



Review of the road safety of disabled children and adults

Prepared for Road Safety Division, Department for Transport

K Williams, T Savill and A Wheeler

First Published 2002
ISSN 0968-4107
Copyright **TRL Limited 2002.**

This report has been produced by TRL Limited, under/as part of a contract placed by the Department for Transport. Any views expressed in it are not necessarily those of the Department.

TRL is committed to optimising energy efficiency, reducing waste and promoting recycling and re-use. In support of these environmental goals, this report has been printed on recycled paper, comprising 100% post-consumer waste, manufactured using a TCF (totally chlorine free) process.

CONTENTS

	Page
Executive Summary	1
1 Introduction	3
2 Method	3
3 Background to the review	4
3.1 Definition of disability	4
3.2 Numbers of disabled people in Great Britain, their characteristics and lifestyles	4
4 Learning difficulties	5
4.1 Prevalence	5
4.2 Impacts on mobility and safety	5
4.3 Accident risk	6
4.4 Remedial measures	6
4.4.1 <i>Research findings</i>	6
4.4.2 <i>Road safety education materials</i>	9
4.4.3 <i>Engineering measures</i>	10
5 Autism	10
5.1 Prevalence	10
5.2 Impacts on mobility and safety	11
5.3 Accident risk	11
5.4 Remedial measures	11
6 Attention deficit hyperactivity disorder	11
6.1 Prevalence	11
6.2 Impacts on mobility and safety	11
6.3 Accident risk	11
6.4 Remedial measures	12
6.4.1 <i>Research findings</i>	12
6.4.2 <i>Road safety education materials</i>	12
6.4.3 <i>Engineering measures</i>	12
7 Physical disabilities	12
7.1 Prevalence	12
7.2 Impacts on mobility and safety	13
7.3 Accident risk	13
7.4 Remedial measures	13
7.4.1 <i>Research findings</i>	13
7.4.2 <i>Road safety education materials</i>	14
7.4.3 <i>Engineering measures</i>	14

	Page
8 Hearing impairment	15
8.1 Prevalence	15
8.2 Impacts on mobility and safety	15
8.3 Accident risk	16
8.4 Remedial measures	16
8.4.1 <i>Research findings</i>	16
8.4.2 <i>Road safety education materials</i>	16
8.4.3 <i>Engineering measures</i>	17
9 Vision impairment	17
9.1 Prevalence	17
9.2 Impacts on mobility and safety	17
9.3 Accident risk	18
9.4 Remedial measures	19
9.4.1 <i>Research findings</i>	19
9.4.2 <i>Road safety education materials</i>	21
9.4.3 <i>Engineering measures</i>	22
10 Dual sensory impairment	22
11 Discussion	23
11.1 Prevalence of disabilities	23
11.2 Road accident risk	24
11.3 Engineering measures	24
11.4 Road safety training	25
11.5 Social inclusion	26
11.6 Improving the effectiveness of educational materials	26
11.7 Summary	26
12 Conclusions	26
13 Recommendations	27
14 Acknowledgements	27
15 References	27
Appendix A: Annotated bibliography of RSE resources and engineering measures for disabled people	32
Appendix B: Understanding road accident risk of disabled children and adults	61
Appendix C: Annotated bibliography - evaluating RSE for disabled children	65
Appendix D: Annotated bibliography - road safety education for disabled adults	72
Abstract	79
Related publications	79

Executive Summary

This review provides a summary and review of the information available on the road safety of children and adults with disabilities (also known as additional or special needs).

The information was obtained in a number of ways including literature database and web searches and discussions with a range of professionals such as those working in charities, local authorities and academic institutions. Information was requested concerning the prevalence of particular types of special need, road accident risk, and the development of remedial measures.

Generally, little research was identified. There is some evidence to suggest that children with hearing or vision impairments are at increased risk of involvement in road accidents. One study, for example, found that vision-impaired children had over four times the risk of injury in pedestrian accidents as children with normal vision (Roberts and Norton, 1995). Children with Attention Deficit Hyperactivity Disorder (ADHD) have also been found to be over-represented among child casualties from pedestrian and cycling accidents. The risk of fatal pedestrian accidents among adults with learning difficulties appears to be two to three times greater than among the general population, although this finding is based on just one study.

Data on the prevalence of various disabilities among children and adults, their accident involvement and their exposure are largely unavailable. It is, therefore, difficult to quantify the extent to which disabled people are at risk of road accident involvement compared with their non-disabled peers.

Road safety education measures have been developed by a number of researchers and organisations. Most of these are designed for children and/or adults with learning difficulties. Studies have shown that roadside training is generally more effective than classroom tuition alone for this group. They have also been found to benefit from very structured lessons with clear expectations, short sentences and simple vocabulary. As with all methods of teaching, positive reinforcement is also very important. Those with learning difficulties can find it difficult to generalise messages to new contexts and this provides a challenge for any educational intervention aimed at this group. Training for people with learning difficulties can be very resource intensive.

Resources are also available for wheelchair users and people with sensory impairments. Although ADHD has been associated with increased accident risk, no road safety education resources are available for children with this condition. Where resources for disabled children and/or adults are available, they often have not been evaluated systematically and many are not well publicised or widely available.

Engineering measures to increase the road safety of people with disabilities are in widespread use. These include the use of dropped kerbs, tactile paving to provide essential safety information (e.g., the blister surface which

warns vision-impaired people of the presence of dropped kerbs), and audible signals at pedestrian crossings.

In summary, there are insufficient data to identify the policy priorities for disabled children and adults. Quantification of the relative risk of the different types of disability would be a major task as national databases of exposure (through walking and cycling) and road accident casualties do not routinely record disability (although the National Travel Survey does record 'travel difficulties' among respondents aged 16 years and over). Data on the prevalence of some disabilities are imprecise or unavailable.

While the evidence on accident risk is limited, it does, however seem reasonable to conclude that some disabled people are at increased risk. Road safety education among all children is well established and children with a disability should be able to benefit from these interventions. However, a recent study (Ardill, in press) has identified that provision of road safety education for disabled children and young adults is 'patchy'.

It is recommended that guidance on road safety education for people with disabilities be issued to the various stakeholders. This might necessitate some evaluation of existing training packages and collation of best practice from professionals, schools, colleges and carers. It is also recommended that local authorities be encouraged to consider appropriate engineering measures, particularly outside special schools.

