour. There was also evidence that the same mechanism produced a greater push towards risk among boys. Whilst gender differences were marginal, there were significant effects in the direction of increased risk for boys on exactly the same set of variables, and again, only on these. These effects were, in addition, coupled with increased reporting of accidents and near-misses among boys, despite similar patterns of exposure to girls, on school journeys at least. Moreover, whilst accidents were rare, they were associated with walking home from school as part of a group, conditions under which peer influence is likely to have a greater impact.

Thus, although influences on intentions and behaviour remain to be examined directly, the profile analyses point strongly to predictions that:

- parental and subjective norms will be positively associated with caution; and
- peer norms and self-identity will be positively associated with risk.

The influence on intentions and behaviour of skill levels and perceptions of difficulty is uncertain at this point, but a connection is plausible since greater individual carelessness and risk-taking was also found to be associated with an increased tendency to underestimate difficulty relative to actual ability. Examination of the extent to which past road safety training might act as a protective influence cannot be gauged in this sample, due to the uniformity with which participants claimed to have received such training.

3.3.2 *Regression analyses for intentions and self-reported behaviour*

3.3.2.1 Overview of procedure

Multiple regression techniques were used to examine the relative influence of these different factors on the key outcome variables, intention to act in cautious or risky fashion, and self-reported cautious or risky behaviour. The requirement of such analyses that all the variables under consideration exhibit a suitable spread of values was met in almost all respects. As has been seen in Section 3.3.1, with the exception of past road safety training, the measures used by the study all showed considerable individual variability, and values on them approximated normal distributions, except in the case of exposure (where the distributions were bi-modal), accidents and near-misses (which both had distributions heavily skewed towards low values).

The investigation employed a hierarchical forced entry procedure for separate analysis of (a) intention and (b) self-reported behaviour for each global and specific scenario in turn, yielding 22 distinct analyses in total. Under this procedure, the relationship of a dependent variable (in this case, intention or behaviour) to a predetermined set of predictor variables is examined in a fixed sequence. Predictor variables are entered into the analysis in related blocks or subsets, earlier blocks being added to by later blocks as the analysis proceeds, until all predictors have been included. This approach has two advantages. First, it allows the degree of relationship or non-relationship of the dependent variable to **all** predictors to be precisely established. Second, mediated (indirect) or conditional relationships can be disentangled from direct ones by examining how the strength of relationships alters as further variables are brought into the analysis. For instance, in the present case, peer norms have been predicted to be an influence on intentions and behaviour, but only by dint of their impact on a mediating variable, self-identity. By entering peer norms into the analysis first, and examining what happens subsequently when self-identity is entered, it is possible to establish whether the effect is mediated as predicted: if it is, peer norms will be related to intention or behaviour at first, but this relationship will disappear in favour of a relationship with the more proximal influence, self-identity, when this is included.

The sequence of entry of variables into the analyses for **intention** to perform each behaviour was guided in part by the conventions governing such analyses within the TPB framework, and in part by the nature of the effects anticipated on the basis of the profile analyses. This same sequence was used for each of the 11 scenarios:

1. demographic variables (age, gender, SES);
2. TPB variables (attitude, subjective norm, perceived behavioural control);
3. skill variables (tight fits and starting delay from visual timing, number of cues identified from drivers' intentions, number of times looked from designated crossings, factor score from safe route planning; see Section 3.2.5.1);

4. perception of difficulty variables (average discrepancy of actual difficulty rating from predicted rating; see Section 3.2.5.1 again – note the average post-estimate of difficulty was dropped from the regression analyses since the initial inspection revealed its degree of overlap with average discrepancy was beyond accepted limits of statistical tolerance);
5. parental and peer norms (ratings for the relevant behaviour for analyses of the specific scenarios, average across these ratings for the global scenarios; note the effect of the interaction between peer norms and strength of identification was not tested for, in contrast to the analyses employed by Terry *et al*. (1999) in view of the fact that identification was uniformly high);
6. self-identity (ratings for the relevant behaviour for analyses of the specific scenarios, factor score for carelessness and risk-taking for the global scenarios); and
7. accident history, near-misses, exposure alone and exposure in a group.

This sequence was also used for the analyses of **self-reported behaviour**, with the sole modification that an additional step was included before step 2 for entry of the intention measure for that behaviour.

3.3.2.2 Analysis of intentions

The outcomes of the hierarchical regression analyses for intentions are shown in Table 3.15. It should be noted that no problems of collinearity (overlap between predictors) were found beyond that identified for perceptions of difficulty: the tolerance and VIF values computed as a normal part of regression analyses were well within acceptable levels on all analyses. The benefit of examining a range of behaviours within the same study is apparent from this table, namely that it enabled consistent effects to be discriminated from sporadic ones. In fact, though, the pattern of outcomes across the 11 analyses was highly stable in most important respects, and little difference was apparent between the global and specific scenarios, except that the final proportion of explained variance was lower for the former, reflecting perhaps the noisier nature of the measures used in those instances. Even here, the levels were acceptable, though; the contrast stemmed largely from the fact that the proportion of explained variance in the final models for the specific scenarios was impressively high, coming close to 0.60 on average.

Table 3.15: Hierarchical regression analyses predicting behavioural intention for three global and eight specific scenarios (significant effects in bold, $^{+}$ $P < 0.05$, * $P < 0.01$, ** $P < 0.001$; where final beta differs in significance level or changes substantially in value from beta at entry, the block(s) at which change occurs is shown in parenthesis)

Scenario	Block 1: Demographic variables								Block 2: TPB variables							
	Age		Gender		SES (ACORN)		Variance explained		Attitude		Subjective norm		Perceived behavioural control		Variance explained	
	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	R^2 (adj)	R^2 ch	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	R^2 (adj)	R^2 ch
Act cautiously	**-0.20***	**-0.13*** (5)	0.02	**-0.13**$^{+}$ (6)	-0.01	0.01	**0.03***	**0.03***	**0.28****	**0.23****	0.09	0.03	0.04	0.05	**0.13****	**0.10****
Take chances	**0.13**$^{+}$	0.08 (5)	-0.10	-0.04	0.01	-0.04	**0.02***	**0.02**$^{+}$	**0.37****	**0.22**** (5/6)	**0.12**$^{+}$	**0.10**$^{+}$	0.09	0.07	**0.21****	**0.19****
Mess about	**0.20***	**0.14*** (5)	-0.05	0.05	0.05	0.03	**0.04***	**0.04***	**0.45****	**0.30**** (5/6)	**0.19****	**0.12**$^{+}$ (5/6)	-0.03	-0.07	**0.27****	**0.23****
Wait for green man	-0.06	0.04	**0.13**$^{+}$	0.02 (2)	-0.09	-0.05	**0.02**$^{+}$	**0.02**$^{+}$	**0.29****	**0.09**$^{+}$ (6)	**0.30****	**0.15*** (6)	0.02	-0.03	**0.28****	**0.26****
Look all round	0.01	0.02	0.07	0.00	-0.05	0.03	0.00	0.00	**0.27****	**0.13*** (6)	**0.35****	**0.18**** (6)	0.06	0.00	**0.26****	**0.26****
Wait for large gap	0.03	0.03	0.01	0.00	-0.01	-0.02	0.00	0.00	**0.31****	0.07 (5/6)	**0.22****	**0.11**$^{+}$ (6)	**0.22****	0.07 (6)	**0.33****	**0.33****
Jump barrier	**0.17***	0.07 (5)	**-0.17***	0.04 (2)	0.00	0.01	**0.05****	**0.05****	**0.43****	0.11^{+} (5/6)	**0.15***	0.08 (6)	0.08	0.06	**0.32****	**0.27****
Run through gap	**0.26****	**0.16**** (2)	-0.10	0.04	0.08	0.04	**0.08****	**0.08****	**0.40****	**0.12**$^{+}$ (5/6)	**0.14***	0.07 (5/6)	0.05	-0.02	**0.26****	**0.18****
Force cars to slow	0.11	-0.03	0.00	0.02	-0.03	0.00	0.00	0.00	**0.40****	**0.19**** (5/6)	**0.20****	0.02 (5/6)	0.01	0.01	**0.28****	**0.28****
Step out before cars pass	**0.18***	0.05 (2)	**-0.12**$^{+}$	0.00 (2)	0.01	0.00	**0.04***	**0.04***	**0.47****	**0.17**** (5/6)	**0.17***	0.02 (5/6)	**0.14***	0.02 (5/6)	**0.37****	**0.33****
Stop in middle	0.16*	0.06 (5/6)	-0.05	-0.01	-0.07	0.01	**0.02**$^{+}$	0.02^{+}	**0.50****	**0.24**** (5/6)	**0.22****	**0.09**$^{+}$ (5/6)	0.03	0.02	**0.46****	**0.44****