1 Introduction

The Government's road safety strategy document 'Tomorrow's roads – safer for everyone' (2000) set casualty reduction targets to be achieved within ten years. The Road Safety Division (RSD) within the Department for Transport (DfT) has a responsibility to seek ways of reducing road accident casualties to meet these national targets. The target for child casualties has been set higher than that for other casualties due to the UK's relatively poor record on child pedestrian deaths compared with many other countries.

RSD also has a responsibility to improve the safety of high risk groups while recognising that the risk of these groups may not be reduced to the level of the general population. Further, the Special Educational Needs and Disability Act (2001) requires schools to take reasonable steps to ensure that disabled pupils are not placed at a substantial disadvantage, compared with other pupils, in relation to education and associated services.

The safety of people with disabilities (also known as 'special needs' or 'additional needs', DfES, 2002) should be considered from these viewpoints. It is recognised that to date little attention has been paid directly to understanding the risk associated with disabilities among school-aged children and adults, although various local authorities and care groups provide advice on road safety training for them.

The current review was undertaken as a systematic attempt to establish the size of the casualty problem associated with disabled people, and their risk relative to other children and adults. It also sought to discover what is known about suitable road safety education and engineering measures.

This report begins with information on the prevalence of disabilities in children and adults a review of the evidence for these disabilities impacting on their mobility and road safety.

Existing remedial measures are then evaluated and recommendations provided.

2 Method

Literature searches were undertaken using a number of publications databases including ITRD (an international transport research database), Medline (an American database of medical publications), Embase (a European database of medical publications), Psychinfo (a database of psychology and related social science publications), ERIC (a database of education publications) and Rosalind (a database of road safety education materials). The library catalogues of larger charities – British Institute for Learning Difficulties (BILD), Royal National Institute for Deaf People (RNID), Royal National Institute for the Blind (RNIB), Mencap, Guide Dogs for the Blind Association (GDBA), National Autistic Society (NAS)– were also searched, online where available, or by request to the librarians. The literature search included all items referring to disabled pedestrians and cyclists (but excluding the transport of disabled people which was

outside the scope of this project) and any articles concerning their characteristics and lifestyles. It was found, not unexpectedly, that few studies had been undertaken about the road safety of people with disabilities. Direct approaches were therefore made to a number of researchers to provide details of unpublished or ongoing studies.

Charities, local authorities, universities, authors and publishers were also contacted by telephone and/or email and asked to provide information on the mobility of disabled children and adults, casualty data, and any interventions aimed at improving their road safety.

Materials designed or adapted for teaching road safety education to disabled children were identified through a search of charities, local authorities and professional organisations (e.g., Access Officers' Association, Local Authority Road Safety Officers Association (LARSOA), National Association of Road Safety Officers – Special Needs Branch). Some materials contained lists of other resources which were obtained wherever possible. In some cases the resources, although they appeared on lists of materials suitable for disabled children, were out of print or otherwise unavailable. Where possible, detailed descriptions of these resources have been provided based on interviews with authors, publishers or users (generally Road Safety Officers).

Information on engineering measures designed to assist disabled people was obtained from the following local highway authorities:

- All English counties.
- A sample of authorities within densely populated areas in England:
 - the former metropolitan counties of Greater Manchester, West Midlands, West Yorkshire, Tyne and Wear, Merseyside.
 - Bristol.
 - Nottingham.
 - Stoke-on-Trent.
 - Bournemouth/Poole/Christchurch.
 - Portsmouth.
 - Southampton.
 - Medway Towns.
 - Milton Keynes.
- A sample of London Boroughs.
- Cardiff.
- Edinburgh.
- Glasgow.

Searches were made of web sites of all these local authorities, and half were contacted directly. Each highway authority is required by central government to produce a five-yearly Local Transport Plan (LTP); these were consulted and, where possible, 2000-01 LTP progress reports were examined. The Scottish Executive was also contacted.

An annotated bibliography of the Road Safety Education (RSE) resources and engineering measures identified as suitable for disabled children and/or adults is provided in Appendix A.

3 Background to the review

This section provides a general overview and background information to support the following chapters, which consider each of the main types of disability in turn, in terms of the estimated numbers of people affected, their characteristics and lifestyles, road safety risk factors and remedial measures.

3.1 Definition of disability

The term 'disability' can encompass a wide range of physical, sensory and cognitive impairments. The Disability Discrimination Act (1995) defines disability as 'a physical or mental impairment which has a substantial and long-term adverse effect on (a person's) ability to carry out normal day-to-day activities'. Special Educational Needs (SEN) are defined as having a 'learning difficulty which needs special teaching' (Department for Education and Skills, DfES, 2002). These 'learning difficulties' encompass physical and sensory impairments, slow learners and 'emotionally vulnerable' children. A definition of Statements of SEN is provided below.

3.2 Numbers of disabled people in Great Britain, their characteristics and lifestyles

Estimates of the prevalence of disability vary. A survey conducted in 1996-1997 found that approximately 8.6 million people, or 20% of the population of Great Britain, had disabilities (Grundy, Ahlburg, Ali, Breeze and Sloggett, 1997). Of these, 1.8 million (4% of the population of GB) were severely disabled. The prevalence of disability increases with age: almost half (48%) of the disabled population were aged 65 years or over.

Using a broader definition of disability, an Omnibus Survey by the Department of Social Services reported that approximately 11.7 million people, including 6.5 million people of working age, were covered by the provisions of the Disability Discrimination Act 1995 (Whitfield, 1997). Multiple disabilities were common, as illustrated by prevalence figures indicating that 2.5 million people reported sensory deficits, 3.9 million had learning difficulties, 6 million had mobility problems and 5.6 million had impaired physical co-ordination. Long-term illnesses such as Alzheimer's disease and mental illness were included in the estimated total number of people affected by disability.

The Labour Force Survey 1999 also found that 6.5 million people of working age had a long-term disability or health problem which substantially restricted their day-to-day activities or their work. This amounted to nearly a fifth of the working-age population of Great Britain (Labour Force Survey, 1999).

In the latest National Travel Survey, 15.7% of adult respondents (aged 16 years and over) reported that they had 'travel difficulties' (Transport Statistics, 2001). This variable was defined from answers to three questions: do you have difficulty (1) going out on foot, (2) using buses, and (3) getting in and out of a car? Of the 2709 people who reported having travel difficulties, 146 used a wheelchair.

Other studies have also shown that disabled adults face additional expense and difficulties with transport. For example, over a third of disabled adults who responded to the 1996-1997 survey reported excess transport costs, and over 40% of the most severely disabled people had not been out of their homes on any kind of excursion in the four weeks prior to the interview (Grundy *et al.*, 1997). A quarter of severely disabled people said they would go out more if there was more help or better facilities available.