Table 3.15: continued

Scenario	Block 3: Skill variables												Block 4: Perception of difficulty variables			
	Visual timing: tight fits		Visual timing: starting delay		Drivers' intentions: no. of cues		Designated crossings: no. of looks		Safe route planning: factor score		Variance explained		Mean discrepancy		Variance explained	
	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	R^2 (adj)	R^2 ch	Beta at entry	Final beta (ch block)	R^2 (adj)	R^2 ch
Act cautiously	-0.04	0.00	**0.14**$^{+}$	0.09 (6)	**-0.14**$^{+}$	-0.07 (6)	-0.02	-0.01	0.02	-0.06	**0.16****	**0.03***	-0.06	-0.01	**0.16****	0.00
Take chances	0.03	0.04	0.01	0.04	0.01	-0.06	-0.02	-0.03	-0.08	-0.05	**0.21****	0.00	-0.03	-0.06	**0.21****	0.00
Mess about	**0.14***	**0.12**$^{+}$ (6)	-0.09	-0.08	0.03	-0.01	0.00	-0.02	-0.06	-0.01	**0.29****	**0.02**$^{+}$	0.03	0.00	**0.29****	0.00
Wait for green man	0.00	-0.04	-0.08	-0.05	**-0.11**$^{+}$	-0.02 (5)	-0.02	-0.07	0.02	0.03	**0.28****	0.00	0.00	-0.02	**0.28****	0.00
Look all round	-0.04	0.00	-0.05	-0.03	-0.04	0.03	0.05	-0.01	-0.01	-0.06	**0.26****	0.00	-0.02	-0.06	**0.26****	0.00
Wait for large gap	0.05	0.04	**-0.11**$^{+}$	-0.06 (6)	-0.04	-0.04	-0.01	-0.04	0.04	0.03	**0.33****	0.00	-0.06	-0.03	**0.33****	0.00
Jump barrier	-0.02	**-0.09**$^{+}$ (6)	**-0.12**$^{+}$	-0.06 (6)	0.05	0.00	-0.01	0.06	-0.05	0.00	**0.33****	0.01	0.05	0.02	**0.33****	0.00
Run through gap	0.02	0.00	-0.09	-0.06	0.06	0.04	-0.02	-0.03	-0.06	-0.04	**0.26****	0.00	-0.04	-0.03	**0.26****	0.00
Force cars to slow	0.04	-0.01	0.00	-0.02	-0.02	-0.01	**-0.11**$^{+}$	-0.05 (6)	-0.02	0.04	**0.28****	0.00	0.04	0.02	**0.28****	0.00
Step out before cars pass	0.01	0.00	-0.01	0.00	0.09	0.02	-0.06	-0.03	-0.04	-0.02	**0.37****	0.00	-0.03	0.02	**0.37****	0.00
Stop in middle	-0.02	-0.05	-0.07	-0.04	0.04	0.00	0.02	0.03	-0.05	-0.01	**0.46****	0.00	-0.06	-0.02	**0.46****	0.00

Table 3.15: continued

Scenario	Block 5: Norm variables						Block 6: Self-identity				Block 7: Accident history and exposure					
	Parental norms		Peer norms		Variance explained		Self-identity		Variance explained		No. of accidents	No. of near-misses	Walk to/ from school alone	Walk to/ from school in group	Variance explained	
	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	R^2 (adj)	R^2 ch	Beta at entry	Final beta (ch block)	R^2 (adj)	R^2 ch	Beta at entry/ final	Beta at entry/ final	Beta at entry/ final	Beta at entry/ final	R^2 (adj)	R^2 ch
Act cautiously	0.04	-0.02	**0.28****	**0.13**$^{+}$ (6)	**0.23****	**0.07****	**-0.39****	**-0.37****	**0.33****	**0.10****	-0.07	-0.02	0.01	**0.10**$^{+}$	**0.34****	0.01
Take chances	-0.03	0.00	**-0.25****	**-0.17*** (6)	0.25**	**0.04****	**0.22***	**0.20***	**0.28****	**0.03***	0.00	0.08	0.05	0.07	**0.28****	0.00
Mess about	-0.05	-0.02	**-0.22****	**-0.14**$^{+}$ (6)	**0.33****	**0.04****	**0.23****	**0.22****	**0.36****	**0.03****	-0.07	0.07	-0.01	0.04	**0.36****	0.00
Wait for green man	**0.14***	0.07 (6)	0.07	0.03	**0.30****	**0.02***	**0.65****	**0.65****	**0.62****	**0.32****	-0.03	0.01	0.01	-0.05	**0.62****	0.00
Look all round	**0.16***	0.01 (6)	0.03	-0.03	**0.27****	**0.01***	**0.61****	**0.61****	**0.56****	**0.29****	0.01	**-0.09**$^{+}$	-0.03	0.01	**0.56****	0.00
Wait for large gap	**0.17***	**0.09**$^{+}$ (6)	0.03	-0.05	**0.36****	**0.03***	**0.62****	**0.62****	**0.60****	**0.24****	0.02	0.00	0.04	-0.02	**0.60****	0.00
Jump barrier	0.01	-0.03	**0.26****	**0.12*** (6)	**0.38****	**0.05****	**0.61****	**0.60****	**0.59****	**0.21****	0.07	0.01	0.01	0.02	**0.59****	0.00
Run through gap	0.09	0.00	**0.25****	**0.13*** (6)	**0.33****	**0.07****	**0.49****	**0.49****	**0.47****	**0.14****	0.00	0.01	0.00	0.00	**0.47****	0.00
Force cars to slow	0.07	0.01	**0.27****	**0.10**$^{+}$ (6)	**0.35****	**0.07****	**0.59****	**0.60****	**0.56****	**0.21****	0.00	0.00	0.06	0.02	**0.56****	0.00
Step out before cars pass	**0.09**$^{+}$	0.04 (6)	**0.30****	**0.15**** (6)	**0.47****	**0.10****	**0.62****	**0.63****	**0.68****	**0.21****	-0.01	-0.05	-0.03	0.01	**0.68****	0.00
Stop in middle	0.06	0.01	**0.27****	**0.11*** (6)	**0.53****	**0.07****	**0.53****	**0.56****	**0.68****	**0.15****	0.02	-0.07	0.02	0.04	**0.69****	0.01

In terms of the detail of the pattern of outcomes, some limited effects of age and gender were identified, as might have been anticipated from the profile analyses, with older participants and boys being more likely to intend to perform riskier behaviours. As anticipated, however, these effects were largely explained by cross-age and cross-gender variation in attitudes and subjective norms, or else in peer norms: the beta values for age and gender weakened or became non-significant when these variables were included in the analyses. SES was not a significant predictor for any behaviour, although, interestingly, the direction of relationship it exhibited was as might be expected for almost all scenarios (i.e. SES value on the 1 to 5 scale was negatively related to caution and positively related to risk), given the tendency for lower SES to be associated with higher accident rates (Roberts *et al.*, 1998). The lack of significant effects suggests, however, that SES on its own is at most a marginal influence, and is only important in terms of its association with other, more proximal and thus more strongly predictive, variables (cf. Thomson *et al*. (2001) on this point).

Both attitudes, and to a slightly lesser extent subjective norms, were highly significant influences on intention, as predicted by the TPB framework, and the influence was positive in all instances: the higher (i.e. the more favourable) the attitude or subjective norm, the more likely an individual was to intend to perform a behaviour; the lower (more negative) it was, the less likely they were. Given that subjective norms in particular were high for cautious behaviours, and low for riskier ones, the data are consistent with the predicted positive association with caution. The third TPB variable, perceived behavioural control, was also positively associated with intention for the most part, but the effects were much more limited in size. This is perhaps not surprising, however, given indications in the profile analyses that perceived behavioural control was, to an extent, a by-product of the subjective norm. Since the latter variable was included at the same point in the analyses, if it were the stronger influence, it would tend to remove any variance that might be explained by the former.

The effects of attitudes and subjective norms weakened substantially when parental and peer norms, and then self-identity, were included in the analysis, the impact of self-identity being almost uniformly the stronger. As far as attitudes are concerned, the effect of self-identity is consistent with the evidence, detailed previously, that attitude was largely a more specific manifestation of identity. Similarly, the impact of behavioural norms is probably attributable to the already-noted influence of peer norms on identity, which would entail a certain degree of relationship with attitudes. That attitudes typically remained a significant influence on intention even when these variables were included in the analyses, however, indicates that they had an impact over and above identity, albeit a limited one in comparison. This suggests that some participants held specific attitudes that led them to intend to carry out a behaviour, even though this attitude was not in fact particularly consonant with their self-identity. There was no apparent differentiation between cautious and riskier behaviours in this respect.

The relationship of subjective norms to behavioural norms and self-identity merits somewhat more careful analysis. The first point to note is that there appears, on the face of it, to be an inconsistency between earlier claims for a restraining influence of parental norms and the fact that these only emerged as at best a weak influence on intention, in the same direction as subjective norms. However, it will be remembered that the claim was that parental norms operated **through** an influence on subjective norms, i.e. that perceived approval/disapproval was the mediating, and therefore more proximal, influence. Since subjective norms were entered earlier in the analyses, as part of the block of TPB variables (in line with convention), the outcomes for parental norms are thus exactly what would be expected. Where parental norms did appear as a significant predictor in their own right, this was primarily where the influence of subjective norms was especially strong, on the three specific cautious behaviours, where the established practice of parents in the presence of their children may have had an impact over and above a sense of approval or disapproval. If this line of reasoning is correct, the reduction in impact on intention of subjective norms when behavioural norms were included in the analyses was therefore more likely to reflect the influence on these of **peer** norms, which, it will be remembered, were related to them too, albeit to a lesser extent. The impact of including self-identity was less anticipated, since the influence of parental norms on perceived approval has been argued thus far to be essentially an external one. However, it is not implausible that such influences would be internalised to a degree as part of self-identity; while peer norms were the stronger influence on identity, parental norms were in fact related to it as well.

As far as peer norms were concerned, these had a sizeable positive influence on intention, especially on the specific riskier behaviours. In view of the association of peer norms with greater risk and less caution, this influence was therefore also in the predicted direction (note the negative relationship of peer norms to intention for the two global risky behaviours reflects the fact that, on the composite norm measures used here, higher scores corresponded to greater caution). The hypothesised mediation of the influence of peer norms through self-identity was also in large measure borne out by the results, since the effect of peer norms was substantially weakened when self-identity was included in the analyses. That it did not, however, disappear entirely suggests that it remained in part an external influence on intention, perhaps in terms of its effect on subjective norms, and a pressure to ‘follow the crowd’. Thus the earlier characterisation of parental norms as an external influence and peer norms as an internalised one should probably be qualified: these would still appear to be their main routes of influence, but both plainly operate to an extent through the opposing route.

All other influences on intention paled before that of self-identity, however, rendering any influence on identity of central interest as regards potential interventions. The more a particular behaviour was seen as part of personal identity, the more likely participants were to intend to perform it; and in more global terms, the greater the general propensity to risk-taking, the more likely they were to eschew caution and espouse risk. This variable accounted on its own for between a fifth and a third of the variance in intentions for the specific scenarios, and whilst the impact of the more global measure of identity was weaker, identity nevertheless remained a significant influence in all analyses.

The relationship of identity to perceptions of difficulty notwithstanding, however, the mean discrepancy (i.e. between actual difficulty ratings and predicted, skill-based difficulty levels) had in contrast no influence on intention. The skill measures exerted a sporadic influence, but whilst the effects of these were, for the most part, readily interpretable (e.g. those who made more tight fits were more likely to intend to mess about; those who exhibited great starting delay were more likely to intend to act cautiously), they were largely explicable in terms of identity differences, dropping out when self-identity was included in the analyses. The impression created by the data is that skill and/or judgements about ability sat largely in the back of participants' minds and had little direct bearing on pedestrian decision-making in this age group – as, of course, might be expected if the perceived importance of these capabilities is devalued, and such decisions are given inadequate attention. Accident history and exposure were similarly lacking in influence, perhaps for the same reason, although it must be remembered that the non-normally distributed nature of the data for these measures may have served to obscure effects to some extent.

3.3.2.3 Analysis of self-reported behaviours

Table 3.16 shows the results of the regression analyses for self-reported behaviours. As with the analyses for intentions, collinearity between predictor variables was within acceptable levels in terms of tolerance and VIF values, though there was some overlap between intentions (a predictor variable here) and self-identity. This was, however, unsurprising given the strength of relationship between them, as described in the previous section. The proportion of variance in reported behaviour explained by the final model in each analysis was somewhat lower than was the case for intentions, but this tends to be typical of analyses of behaviour within the TPB framework. This characteristic is generally explained in terms of the greater number of extraneous variables that can intrude on the commission of a behaviour relative to the intention to perform it. For example, the lack of occasion to act in a particular fashion during the period being examined (a fortnight in the present case) might weaken the measured relationship between predictors and behaviour for reasons outside the control of the study itself. There was also slightly less stability from behaviour to behaviour in the pattern of effects than was the case for intentions, which is attributable to the same cause. In general, though, the pattern of effects remained relatively clear-cut.

The effects of age and gender on reported behaviour were again found to be limited, and in this case they were largely explicable by the associated variation in intentions (and thence attitudes and norms), dropping out when this variable was included in the analyses. SES once more had no impact. Intention, the central variable mediating between other predictors and behaviour in the TPB framework, was a consistent and sizeable positive predictor of behaviour when first entered, barring one exception, but tended to reduce to a weaker, if still significant, influence once attitudes, norms and self-identity were included (even becoming a **negative** predictor in one case).

Table 3.16: Hierarchical regression analyses predicting self-reported behaviour for three global and eight specific scenarios (significant effects in bold, $^{+}$ $P < 0.05$, * $P < 0.01$, ** $P < 0.001$; where final beta differs in significance level or changes substantially in value from beta at entry, the block(s) at which change occurs is shown in parenthesis)

Scenario	Block 1: Demographic variables								Block 2: Intention				Block 3: TPB variables							
	Age		Gender		SES (ACORN)		Variance explained		Intention		Variance explained		Attitude		Subjective norm		Perceived behavioural control		Variance explained	
	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	R^2 (adj)	R^2 ch	Beta at entry	Final beta (ch block)	R^2 (adj)	R^2 ch	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	R^2 (adj)	R^2 ch
Act cautiously	-0.06	0.00	0.01	-0.04	-0.06	-0.06	0.00	0.00	**0.41****	**0.18*** (3/6/7)	**0.16****	**0.16****	**0.16***	**0.14**$^{+}$	**0.12**$^{+}$	0.07 (6)	0.01	0.01	**0.19****	**0.03***
Take chances	0.05	-0.02	-0.08	0.05	0.04	0.03	0.00	0.00	**0.39****	**0.15**$^{+}$ (3/6/7)	**0.15****	**0.15****	**0.28****	**0.17*** (7)	-0.01	-0.01	0.01	-0.03	**0.20****	**0.05****
Mess about	0.08	0.00	-0.05	0.07	0.01	0.00	0.00	0.00	**0.50****	**0.18*** (3/6/7)	**0.24****	**0.24****	**0.28****	**0.16*** (6/7)	0.05	0.00	-0.02	-0.08	**0.30****	**0.06****
Wait for green man	-0.08	-0.05	**0.27****	**0.18*** (5)	0.03	0.03	**0.07****	**0.07****	**0.16***	0.15 (3/6/7#)	**0.09****	**0.02***	**0.16**$^{+}$	0.13 (6)	0.00	0.00	-0.07	-0.02	**0.11****	0.02
Look all round	-0.09	-0.04	0.07	-0.01	-0.04	0.01	0.00	0.00	0.07	**-0.18**$^{+}$ (7)	0.01	0.01	0.08	0.01	0.03	0.04	-0.05	-0.04	0.01	0.00
Wait for large gap	-0.01	0.02	0.07	0.00	0.01	0.04	0.00	0.00	**0.27****	0.07 (3/6)	**0.06****	**0.06****	**0.32****	**0.21*** (6)	-0.07	-0.01	-0.01	-0.03	**0.12****	**0.06****
Jump barrier	**0.17***	0.08 (2)	**-0.24****	-0.08 (2)	0.04	0.05	**0.09****	**0.09****	**0.47****	**0.17**$^{+}$ (3/6/7)	**0.29****	**0.20****	0.12	0.03	0.02	0.03	0.05	0.05	**0.30****	0.01
Run through gap	0.09	0.01	**-0.12**$^{+}$	-0.01 (2)	0.07	0.06	**0.02**$^{+}$	**0.02**$^{+}$	**0.46****	**0.20*** (3/6/7)	**0.21****	**0.19****	**0.22****	0.06 (6/7)	0.04	-0.04	0.08	0.06	**0.25****	**0.04****
Force cars to slow	0.05	-0.02	-0.02	0.01	0.03	0.04	0.00	0.00	**0.44****	**0.18**$^{+}$ (3/6/7)	**0.19****	**0.19****	**0.21***	**0.16**$^{+}$ (6)	-0.03	-0.05	0.04	0.03	**0.21****	**0.02***
Step out before cars pass	0.11	0.03	-0.06	0.05	0.05	0.05	0.01	0.01	**0.43****	0.05 (3/6/7)	**0.18****	**0.17****	**0.13**$^{+}$	0.09 (7)	-0.11	**-0.14**$^{+}$ (6/7)	0.02	-0.03	**0.19****	0.01
Stop in middle	**0.15***	0.09 (2)	0.03	0.07	-0.01	0.05	0.01	0.01	**0.30****	0.05 (3/6/7)	**0.10****	**0.09****	**0.16**$^{+}$	**0.16**$^{+}$	-0.04	-0.06	0.11	0.11	**0.11****	**0.02**$^{+}$

Effects tend to cancel out – TPB/norms reduce beta, self-identity increases it.