It is difficult to establish with any accuracy the prevalence of disability among children. In 1989, surveys published by the Office of Population Censuses and Surveys (OPCS; now known as the Office of National Statistics (ONS)) estimated that there were around 360,000 disabled children (aged 0-15 years) living in Great Britain (Meltzer, Smyth and Robus, 1989). Since the OPCS surveys in the 1980s, there has been no systematic attempt to document the number of disabled children in this country. The best estimates available are prevalence figures (from charities, discussed below) and statistics on Statements of Special Educational Needs (SEN).

One in five school children in the UK has special education needs at some point in their school life (DfES, 2001). In most cases these difficulties are transitory. Where these difficulties cannot be resolved within the resources available to the child's school, a Statement of SEN may be issued.

If parents, teachers or other professionals believe that a Statement is needed, the Local Authority carries out an extremely detailed assessment of the child and his or her needs. The issuing of a Statement indicates that the Local Education Authority (LEA) believes that all the special help the child requires cannot be provided reasonably within the resources normally available to his or her school. It creates a legally binding obligation on the LEA to provide resources to the school to meet the needs and on the school governors to ensure the child receives all the special help set out in the Statement. According to the Education Act 1993, which superseded the 1981 Act, LEAs are bound to have regard to a SEN Code of Practice issued by the Secretary of State for Education. The latest Code, dated 2001, provides practical advice to LEAs and others on carrying out their statutory duties to identify, assess and provide for children's special educational needs (DfES, 2002).

The system of formal, written statements for children with special educational needs began in 1983 following the 1981 Education Act. In 1985, when the OPCS surveys were carried out, only 22 per cent of parents of disabled children had heard of the new system of formal, written statements of Special Educational Needs. Sixty-three per cent of the children in the surveys had not been assessed

by the education authority for any special needs (Meltzer *et al.*, 1989). In January 1986, Statistics of Education reported that 135,000 children had Statements of Special Educational Needs (Meltzer *et al.*, 1989).

In January 2001, the number of children with statements of Special Educational Needs in England was 258,000 or 3.1 per cent of all school children (no figures were available for Scotland, Wales or Northern Ireland; ONS, 2001). Of these, almost two-thirds (61 per cent) were educated in mainstream nurseries, primary or secondary schools, 36 per cent in special schools and three per cent at independent schools. In addition, an estimated 927,000 primary school pupils and 586,000 secondary school pupils have special education needs without statements (ONS, 2001).

The characteristics of 1200 children with disabilities living at home or in institutions were documented in two separate OPCS surveys in the mid- to late-1980s (Meltzer *et al.*, 1989). Although these data are now over ten years old, they remain the most comprehensive account of the lives of disabled children available today, and it is considered worth reiterating some of the findings here.

Multiple disabilities were common in the OPCS survey samples. Almost half (48%) of the children in private households had disabilities in two or more of the following areas: physical, mental, vision, hearing and communication, consciousness (e.g. epilepsy), continence or digestion. This figure was slightly lower (43%) among children living in institutions but it was notable that all of these children had mental impairment including problems with intellectual functioning, communication and/or behaviour.

Among children living at home, almost half (46 per cent) of those who attended school or a special nursery walked to school sometimes, and three per cent cycled to school. It is not clear how often these children walked or cycled to school, or whether it was their usual mode of transport, because parents were asked to indicate all the ways in which their children travelled to school. Levels of accompaniment are also not clear. Eight per cent went to school in a taxi, and 14 per cent in a mini-bus adapted for disabled children. Mobility was more restricted among children living in communal establishments (Meltzer *et al.*, 1989).

The number of disabled children reported as walking to school in the OPCS survey is surprising, considering the low levels of walking to school among children in general (Transport Statistics, 2001). Further, many children with disabilities are educated at special schools or at mainstream schools which have been provided with special resources and qualified staff. This means they often have longer journeys to school than their non-disabled peers (National Deaf Children's Society, 1989). Local Authorities provide transport by taxi or minibus for many of these long school journeys.

More recently, social researchers from the University of York surveyed 1,100 parents caring for severely disabled children (Beresford, 1995). Less than half of the children aged five years or over were independently mobile; that is, able to walk without support when outside the home. Parents reported that one of the most common unmet needs of their severely disabled children related to learning skills for future independence.

Details on the prevalence and impact of disabilities on mobility and road safety, according to type of impairment, are provided below.

4 Learning difficulties

4.1 Prevalence

A learning disability does not mean that a person cannot learn, but that they have greater difficulties than others the same age and so need additional support in learning (Mencap web site, 2001).

Estimates of the prevalence of learning difficulties vary widely. According to Mencap, a major charity working with learning disabled people, this is the most common disability in the UK. Based on an Omnibus Survey conducted for the Department of Social Services, Whitfield (1997) reported that 3.9 million adults in Great Britain had learning difficulties. The Disability Rights Commission stated in September 2001 that one million British residents had learning difficulties. In contrast, the Labour Force Study (1999) found that 146,000 adults named learning difficulties as their *main* disability.

Based on studies which have screened populations in Europe, North America and Australia, the Foundation for People with Learning Disabilities (FPLD) estimates that there are between 230,000 and 350,000 people in the UK who have severe learning disabilities, and 580,000 to 1.75m people with mild learning difficulties (FPLD web site, 2001). This amounts to between three and six people per thousand in the population.

No separate figures are available for the number of children affected by learning difficulties. As an indicator, in the UK each year about 600 babies are born with Down's syndrome, a genetic disorder associated with learning difficulties. This is a rate of one in every thousand births (Down's Syndrome Association web site, 2001).

Due to above-average mortality rates, learning disabilities are more common in younger than in older people. They are also more prevalent among males than females, possibly because of gender-linked genetic factors (FPLD web site, 2001).

About a quarter of those born with learning difficulties will have profound disabilities; for example, they may be unable to speak, and have serious physical problems as well (Morgan, 1997). Some conditions also involve sensory impairments. For example, more than half of children with Down's syndrome have significant hearing problems and an even greater proportion of these children have vision impairments (Down's Syndrome Association web site, 2001).

4.2 Impacts on mobility and safety

Learning disabilities affect people's lives in various ways. While some people need 24-hour care, others require support for daily tasks such as getting dressed and cooking. Many children with learning disabilities will grow up to live fairly independently, attend college or vocational training courses and eventually be employed.

Current health and social policies based on the idea of care in the community, rather than in institutions, create a need to provide appropriate road safety training for learning disabled people.