Table 3.16: continued

Scenario	Block 4: Skill variables												Block 5: Perception of difficulty variables			
	Visual timing: tight fits		Visual timing: starting delay		Drivers' intentions: no. of cues		Designated crossings: no. of looks		Safe route planning: factor score		Variance explained		Mean discrepancy		Variance explained	
	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	R^2 (adj)	R^2 ch	Beta at entry	Final beta (ch block)	R^2 (adj)	R^2 ch
Act cautiously	-0.03	0.00	-0.01	-0.01	0.03	0.06	-0.04	-0.04	**0.13**$^{+}$	0.05 (6)	**0.20****	0.01	-0.07	-0.04	**0.20****	0.00
Take chances	-0.01	-0.01	**-0.12**$^{+}$	-0.10 (7)	0.07	0.02	0.05	0.03	-0.10	-0.05	**0.22****	0.02	0.03	-0.02	**0.22****	0.00
Mess about	0.00	-0.01	-0.08	-0.08	0.09	0.05	0.04	0.02	**-0.15***	-0.10 (7)	**0.32****	**0.02**$^{+}$	0.03	-0.01	**0.32****	0.00
Wait for green man	-0.06	0.04	0.03	0.05	-0.04	-0.02	-0.10	**-0.13**$^{+}$ (5)	0.09	0.02	**0.11****	0.00	**-0.18***	**-0.14**$^{+}$	**0.13****	**0.02***
Look all round	-0.09	-0.10	-0.04	-0.06	**-0.12**$^{+}$	-0.03 (6)	-0.03	-0.01	**0.15**$^{+}$	0.10 (8)	**0.03**$^{+}$	**0.02**$^{+}$	-0.02	0.02	0.03	0.00
Wait for large gap	-0.06	-0.04	0.05	0.02	-0.08	-0.03	0.00	0.01	0.09	0.05	**0.12****	0.00	-0.05	0.01	**0.12****	0.00
Jump barrier	**0.10**$^{+}$	0.04 (5)	-0.05	-0.07	0.01	0.00	-0.02	0.01	-0.01	0.00	**0.30****	0.00	0.02	0.02	**0.30****	0.00
Run through gap	0.03	-0.02	-0.04	-0.06	0.07	0.04	0.04	0.05	**-0.13**$^{+}$	-0.09 (8)	**0.26****	0.01	0.05	0.02	**0.26****	0.00
Force cars to slow	0.01	-0.02	0.04	0.04	0.02	0.00	-0.04	-0.02	-0.06	-0.05	**0.21****	0.00	0.03	0.01	**0.21****	0.00
Step out before cars pass	0.01	-0.03	**-0.11**$^{+}$	**-0.11**$^{+}$	0.09	0.06	-0.01	-0.01	**-0.12**$^{+}$	-0.08 (8)	**0.21****	0.02	0.04	0.05	**0.21****	0.00
Stop in middle	0.10	0.07	-0.10	**-0.11**$^{+}$	0.04	0.03	0.01	-0.01	**-0.12**$^{+}$	-0.10	**0.13****	0.02	0.00	0.00	**0.13****	0.00

Table 3.16: continued

Scenario	Block 6: Norm variables						Block 7: Self-identity				Block 8: Accident history and exposure					
	Parental norms		Peer norms		Variance explained		Self-identity		Variance explained		No. of accidents	No. of near-misses	Walk to/ from school alone	Walk to/ from school in group	Variance explained	
	Beta at entry	Final beta (ch block)	Beta at entry	Final beta (ch block)	R^2 (adj)	R^2 ch	Beta at entry	Final beta (ch block)	R^2 (adj)	R^2 ch	Beta at entry/ final	Beta at entry/ final	Beta at entry/ final	Beta at entry/ final	R^2 (adj)	R^2 ch
Act cautiously	0.10	0.07	0.14+	0.06 (7)	0.23**	0.03*	-0.25**	-0.25**	0.26**	0.03**	0.03	-0.05	0.03	0.05	0.26**	0.00
Take chances	-0.05	-0.03	-0.20*	-0.08 (7)	0.25**	0.03**	0.27**	0.23* (8)	0.30**	0.05**	-0.04	0.21**	-0.05	0.02	0.32**	0.02*
Mess about	-0.04	-0.02	-0.25**	-0.15* (7)	0.37**	0.05**	0.28**	0.25**	0.41**	0.04**	-0.03	0.18**	-0.01	0.00	0.43**	0.02+
Wait for green man	0.24**	0.25**	0.15*	0.12+	0.21**	0.08**	-0.16+	-0.17+	0.22**	0.01+	0.01	-0.12+	0.03	-0.01	0.22**	0.00
Look all round	0.16*	0.13+	0.36**	0.32**	0.19**	0.16**	0.18+	0.20+	0.20**	0.01+	0.06	-0.17*	-0.01	-0.01	0.22**	0.02+
Wait for large gap	0.28**	0.26**	0.24**	0.23**	0.26**	0.14**	-0.01	-0.02	0.26**	0.00	0.00	-0.12+	0.00	0.07	0.27**	0.01
Jump barrier	0.11+	0.11+	0.18*	0.13+ (8)	0.33**	0.03**	0.23*	0.18+ (8)	0.35**	0.02*	0.03	0.22**	-0.05	0.06	0.39**	0.04**
Run through gap	0.19*	0.18*	0.11+	0.03 (7/8)	0.30**	0.04**	0.15+	0.09 (8)	0.31**	0.01+	0.05	0.34**	-0.03	-0.03	0.40**	0.09**
Force cars to slow	0.04	0.05	0.29**	0.23** (8)	0.28**	0.07**	0.07	0.07	0.28**	0.00	0.03	0.18*	0.05	0.03	0.30**	0.02*
Step out before cars pass	0.03	0.02	0.29**	0.23** (8)	0.27**	0.06**	0.33**	0.28* (8)	0.30**	0.03**	-0.03	0.17*	0.08	-0.01	0.33**	0.03*
Stop in middle	0.16+	0.17+	0.12	0.11	0.16**	0.03*	0.06	0.01	0.16**	0.00	-0.04	0.11	-0.05	0.05	0.17**	0.01

The implication is that, to a certain extent, self-reported behaviours were not deliberate and thus informed by intention, but a function of more spontaneous feeling (given the influence of attitudes on behaviour over and above their influence on intention), habitual practice, and following the lead of others (hence the direct impact of self-identity and norms). Even attitudes were, at best, a weak residual influence once norms and self-identity were included, however, indicating that it was these elements that were paramount. Moreover, in contrast to intentions, of these two more consistent influences, it was norms that had the stronger influence on behaviour, certainly for the specific scenarios. In addition, parental norms acted in this case as a direct influence, especially as regards the cautious behaviours, rather than via subjective norms and perceived approval or disapproval, which had little or no impact in these analyses. This suggests that, whilst parental and peer norms become rationalised into mediated influences on deliberate decision-making, via perceived approval and self-identity, when it comes to actual behaviour they retain a direct, uncognized impact – although they still pull in opposing directions. This would of course serve to explain something of the slippage between intention and behaviour noted in Section 3.3.1.3. It also explains why slippage should be in the direction of reduced caution, given the nature of the reported peer norms and the frequency with which participants walked home from school as part of a group.

Two other important points emerged from these analyses. The first is that, at the level of direct, less deliberated influences on behaviour, the skill variables emerged as having rather more impact than they did on intentions. Significant relationships were apparent between skill and behaviour for 9 of the 11 scenarios, and in a number of instances these relationships did not decrease markedly when other variables were included in the analyses. The nature of these influences was, moreover, strikingly consistent with what might be expected on most points of detail (e.g. those who showed smaller starting delays were more likely to report stepping out before cars passed). This relationship to behaviour was particularly consistent, if not always strong, in the case of safe route planning, construction of safer routes and better understanding of sources of hazard being associated with greater caution and less risky behaviour. There was also more sign of influence from perceptions of difficulty. The discrepancy measure only had a significant relationship with one reported behaviour, waiting for the green man, but initial relationships were in the predicted direction for all but one scenario (i.e. positive values, or underestimates of difficulty, were positively associated with the reporting of riskier behaviour). The implication is these misperceptions are potentially a weak influence on behaviour.

The second point of importance is the consistent and, in many cases, strong relationship of reported behaviour to near-misses. This was in the predicted direction even when it was not significant, with greater reporting of riskier behaviour being associated with increased numbers of near-misses. This association was probably not a reflection of a true causal relation, in the sense that experiencing more near-misses led participants to take more risks, but it does indicate that riskier behaviour is connected to near-misses even when a range of other variables have been taken into account. In view of the shibboleth that accidents occur at a **conjunction** of hazards, it is of particular interest that the connection is not with accidents, but with near-misses, as would be expected if risky behaviour only constituted one element of that conjunction. Both the fact and the nature of this association act to confirm the likely validity of the present data.

3.3.2.4 Summary of regression analyses

As anticipated, the regression analyses indicated that the key influences on cautious and riskier pedestrian behaviour in this age group were parental and peer norms. With regard to behavioural intentions, it was confirmed that these influences operated by (a) shaping perceived approval or disapproval for a behaviour and (b) being subsumed into individuals' self-identity. Parental norms were the dominant influence in the first case, and peer norms in the second. Both also had a direct, unmediated influence on behaviour over and above intentions, indicating that where pedestrian behaviour was unpremeditated (as appeared to often be the case), it remained subject to essentially the same causes, even if the mechanisms differed somewhat. Given that parental accompaniment was almost certainly a rarer experience than peer accompaniment in this age group, the impact of parental norms on behaviour seems most likely to have stemmed from previously established practice, whilst that of peer norms came from pressure to conform. In both cases, the influence was in the same direction, in that the espousal and enacting of risk-taking was more likely where norms were less cautious. Parental norms were characteristically cautious, however, whereas peer norms were more risky. Thus the net effect tended to be that they pulled in opposite directions, parental norms having a protective influence and peer norms pushing towards risk-taking. Risky behaviour was, in turn, strongly associated with greater hazard, in the form of near-misses. Influences of attitudes, age group and gender were largely (though in the first case not wholly) explicable in terms of variation in the nature of peer norms and concomitant self-identity. SES and exposure had no detectable influence on intentions or behaviour. Skills and perception of ability had little or no impact on intentions, but there were signs that they had some direct influence on behaviour, albeit a weaker one than parental and peer norms, better skills tending to be associated with greater caution, and overestimation of ability with greater risk-taking.

3.4 Conclusions from Study 2

The key objective of Study 2 was to ascertain the relative influence of social and skill-related factors on intended and actual engagement in hazardous pedestrian behaviours. This was achieved by measuring pedestrian skills, perceptions of task difficulty, and a range of theoretically pertinent social variables within a single sample, and examining the conjoint relation of these to measures of outcome and reported behaviour in 11 representative scenarios. In terms of the overall goals of the project, attention was focused in particular on the extent to which the apparent propensity amongst 13- to 15-year-olds to overestimate their ability, detailed by Study 1, led to increased risk-taking.

The skills data collected in the first part of Study 2 established that the sample was in almost all respects highly comparable to that employed in Study 1, the one exception being that misperceptions of ability were not found to increase systematically with age. Such misperceptions were extensive, however, and appeared to be stable individual characteristics, consistent with the conclusion from Study 1 that they were a function of some other factor operating within this age range. Analysis of responses to the questionnaire items measuring variables within the extended TPB framework established that these misperceptions were in fact reliably (albeit not strongly) related to biases in individuals' self-identity towards carelessness and risk-taking.

Taken overall, the bias in this direction shown by the sample was not extreme, and on balance they favoured caution over risk-taking. However, there was a high level of variability within this overall pattern, and thus a subset of participants who exhibited more extreme risk-taking tendencies. There was also a shift towards a more positive perception of risk-taking with age and among boys. In all cases, these characteristics were attributable to direct and indirect pressure from riskier peer norms. This pressure led to increases in both intended and actual hazardous behaviour. The latter was in turn associated with measurably higher risk of injury, as indexed by elevated levels of near-misses, which were correlated with actual pedestrian accidents. Parental norms tended to act as a countervailing influence, their generally more cautious character exerting an influence in this direction via perceived disapproval for risk-taking and patterns of established practice. The extent of parental caution was also variable, though. In general, then, risk-taking was highest where **both** parental and peer norms tended towards lack of caution. Cross-community variation in the rate of adolescent pedestrian injury (see e.g. Roberts *et al.*, 1998) might thus be explained if there were trends within particular communities towards the entrenchment of such patterns of behaviour across generations.

In terms of the primary question addressed by the study, it was plain that the impact of these social factors outweighed that of skill-related factors in this age range. Improved levels of pedestrian skills did have a protective value, but the influence of these was weaker than that of parental and peer norms. Misperceptions of ability seemed mostly to be **symptomatic** of wider carelessness, inattention and increased risk-taking, rather than major sources of hazard in their own right. The apparently non-reflective nature of much pedestrian decision-making that is implied by the (at best) moderate influence of intentions on behaviour is of a piece with the same picture. In this sense, then, Study 2 confirms the underlying conclusion of Study 1: if there is a central problem amongst young adolescents that leads to increased risk of injury, it is the tendency to act carelessly. This tendency would appear to be attributable to a deliberate espousal of this characteristic as part of individual self-identity in at least some cases.

4 FINAL CONCLUSIONS AND RECOMMENDATIONS

Taken together, Studies 1 and 2 highlight a consistent trend among young adolescents towards a careless approach to the demands of the road-crossing task, driven in large measure by a perceived lack of caution in the behaviour of peers. This trend manifests in more extreme instances in overestimation of ability, failure to notice behavioural feedback and increased risk-taking, but its strength should not be overstated. Most participants in Study 2 showed moderate degrees of carelessness at worst, and they were more likely to report acting in a cautious manner than to report taking risks. In this respect, the sample bore considerable resemblance to the adolescents observed by Chinn *et al*. (2004a), who almost never exhibited actively dangerous actions.

However, the difficulty is that, perhaps due to the type of environment adolescents have to negotiate (see Section 1.1), relatively moderate increases in risky behaviour appear to lead to fairly steep increases in risk of injury. If the near-miss data reported in Sections 3.3.1 and 3.3.2 are accurate, not only are such occurrences quite strongly associated with riskier behaviour, but nearly half the Study 2 sample had experienced at least one instance of this happening. Extrapolation from the data presented in Figure 3.18 would suggest, moreover, that as many as approximately one in six encounters of this kind results in contact with a vehicle, even if the consequence is only minor injury. Inattention and carelessness present a real problem, therefore, and one that extends to the normal population of teenagers, not just the extreme risk-takers who were the focus of earlier research by West *et al*. (1998). Indeed, one of the key features of the present work is that it has elucidated the mechanisms that are likely to have been the source of the relationship between risk-taking and injury reported in that research, and shown how these might apply more widely.

This, of course, begs the question of how representative the present data are and whether they, in fact, accurately capture the mechanisms leading to increased risk of pedestrian injury amongst adolescents. In favour of accuracy are the high levels of consistency between the Study 1 and Study 2 results, and the various points on which the data have good face validity (e.g. the lack of variation with age in reported parental norms coupled with age effects for reported peer norms; and the relationship between self-reported risky behaviour and various aspects of pedestrian skill). In favour of representativeness is the gap between girls and boys in the shift with age towards increased risk-taking: both the relatively modest size of this gap, and the fact that girls exhibited the same shift as boys as they got older would appear to fit in well with the known two-year lag in peak injury rates (see Sentinella and Keigan, 2004). Less consistent with the injury rate data is the actual age profile of these shifts, since both boys and girls showed increases in risk-taking to at least age 15, which is harder to reconcile with peak injury rates at 12 and 14 years respectively. However, increased risk-taking might not map directly onto injury rates if, for instance, the modest improvements in skill across S1 to S3 noted in Section 3.3.1.1 were sufficient to provide counteracting protection. That risky behaviour was far from perfectly correlated with near-misses, even if the relationship was a relatively strong one, argues that other factors were certainly at work. In addition, the slightly later point of transition to secondary school in Scotland may have impacted upon both risk-taking and injury rate trends in ways that cannot be discerned solely from the present data.

On balance, then, there are good grounds for holding that the data are both accurate and representative, and that the mechanisms leading to increased injury risk are as outlined in Section 3.4. If so, the central point to note is that **all** the potential factors detailed at the outset appear to play a role: the busier traffic environment, greater independence to travel alone or as part of a group rather than with parents, partially underdeveloped skills, mistaken perceptions of competence, inattention to feedback, and both direct and indirect pressure from peer norms to act in a more careless fashion have all been implicated in increased risk in one way or another. Thus, although the social influences appear to be core, they interact with the other factors in complex ways. Given this complexity, the question is, then, whether there are straightforward methods of intervention that might serve to reduce risk. It seems to us that there are, in fact, at least four possible factors that might be addressed:

1. **Parental norms.** The strongest protective influence identified by this research was parents' patterns of road-crossing behaviour, and bolstering this influence would seem likely to have substantial positive results, although the effect of peer norms is such that it is improbable that it could be undermined totally in this way. It is important to be clear, however, about what bolstering the impact of parental norms would actually entail. In the first place, it needs to be emphasised that it is what parents **do** that the data point to as the crucial strand of influence. Increasing the positive effect of this would therefore mean encouraging changes in parents' pedestrian behaviour around their children (and other people's too, perhaps), by sensitising them to the impact they have as models for how to act. In addition, it is plain that such efforts should be directed at parents of **younger** children, not adolescents. Not only are teenagers less likely to witness what their parents do, due to changes in patterns of accompaniment, the present data indicate clearly that parental norms have their greatest impact on both intended and spontaneous behaviour when they reflect well-established practices, that do not require further reflection.

2. **Skills**. By the same token, skills training at primary school level is also likely to have benefits. Adolescents are unlikely to be receptive to such training, since they will typically regard it as childish (Tolmie and Thomson, 2003), but higher skill levels were identified as having a direct protective influence on behaviour, and this influence is likely to be enhanced if good skills have been established from an early age. Even if this fails in the face of the impact of peer norms,

better skills are more likely to help teenagers extricate themselves from difficult situations than poorer skills.