People with learning disabilities may have problems with memory, literacy, interpersonal skills and confidence (Beveridge *et al.*, 1997). It is difficult for them to understand how new information fits into a bigger picture (Mencap website, 2001). Everyday practical skills present greater challenges than for non-disabled people.

A recent study of mobility patterns and strategies used by children and young adults with learning disabilities in the Leeds and Bradford region of England found that very few of these children travelled independently to school (Sally Beveridge, personal communication, November 2001). Most did not attend school in their home catchment area and were escorted in taxis and mini-buses to special schools or, in one case, to a mainstream school with extra resources and staff. This meant that they had little opportunity to put their road safety training into practice on the school journey.

Escorted walks with 20 young people aged 16 to 25 years with moderate learning difficulties demonstrated a great deal of variation in their awareness of way-finding and personal safety (Sally Beveridge, personal communication, November 2001). Most had the required road safety knowledge – they could, for example, recognise road signs and knew how to use a pelican crossing. They did not, however, transfer this knowledge into appropriate road safety skills. While they were capable of being aware of hazards, they needed prompting and explicit teaching of safety and danger cues. The researchers suggested this was because these young people had little experience of taking responsibility for themselves. This view was confirmed when some participants' behaviour improved considerably from the first walk to the second escorted walk, because they now 'knew the rules of the game' (Sally Beveridge, personal communication, November 2001).

The impact of family support and the physical environment on the ability of young adults to overcome their disabilities was also highlighted in this research. Questionnaire data were collected from 444 young learning-disabled people (aged 16-25 years), their parents and their service providers (Beveridge *et al.*, 1997). Some participants in the research had skilled and imaginative support from parents and staff, but heavy traffic, lack of pedestrian crossings and other such hazards in their local environment restricted their opportunities to travel independently. Others lived within a safer, more secure, area where independent exploration would be possible, yet were limited by a lack of parental and staff support.

4.3 Accident risk

Evidence on risk relating to learning difficulties among children is limited. There was no difference in 'intelligence' between 34 children aged 5-14 years injured in road accidents and 34 controls (Backett and Johnston, 1959). More recently, learning difficulties were found to be more prevalent among road-accident-injured children

than controls (Christie, 1995). As the incidence of learning difficulties in both groups was extremely low, this finding can only be viewed as an indicator rather than a statistically significant difference.

In California, the rate of accidental death among developmentally disabled (i.e., learning disabled) people aged 15-59 years was compared with that for the whole population over a 15-year period, 1981-1995 (Strauss, Shavelle, Anderson and Baumeister, 1998). Accidental deaths were examined for all clients of the Californian Department of Developmental Services aged 15 to 59 years with good or fair mobility; this amounted to a total of 520 deaths. Standardised mortality rates for developmentally disabled people and the general population were constructed taking into account exposure, age and gender. People with learning disabilities had 2.8 times the risk of being killed in a pedestrian accident compared with the general population, and this was statistically significant. The risk was highest among those living semi-independently rather than in their parents' homes, small-group homes or institutions.

These studies and others relating to accident risk among disabled people are discussed more fully in Appendix B.

4.4 Remedial measures

4.4.1 Research findings

As people with learning disabilities vary widely in their personalities, backgrounds and type and extent of difficulties, road safety education programmes must cater to a range of needs and abilities. Teaching strategies which have proved successful with children who have learning difficulties include: providing very structured lessons with clear expectations; using short sentences and simple vocabulary; using self-correcting materials which provide immediate feedback without embarrassment; and providing plenty of positive reinforcement (National Information Centre for Children and Youth with Disabilities (US) web site, 2001).

Nine evaluation studies were identified in which the participants for the intervention were people with learning difficulties. Three of these focused specifically on children and these are described fully in Appendix C. The other six studies, which focused on adults, are reviewed below and described in Appendix D.

Horner and colleagues (1985) set out to teach their students to cross any street in their home town, a city with a population of approximately 120,000. Participants were a 12-year-old boy, a 16-year-old girl and a 53-year-old woman, all with profound learning disabilities. Training consisted of walking around a circular, set route with eight intersections (each crossed at least once on the outward and return journeys respectively), with the trainer escorting the student to each street and instructing them to 'cross when you are ready'. Verbal and physical prompts to stop, go, look etc., were provided where needed and correct responses were reinforced with praise and (in the case of one subject) coins. Assistance and feedback were gradually withdrawn over trials as the students' performance improved.

Performance was tested on 10 streets chosen to represent the full range of traffic conditions and intersection types participants were likely to encounter while travelling independently in their home town. Both of the trained participants (the boy and the older woman) improved from low baseline levels to correct crossing behaviour on 85% of the initial experimental trials, increases which were maintained and improved during subsequent experimental trials. (The girl's family moved away before her training was completed.)

This training method achieved good generalisation of skills across different situations. In choosing assessment sites, Horner and colleagues (1985) systematically sampled the range of traffic conditions and situations that their students were likely to encounter in their daily travels. Thus they were able to show that training produced functional, safe, behaviour in participants' usual environments. Only a limited range of skills was taught, however. While the two students demonstrated their ability to recognise signs and to step off the kerb at a safe moment, they were not taught to find safe routes or safe crossing places, which are also important skills for safe, independent travel. (These criticisms apply equally to the pedestrian training studies with adult participants, discussed briefly below.)

It is also of concern that neither of the trained participants achieved 100% correct crossings when tested at the end of the initial set of training sessions; both required ongoing instruction to reach this level. As the researchers acknowledged, *'It is of limited value to show that a student has improved to a 90-95% level of accuracy if the step he or she misses is 'initiates crossing when safe''* (Horner *et al.*, 1985, p. 72). This raises questions about when it is appropriate to terminate training and may mean that considerable resources are required over a long time period to bring students to an acceptable level of safety.

The issue of using resources most effectively was recently addressed by a British study which compared two methods of delivering road safety training to children with learning difficulties (Phillips and Todman, 1999). Two groups of 15 children, matched on age (10-16 years) and initial pedestrian safety assessment scores, were trained using the same road safety package, which consisted of roadside training supported by instructional videos and table-top games. Following six months of training, children taught by home-based carers performed significantly better than those taught by professional service-providers on both the road safety knowledge test and the skills test. The authors concluded that carer-led training had the potential to save considerable amounts of provider time and expense while achieving significantly greater gains in safety knowledge and behaviours. One reason for this finding may be that carers naturally have more contact with the children and so are better able to ensure that skills are constantly practised and reinforced, a point that has been emphasised by several writers (Bailey and Head, 1993; Ellis, 1991).