3. **Reflection**. Whilst the precise methods by which it might be achieved are less clear-cut, encouraging adolescents to reflect on what they are doing whilst engaged in road-crossing might have benefits, since, as noted in Section 3.3.1, intended behaviours tended to be more cautious in character than spontaneous behaviours. Such reflection might also promote better attention to behavioural feedback.
4. **Peer norms**. As pointed out in Section 3.3.1.2, it cannot logically be the case that Study 2 participants' own behaviour was systematically more cautious than their peers since they must constitute at least part of the set of peers reported on by others. Thus it is almost certainly true that the perceived characteristics of peer behaviour are the result of distorted impressions, and that there is a gap between perceived and actual peer norms. Without further examination of the process by which this impression arises, it is hard to recommend a specific course of intervention, but it seems evident that some means of sensitisation to this gap ought to act to reduce apparent peer influence in favour of increased risk-taking.

Contrary to popular belief, there is little indication in the present research that young adolescents are bent on courting danger, but they do appear to suffer from systematic misperceptions and under-processing of available information, both social and traffic-related, which bias their actions towards carelessness within potentially hazardous environments. Altering these false impressions and establishing better practices is likely to require a degree of sophistication and forethought that would be less necessary with younger children, but the suggestions above are practical ways forward. There is no reason to suppose that adolescents would be particularly resistant to their influence if they were enacted appropriately.

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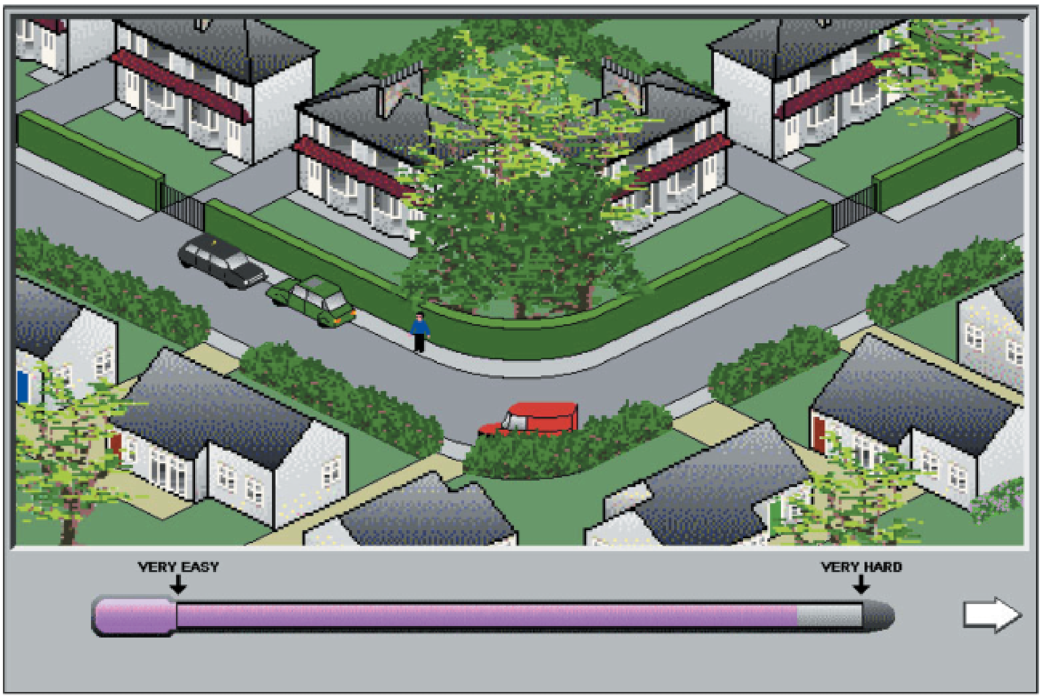
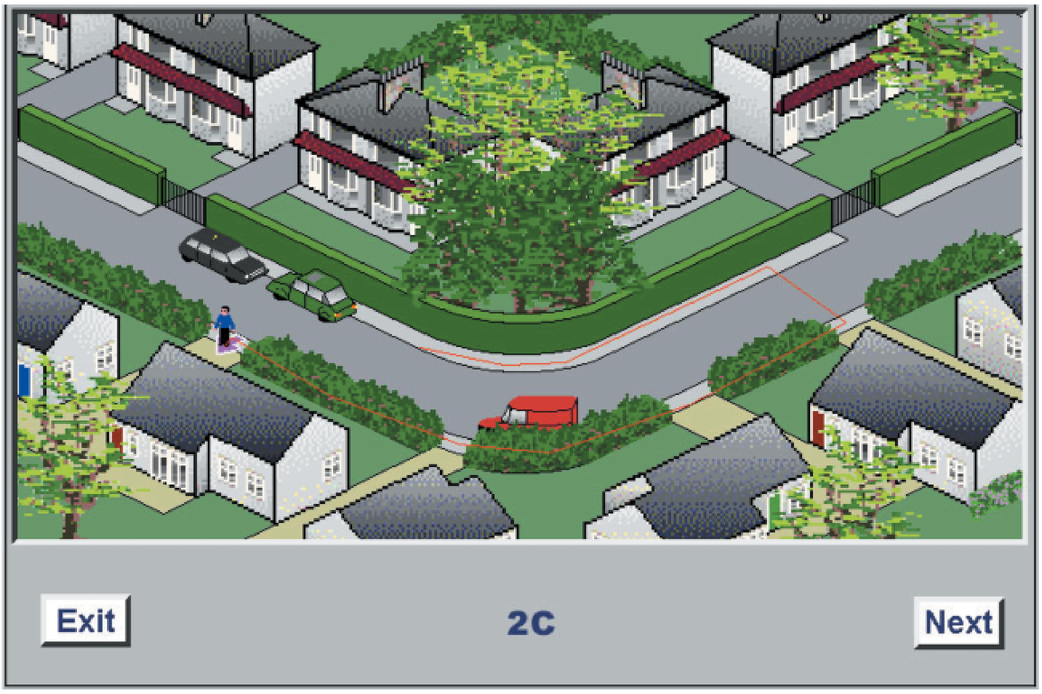
APPENDIX 1: EXAMPLES OF SIMULATIONS USED IN SKILLS TESTS

Figure A1.1: **Safe route planning – (a) blind bend crossing: recording of pre-estimate of difficulty; (b) blind bend crossing: destination (arrow) and record of chosen route (red lines). Authored using Macromedia Director 6.0.**



(a)



(b)

Figure A1.2: **Visual timing – selection of safe gap and initiation of crossing. Authored using Macromedia Director 6.0.**