A recent development in this area of research has been the use of new technologies – namely, Virtual Environments – to teach road safety skills in a way that

may combine the advantages of roadside contexts with the greater safety and flexibility of a classroom format. In the United States, Rusch and Heal (unpublished) tested the effectiveness of self-instructional strategies with 81 children from elementary, middle and secondary schools. Participants included 41 children with a range of learning disabilities. Teaching and testing took place in a Cave Automated Virtual Environment (CAVE).

Users stood within the CAVE, surrounded by screens and wearing stereoscopic glasses, and 'moved' themselves through the virtual environment using a 'wand'. They were presented with three types of junction, each with three levels of traffic patterns: simple (no traffic), typical (one car passing through the junction) and complex (three cars). Students in the self-instructional condition were trained to recite four statements before attempting to cross the virtual road. These were: 1) *Walk* to the corner; 2) *Look* to your left, then to your right; 3) If no cars, then quickly *cross* the street; and 4) *I made it* (self-reinforcement). Regardless of academic ability level, students in this group outperformed the control group at the traffic light controlled junction in all three traffic conditions, and at the two-way stop sign junction under typical traffic conditions.

The authors concluded that the self-instructional strategy was 'modestly successful' in teaching students with and without learning difficulties to cross virtual junctions of varying difficulty and type. Plans to validate this training against real-world situations were not carried out, however, due to changes in equipment and software in the research unit operating the CAVE (Frank Rusch, personal communication, October 2001). It is therefore unclear whether training in a virtual environment would transfer to students' normal journeys, and whether the extent of generalisation differs between disabled and non-disabled children.

Similar studies have been conducted with learning-disabled adults, and have found that pedestrian training schemes work reasonably well with these groups. (A fuller description of these studies can be found in Appendix E.)

In one early American study (Page, Iwata and Neef, 1976), five adult male students with learning disabilities were taught to cross the road at various types of junctions and controlled pedestrian crossing points. They learned these skills by manipulating a doll on a scale model of city streets, following instructions from the experimenter. Each skill was broken down into components, including walking to a junction to cross the street, waiting for lights to change to the pedestrian phase or for a suitable gap in the traffic, looking both ways, and walking across without stopping. Before, during and after training, skills were tested both on the model and on a city street under normal traffic conditions. Between 14 and 29 training sessions, each lasting approximately 15 minutes, were required to bring all participants to a 'safe' standard for crossing the road. All skills were checked again – at least three times for each participant – during the two to six-week period following the end of training. These follow-up tests showed that gains in road crossing skills were maintained in the short-term.

Later researchers questioned the value of classroom-based training in road safety education for people with

learning difficulties, because they may be unable to grasp the connection between moving a doll around a model and moving themselves around in a real traffic environment (e.g. Matson, 1980). In a follow-up study, Matson (1980) compared the efficacy of model and roadside training. Participants were 30 adults with moderate to severe learning disabilities. They were randomly assigned to three groups: those in the classroom and independence training groups each received 30 minutes' training every day for three months, while the control group received no training.

Training in the classroom was conducted individually, using a scale model similar to that employed in the earlier study (Page *et al.*, 1976). Roadside training was carried out with groups of three students at a specially constructed mock junction, equipped with movable pedestrian signs and lights, within the grounds of the hospital unit where the participants lived. Students were asked to evaluate their own performances and also received feedback from the trainer and praise from the other students present at the training session. Pedestrian skills were assessed at a city junction before and after the training period.

Classroom training was significantly more effective than no training, while roadside training was significantly more effective than either no training or classroom training (Matson, 1980). The author suggested that the social reinforcement and self-evaluation aspects of the practical roadside training were important, along with the fact that the skills were learned in a more realistic context and so were more easily generalised to a genuine traffic environment.

These findings were echoed in a later experimental study involving 18 adults with profound learning disabilities who were taught either in the classroom with a scale model or at various junctions in the local area near their residential facility (Marchetti *et al.*, 1983). A checklist of 32 skills required at six types of controlled and uncontrolled pedestrian crossings was used as a basis for training and assessment. On all three post-test trials, at three different junctions, participants in the roadside training group performed significantly better than those trained in the classroom.

A roadside training approach also proved successful with three young adults who had severe, multiple disabilities including profound learning difficulties and problems in walking, social behaviours and speech (Vogelsburg and Rusch, 1979). The students were trained individually at a stop sign controlled crossroads near their school over a period of approximately 15 weeks. Working at the roadside, the instructor first told students to 'walk to the corner, stop, look behind you, in front of you, to your left and to your right; if there are no cars coming walk quickly across the street, step up on the kerb and stop' (Vogelsburg and Rusch, 1979). Feedback was also given (e.g., 'Good, you're looking for cars' or 'You didn't look for cars'). This verbal instruction and feedback was sufficient to teach all three students to approach the corner and to walk across the street. However, teaching students to look safely and to make a well-timed decision to step off the kerb required three further steps in training: the instructor modelled the behaviour and provided total and (later) partial physical prompts (i.e., guiding the student through the behaviour).

In each of the preceding studies, the dependent variable was defined as the number or percentage of road crossing task components performed successfully. This has limited practical value, as the desired outcome of training is that the student is able to cross the road at a safe time and place on *every* occasion (Horner *et al.*, 1985). Further, the format of the tests used to check whether training had generalised beyond the immediate training setting (i.e., the classroom, mock intersection or training site) used a limited number and type of non-trained junctions.

Nevertheless, results from the series of studies cited above indicate that roadside practical pedestrian training may be more suitable than classroom-based schemes for people with learning disabilities. This being said, one of the studies (Page *et al.*, 1976) found that skills learned while manipulating a doll around a scale model of a road environment generalised to real traffic conditions. This may have been partly because the participants in this study had mild to moderate learning difficulties. Later studies employing roadside teaching with more severely disabled students found a distinct advantage for this more practical method. This makes sense, when considered alongside the assertion that a tailored, route-learning approach is most appropriate for children and young people with severe, multiple disabilities (Bailey and Head, 1993).

Grossmark (1983) described a structured, tailored approach to training a young woman with learning disabilities to travel by bus between a hostel and a college. Correct behaviours were modelled by the trainer and verbal and physical prompts were provided; these were gradually faded as the student's performance improved. By the eleventh training session, the woman was able to make the entire return journey without assistance, and these gains were maintained at a follow-up trial a month later. The authors concluded that this structured approach, which incorporated constant observation (some of it unobtrusive) and assessment of the student's performance, enabled her to learn independent travel skills without jeopardising her safety. An additional benefit was also noted: the woman's poor social behaviour, which had been a major problem, improved noticeably during the course of the training.