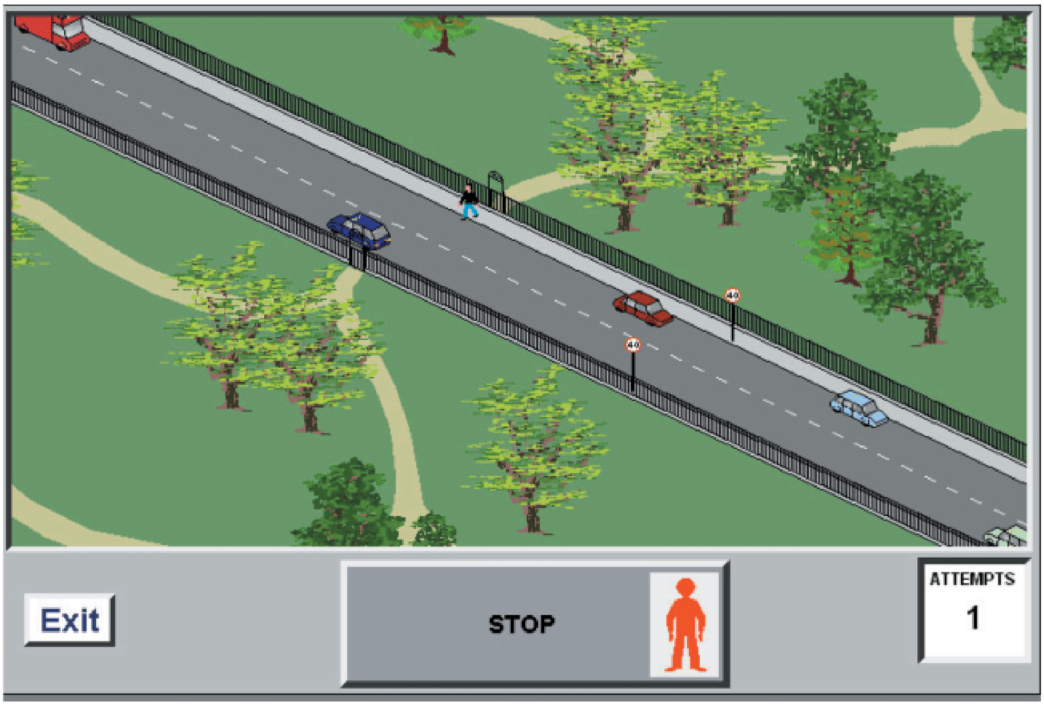
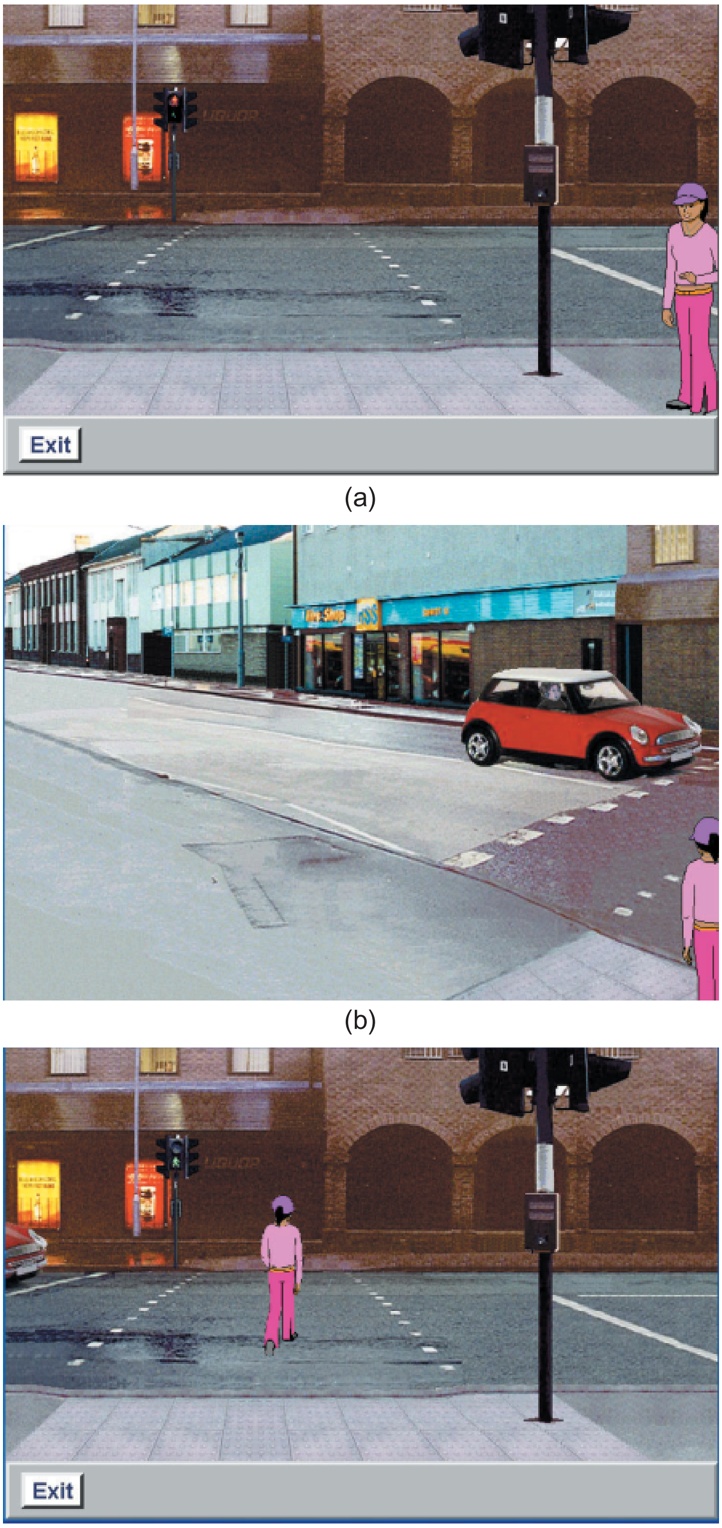


Figure A1.3: Use of designated crossings – (a) character standing adjacent to a pelican crossing; (b) view to left, showing traffic approaching slowly; (c) character crossing, while traffic stopped. Authored using Macromedia Director 6.0.



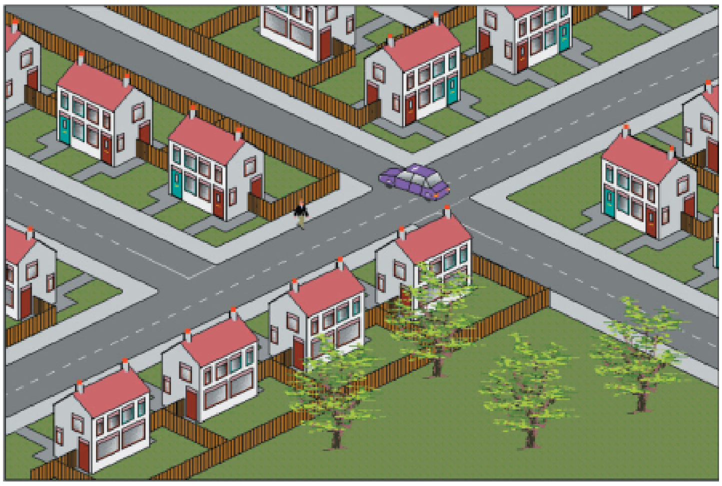
(a)

(b)

(c)

Figure A1.4: Perception of drivers' intentions – (a) presentation of cues: car is indicating left and is slowing down; (b) feedback to participants: car turning left, character stepping out; (c) recording of post-estimate of difficulty, after character has crossed. Authored using Macromedia Director 6.0.

(a)



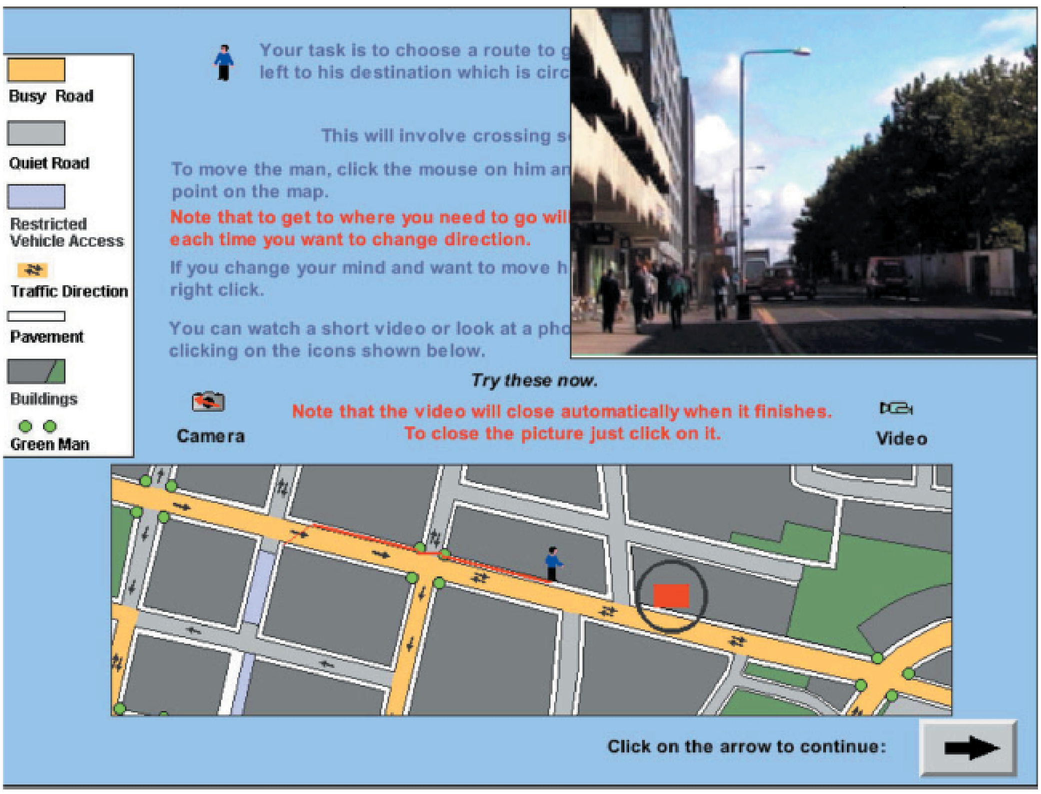
(b)

(c)

APPENDIX 2: STUDY 2 TRIAL MAP TASKS – MATERIALS AND DATA

At the end of the third block of testing, participants were asked to work through two online map tasks in order to gauge the extent to which they spontaneously performed safe and unsafe pedestrian behaviours under unstructured conditions. The rationale for these tasks was that they would generate a genuine measure of outcome behaviour to relate back to the other factors under investigation in Study 2, without the need for complex and essentially uncontrollable roadside observations. The tasks utilised two online environments, the first depicting an area around the participant's school, with which they might be expected to be relatively familiar (the extent to which this was the case was checked by questioning after the task had been completed), and the second depicting an area which they were less likely to have been exposed to before (part of Glasgow city centre adjacent to Strathclyde University). These locations were used in order to obtain a representative picture of behaviour, by sampling not only conditions where local knowledge and habit might result in reduced caution, but also those where lack of familiarity might lead to a greater degree of caution. The familiar locations were chosen as far as possible to be comparable across the different schools in terms of complexity and length of route to be traversed. All participants saw the same unfamiliar location.