The student's journey was divided into 17 stages including walking to and from the correct bus stop, paying the correct fare and getting off the bus at the right place. A similar task-analysis approach is common to many of the training schemes discussed above. However, as Horner and colleagues (1985) have pointed out, this approach is only functional if key components (e.g., recognising the correct bus, selecting a safe gap in traffic) are performed correctly every time. This emphasises the importance of learning and practising the entire sequence of skills in a meaningful context, as recommended by Bailey and Head (1993). Indeed, the students of one practical training programme improved their ability to make a safely timed decision to step off the kerb only after the trainers began modelling and rehearsing the whole behavioural sequence with them, rather than just the decision-making component (Vogelsburg and Rusch, 1979).

The available evidence indicates that roadside training is preferable to classroom-based training, particularly for

people with more severe disabilities. Some limitations of this approach should be noted, however. Roadside training in each of these studies required between 11 and 70 training sessions over periods of up to 20 weeks. In most cases, two trainers took part in each session, for safety reasons. This represents a substantial commitment of time and resources, especially when considered against the results achieved in fewer than 30 15-minute training sessions with a single trainer using a classroom model (Page *et al.*, 1976). Further, it is unclear whether such training equips trainees to cope with unexpected situations. Reversing vehicles, for example, and other unusual or unanticipated manoeuvres have been found to present particular problems for elderly pedestrians and people with learning difficulties may also find these a challenge.

In their review of independent travel training for developmentally disabled people, LaGrow and colleagues concluded that different types of practical roadside instruction may be suitable for different clients (LaGrow, Wiener and LaDuke, 1990). Training in a range of 'neutral' territories may be best when the goal is to provide the client with a broad range of travel skills that can be applied in almost all environments. For profoundly disabled people who have little potential for generalising skills it may, however, be more appropriate to select specific routes in the area where the client lives and travels regularly.

Research teams at two British universities have been involved in an attempt to use virtual reality technology to teach adults with learning disabilities to make a real journey safely (Lewis, Brown and Powell, 2000). Travel training software was developed at the Nottingham Trent University in collaboration with the charity Mencap and the University of East London. It was designed to teach a group of people with learning disabilities to travel on foot and by bus from Greenwich to the Millennium Dome, where they were working at a conference. The virtual environment of central Greenwich was custom built from maps, aerial and ground-level photographs and site visits. Among the important learning objectives identified during the consultation process was crossing roads safely.

Time constraints and the specialised design of the package meant that a full evaluation of the effectiveness and ease of use of the package was not feasible (Barbara Brooks, personal communication, November 2001). However some lessons can be learned from a project in which 24 young adults with learning disabilities learned food preparation and hazard awareness tasks required as part of the NVQ Level 1 Catering course using a 'virtual kitchen' (Rose, Brooks and Elliot-Square, undated). The students were able to use the virtual environment and found it very motivating. Virtual reality (VR) training produced similar improvements in task performance to practical training in the real kitchen and better performance than training with workbooks. Importantly, VR training generalised to real task performance, even when the virtual kitchen did not match the real kitchen in appearance and layout.

The research group at Nottingham Trent University is currently developing another training package aimed at helping people with learning disabilities achieve

independent travel to and from their places of work (Nicholas Shopland, personal communication, 23 October 2001). This project is known as TRAVERSE and is being carried out for the London Borough of Sutton. The simulator will present various scenarios in which users must cross virtual roads and use virtual public transport – skills which user groups have identified as being of most concern.

VR technology has also been developed for use in assessment and rehabilitation of people with brain injury (see Rose *et al.*, undated, for a review). Further testing is required to assess its effectiveness and relative cost as a training tool for people with and without disabilities. This is likely to depend on the format of the training provided, so the design of these programmes will need to be informed by research into effective special education methods in general, and road safety education in particular. It is particularly important for future investigations to consider the extent to which skills are transferred from virtual to real environments.

4.4.2 Road safety education materials

By far the majority of RSE materials for disabled people have been designed for those with learning difficulties. Resources collected during the review include a board game with flash cards (Ellender, 1997) and a video intended to prepare students for practical roadside training (Sturmer, 2000), along with several booklets (Essex County Council, 1997; Pountney, 1993; Taylor and Robinson, 1979) and training packs (Durham County Council, date unknown; Oxfordshire County Council, c1991; Phillips, 1995; Scottish Road Safety Campaign, date unknown; Thomas, 1988/1998). Safety Centres, such as 'Hazard Alley' at Milton Keynes, provide practical training in simulated environments for children and adults with learning difficulties.

Additional materials are currently under development. In Northamptonshire, a new Mobility and Orientation Training Course for adults with learning difficulties, wheelchair users and sensory impaired adults was developed and tested in the 12 months to August 2001 (Allen, 2000). This scheme focuses on individuals, aiming to provide hazard awareness and safety skills which will be useful whether the client is walking, cycling or using public transport. It was developed by the county council in partnership with charities, health and social care providers and a local sheltered workshop. The county is now offering training for course tutors.

In the London borough of Newham, Road Safety Officers are writing a Makaton guide to road safety, aimed at adults with learning difficulties. Makaton is a language programme for children and adults with learning difficulties or communication problems resulting from physical or sensory impairments. It uses a combination of simple pictures (symbols) and signs from British Sign Language. The road safety guide will cover topics such as roads and traffic, the footpath, safe places to cross the road, and emergency vehicles, incorporating Makaton symbols with text and pictures as well as notes for trainers (Darren Divall, personal communication, 25 February 2002). The content is at a basic level and so may also be suitable for children. It is expected to be piloted from April 2002.

Standard cycle proficiency training schemes have been adapted for children and adults with learning difficulties in several local authority areas. In Swindon, children with learning difficulties are assessed on their knowledge of the highway code via oral, rather than written, tests. If they do not meet the same standard as the other children in the practical sessions, due to poor co-ordination or understanding, they receive a Certificate of Achievement acknowledging the level they have reached. The borough council also offers training in cycling skills and road safety to adults with learning disabilities. *'We do not exclude anyone from the service and try and tailor programmes using current materials ... There needs to be discussion to determine aims, learning age and practical abilities, this is most important.'* (Margaret Tester, personal communication, 1 March 2002). In Gloucester council staff train carers and teachers so that they can provide 'in-house' cycling and road safety instruction to the depth and breadth suitable to individual clients' needs (Mary Roberts, personal communication, 4 March 2002). The Road Safety Officers attend assessments and also make guest presentations at special schools.

There are particular safety issues to consider when working with adults and children with learning difficulties. In West Sussex the Road Safety Unit is starting a programme of cycle training for Year 6 and 7 students with severe specific learning difficulties who are in mainstream education. The aim is for these children to take part in the same course as their classmates but with extra support, particularly prior to the course. *'This is a tricky area ... the combination of learning the sequences (check behind, signal, slow down, stop, prepare to move, etc), combined with the physical and co-ordination skills required to cycle under control and respond to traffic is very demanding for some ... the potential hazard should one of these children lose their self control whilst out on the highway with a group of others is a significant factor'* (Honor Byford, personal communication, 26 February 2002). The Road Safety Unit at West Sussex is therefore trying to anticipate such demands and pre-empt any incidents, while enabling the children to reach as high a standard as possible.

Road safety education materials aimed at children with learning difficulties should ideally comply with current good practice guidelines for RSE in general. In particular, materials should be age-appropriate, linked with the national curriculum, focused on the child's needs and should also facilitate connections between the child and the wider community (DETR, 1998). Training begins with an understanding of hazards and rules for safe play and the child is encouraged to develop safety strategies through practical activities in the classroom linked with national curriculum topics. There is emphasis on acquiring the practical skills needed to use the road network safely (DTLR, 2001).

Drawing on the research findings described above, RSE for people with learning difficulties should also take into account their special problems with understanding language and with generalising skills to new contexts. Messages should be kept simple, focused and coherent and

must be constantly reinforced by trainers, carers, teachers, indeed everyone who spends time with the person in the road environment. Several of the RSE packs and booklets currently in use meet these criteria well, while other materials (e.g., the video 'Stride ahead in safety', Sturmer, 2000) provide useful support for practical training.

4.4.3 Engineering measures

A number of authorities have installed, or are proposing to install, painted 'footprints' along designated safe routes to school. One highway authority said that, as well as helping children walking to school generally, footprints could help children with special educational needs (because they may find it more difficult to find the way). Authorities using this technique include Camden, Hammersmith & Fulham, Lambeth, Leicester, Midlothian (e.g., Newtongrange), North Lanarkshire, North Lincolnshire (e.g., Scunthorpe), North Yorkshire (e.g. Scarborough), Nottingham, Peterborough, Sandwell, Staffordshire (e.g., Lichfield), Stoke-on-Trent and Wolverhampton.

The provision of guard-rails outside schools can help guide learning disabled children to a crossing, or prevent those with no sense of danger from running into the road from the school exit.

5 Autism

5.1 Prevalence

Among the conditions associated with learning disabilities are the autistic spectrum disorders. Classical autism, also known as Kanner syndrome, affects an estimated 5200 children and 17,700 adults in the UK, and a further 21,000 children and 71,100 adults have other autistic spectrum disorders associated with learning disabilities (National Autistic Society, 2000). In addition, around 90,000 children and 310,000 adults are believed to have high-functioning autism or Asperger syndrome, in which intellectual ability is average or above average.

All autistic spectrum disorders are characterised by a triad of impairments in social interaction, communication and imagination. The National Autistic Society's web site states that *'autism is a lifelong developmental disability that affects the way a person communicates and relates to people around them. Children and adults with autism are unable to relate to others in a meaningful way. Their ability to develop friendships is impaired as is their capacity to understand other people's feelings. People with autism can often have accompanying learning disabilities but everyone with the condition shares a difficulty in making sense of the world'*.

Common features of autistic spectrum disorders include difficulties in understanding and using non-verbal and verbal communication, difficulties in interpreting social behaviour, and rigid patterns of thought and behaviour. In some cases, sensory perception differs from that of non-autistic people. They may interpret and respond to sights, sounds, and other sensory information in unexpected ways.

5.2 Impacts on mobility and safety

People with autistic spectrum disorders have particular difficulties with communication and adapting to new situations. They may take statements very literally, and remember details of instructions or stories without grasping the main points or the overall gist (Jones, Jordan and Morgan, 2001). Learning is tied to the context in which it occurred, so they need extra help and encouragement to generalise skills and adapt them to new situations.

5.3 Accident risk

No studies of accident risk among autistic children or adults were identified.

5.4 Remedial measures

No evaluations of road safety measures specific to autistic children or adults were identified. A summary of relevant research findings is provided below.

Despite some specific learning difficulties, described above, children with autistic spectrum disorders are able to concentrate on something of interest to them for long periods, giving it their sole attention (Jones *et al.*, 2001). While verbal instructions may not be absorbed and processed, information presented visually can be processed much more easily by these children. Books, stickers, posters and videos may therefore be particularly useful in road safety training.

Virtual reality technology has been used as a learning tool with autistic children and in developing social skills among adults who have Asperger syndrome (see Rose *et al.*, undated, for a review), although its use in road safety education with this population is as yet untested.

6 Attention Deficit Hyperactivity Disorder

6.1 Prevalence

Attention Deficit Hyperactivity Disorder (ADHD) is believed to affect three to five per cent of children (National Institute for Mental Health (US) web site, 2001). It is two to three times more prevalent among boys than girls. This condition has been known by many previous names, including Attention Deficit Disorder (ADD), hyperactivity, hyperkinesis and minimal brain dysfunction. Children with the disorder consistently display three types of characteristic behaviours: inattention, hyperactivity and impulsivity. These behaviours begin early in life, before the age of seven years, and create real handicaps in schooling, home life, and later in work and social settings. While ADHD is not a specific learning disability, it is often associated with learning difficulties, particularly in language and mathematical skills. Nearly half of children with ADHD also have severe behavioural problems (or, in psychiatric terms, 'oppositional defiant disorder').

6.2 Impacts on mobility and safety

A recent study found that children with clinically diagnosed ADHD are less able than other children to

respond to risks with suitable preventive strategies. Thirty boys aged between seven and 11 years, including 14 with and 16 without ADHD, watched a video filmed from the perspective of a child walking home from school, giving a running commentary on his thoughts and items he saw along the way (Farmer and Peterson, 1995). Five risky situations were presented during the journey, including crossing a road between parked cars and a cyclist failing to stop at a stop sign resulting in a near collision with a car. The two groups of children did not differ in their ability to recognise hazards, but did have quite different cognitive responses to the hazards. Compared with the control group, boys with ADHD were less concerned about the risks, expected less severe consequences and were less able to describe ways in which they could avoid injury, such as safety rules or alternative behaviours.