Figure A2.1: Instruction screen (video icon has been pressed and video is playing in the top-right corner)



In both cases, participants were asked to navigate an onscreen character from a fixed start point to a marked destination using whatever they thought was the best route (this phrasing being employed in order to avoid specifically cuing safe choices). This meant that they were able to decide for themselves how far to take into account:

- road layouts;
- road furniture, such as refuges and designated pedestrian crossings; and
- indicative information about traffic flows, provided on-screen through symbols and either photos (familiar maps) or brief video clips (unfamiliar maps, where the cuing of personal knowledge by photos was unlikely to be sufficient).

Full instructions were given on the first screen for the familiar map (illustrated in Figure A2.1). Participants were required to demonstrate at this point that they understood all the features of the maps (e.g. the symbols used to indicate busy or quite roads and designated crossings), the way they could make the character move, and how to access the videos and pictures of the areas. Only when they had done this were they able to move on to the task proper, beginning with the familiar map appropriate to their school (see Figure A2.2 for an illustration of the task screen).

Once the task itself had begun, in order to get the character to the required destination, participants had to make a number of decisions about where they would cross roads (e.g. mid-block on a busy road versus diverting to a safer crossing at a junction) and how (e.g. making use of a designated crossing; crossing directly or diagonally), and translate those decisions into actions. As in the software for testing safe route planning, selected routes were marked on the map by making a series of mouse clicks, each of which inserted a red line to show the path taken since the previous click. The participants were clearly instructed that they needed to re-click on the mouse every time they wanted to change direction to ensure that the red line represented exactly the route they wanted to take. Right mouse clicks allowed sections to be retraced if an individual changed their mind about the route. Records of completed routes, time taken and additional resources accessed were saved automatically by the computer to provide the basis for subsequent data analysis.

Figure A2.2: Example of map for familiar location, with photo display active

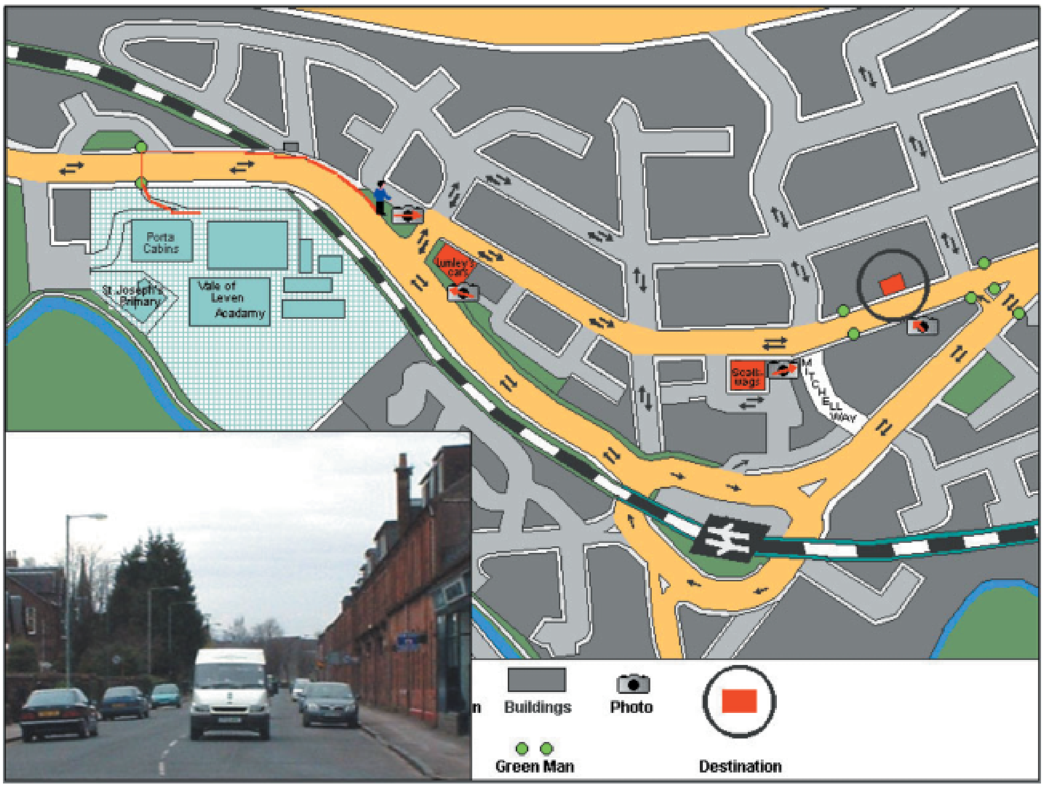


Table A2.1: Familiar and unfamiliar map task variables

Variable	Description
Delay	Delay before first mouse click to commence route (excluding video play time)
Routesec	Time taken in seconds to traverse route (excluding delay time and video play time)
Routepix	Length of route in pixels
Photos	Number of photos clicked on (familiar map)
Videos	Number of videos clicked on (unfamiliar map)
Moves	Number of moves taken to reach destination
Noroadx	Total number of roads crossed (includes diagonal crossings, roundabouts and car park exits)
Perconx	Percentage of roads crossed at a designated crossing
Permajx	Percentage of major roads crossed **not** at a designated crossing
Perminx	Percentage of minor roads crossed **not** at a designated crossing
Circum1	Number of circumlocutions taken in order to use designated crossing
Diagmid	Number of mid-block diagonal crossings (diagonally across one road)
Diagjun	Number of junction diagonal crossings (diagonal crossing across two roads at a junction)
Misalig	Presence/absence of misalignments of route with pavement (binary variable)
Circum2	Number of times avoid crossing road at a junction, or makes a circumlocution which makes route safer but is not to a designated crossing
Carpark*	Number of car park exit crossings (not within car park)
Round*	Number of crossings at roundabout

* These variables were applicable only to some maps.

Note: The first five variables were recorded automatically by the computer, the rest were coded later.

Table A2.1 displays the variables extracted from these records, separate values being derived for familiar and unfamiliar maps for each participant. In order to reduce these to a manageable set for use as dependent variables in regression analyses, values from the familiar and unfamiliar maps were subjected in turn to factor analysis (principal components with varimax rotation). The results from these analyses and the factors that emerged are shown in Table A2.2. However, in subsequent analysis, attitudes, pedestrian skills, subjective norms, perceived behavioural control and self-identity all failed to predict performance of safe and unsafe behaviours as indexed by these factors, despite the strong patterns of relationship that emerged between those variables and self-reported behaviour, as detailed in the main body of the report. As a result, even though they offered some insight into the road-crossing decision-making of adolescents, scores on the map tasks were not considered sufficiently reliable for the purposes of the present study, and the data were not used in further analysis.

Table A2.2: Summary of map task factor analysis

	Familiar map		**Unfamiliar map**	
No. of factors	**5**		**5**	
Variance explained	**67.6%**		**65.6%**	
	Variables	**% variance**	**Variables**	**% variance**
Factor 1	Moves, routpix, routesec, circum2, noroadx	19.8	Routpix, noroadx, circum1, moves	19.2
Factor 2	Perminx, perconx, circum1	17.5	Perconx, permajx, diagjun, diagmid	14.3
Factor 3	Permajx, diagjun	11.5	Videos, routesec, delay	12.7
Factor 4	Photos, delay	10.0	Misalign, circum2	9.9
Factor 5	Misalign, diagmid	8.9	Perminx	9.3
Variables with low communalities (< 0.6)	Delay, circum1, diagjun and circum2		Delay, circum1, diagmid, diagjun, misalign and circum2	

However, there were a number of interesting associations between individual map task variables and self-reported behaviours/experiences, suggesting that this approach to obtaining measurements of natural pedestrian behaviour has sufficient potential to merit further development. In particular, for the familiar map task, time taken and route length were negatively associated with the reported frequency of jumping a barrier (-0.11 and -0.14 respectively) and running through tight gaps (-0.13 and -0.25). Route length was similarly related to the frequency of taking chances (-0.16), messing about (-0.16) and forcing vehicles to slow down (-0.15). It was also negatively correlated with reported near-misses (-0.19) and accidents (-0.17), which is particularly interesting, bearing in mind the sizeable relation of near-misses to self-reports of risky behaviour. The number of moves and total number of road crossings exhibited similar relationships to accidents (-0.13 and -0.12 respectively) and near-misses (-0.25 and -0.19). Mid-block diagonal crossings, on the other hand, were positively related to both accidents (0.13) and near-misses (0.14), whilst junction diagonal crossings were positively related to accidents (0.16). None of these relationships is especially strong, which indicates a certain amount of noise in the data (and explains the lack of predictive relation to these variables of other factors). Nevertheless, they all point to a consistent tendency for the familiar map task to capture elements of care and carelessness in decision making that reflect actual behaviour at the roadside. There would seem to be some advantage in attempting to refine this capability further, therefore, but only in the context of simulations of familiar environments – relationships of this type were almost uniformly absent for the unfamiliar map task.