Other cognitive deficits in children with ADHD include a reduced ability to sustain attention, scan a visual field effectively and co-ordinate movements with sensory information (see Farmer and Peterson, 1995, for a review). They are also less able to generate solutions to complex problems. These difficulties in processing information, combined with behavioural problems such as over-activity, impulsiveness and defiance, may explain their increased risk of accidental injury both on the roads and in general.

ADHD is a long-term, pervasive disorder which can persist into adulthood (National Institute for Mental Health (US) web site, 2001). Nevertheless, no research specifically dealing with mobility and safety issues for adults with ADHD was identified by the review.

6.3 Accident risk

A high proportion of child pedestrian accidents in general are associated with impulsive actions or distractions (Sandels, 1995/1970; MVA, 1989). It may therefore be expected that children who have extra difficulty controlling their impulses and focusing attention will be at greater risk. This review identified six studies in which the road accident risk of children with ADHD was examined.

Researchers in Canada compared 286 children aged 5-15 years injured as pedestrians or cyclists with 562 children injured in accidents they considered were not due to the child's behaviour (e.g., passengers in vehicles, falls, sports). Computerised tests of vigilance and impulsivity revealed more objective symptoms of hyperactivity among the road-accident-injured children than controls (Pless, Taylor and Arsenault, 1995). Cases also scored higher than controls on parent- and teacher-reported (i.e., subjective) measures of hyperactivity.

In contrast, a study conducted in the United States comparing 128 children aged 5-12 years injured as pedestrians with 128 controls matched on age, sex, race, neighbourhood and parental education found no difference in scores on questionnaire measures of hyperactivity, inattention or overactivity (Christoffel *et al.*, 1996).

A review of charts from 70 US hospitals on 22,142 child patients aged 5-14 years found that children with ADHD were more likely than those without the condition to be injured as pedestrians or cyclists. They were also more likely to sustain injuries to multiple body regions, to

sustain head injuries and to be more severely injured overall (DiScala, Lescohier, Barthel and Li, 1998). The same research team earlier found that child cyclists with pre-existing mental disorders – mainly ADHD – were 2.4 times as likely as those without such a disorder to sustain head injuries in a bicycle crash, controlling for helmet use (Li, Baker, Fowler and DiScala, 1995). This finding was based on the records of 2,333 children (up to and including 14 years of age) admitted to 62 US trauma centres with injuries following cycling accidents.

A recent British study also found an increased risk of pedestrian or cycling accidents among children with high levels of impulsiveness and hyperactivity, as reported by carers and teachers (DETR, 1997). This study involved 1,027 children aged 7-15 years, 150 of whom had been involved in pedestrian or cycling accidents.

In Germany, researchers followed up 10 males who had been treated at a child and youth psychiatry clinic for symptoms of ADHD and asked them about road traffic accidents before and since gaining their driving licences (Beck, Warnke, Krüger and Barglik, 1996). The men with ADHD reported 13 cycling accidents and three moped accidents between them during their childhood and teens (an average of 1.6 accidents each), while the 10 age-matched controls reported an average of 0.3 accidents each (one cycling and two pedestrian accidents).

There is also evidence that children diagnosed with ADHD later have an increased risk of injury in motor vehicle accidents and various traffic violations in their first few years of driving (Woodward, Ferguson and Horwood, 2000). A 21-year longitudinal study of 1,265 children in New Zealand found a relationship between parent and teacher reports of attentional difficulties at age 13 and adverse driving outcomes at age 21 years. This study also found a strong dosage effect: the risk of accident injury increased significantly with higher levels of impairment. The German study discussed above also found that, compared with controls, men with ADHD had 1.75 times the risk of having a traffic accident and 2.4 times the risk of causing an accident while driving (Beck *et al.*, 1996).

These studies and others relating to accident risk among disabled people are discussed more fully in Appendix B.

6.4 Remedial measures

6.4.1 Research findings

No evaluations of road safety measures specific to children or adults with ADHD were identified. A summary of relevant research findings is provided below.

Children with ADHD will find it difficult to keep their minds focused on the road safety lesson and may become bored very quickly. Teachers and parents may well feel that roadside pedestrian training presents unacceptable risks for these children because of their excessive, incessant movement and sudden, inappropriate behaviours. Medication is often used to control this condition. Parents can help by talking out loud about the strategies they use to keep themselves safe on the road, by rehearsing safety behaviours with the child, and by discussing situations seen on television or in books to help the child identify

risky situations and generate ideas for protecting themselves (Packer, 2000).

Some researchers have suggested that behavioural role-playing might prove useful in teaching safety skills to children with ADHD (Farmer and Peterson, 1995). Training should aim to increase children's awareness of the negative consequences of risky behaviour and to reinforce safe behaviours positively. To maximise the benefits of such training, parents would need to be aware of the problem and to take part in any interventions.

6.4.2 Road safety education materials

No materials specifically designed for people with ADHD were identified, although some of those designed for people learning disabilities may be suitable for use with children or adults who also have emotional and behavioural problems. Road Safety Units at Swindon and West Sussex provide training for staff in dealing with children who have behavioural problems in order to make cycle training available to this at-risk group (Margaret Tester, personal communication, 25 February 2002; Honor Byford, personal communication, 26 February 2002).

6.4.3 Engineering measures

Physical safety measures, such as guard railings to stop children from running straight out of the school gate and onto the road, will be particularly important for this group.

7 Physical disabilities

7.1 Prevalence

There are widely varying estimates of the number of people with physical disabilities. The charity RoSPA estimates that there are between 0.5m and 0.75m wheelchair users in Great Britain (Pountney, 1999). The Labour Force Survey (1999) indicated that around 1.2 million people in the UK have major problems with their back or neck, and 726,000 have problems with their legs and/or feet. When all disabilities of locomotion are considered, more than six million people in Great Britain may be affected (Grundy *et al.*, 1997). Prevalence rates for various conditions which may lead to physical impairment are given below.

Physical impairments vary widely in their causes, extent and impacts on people's lives. Neurological conditions such as cerebral palsy and brain and spinal cord injuries can result in varying degrees of mobility impairment. Other causes of physical disability include neuromuscular conditions such as muscular dystrophy, joint diseases such as arthritis, and developmental impairments such as spina bifida.

Spina bifida is a defect in the formation of the spinal column in a developing baby. Approximately 120 babies are born in the UK each year with the condition (Association for Spina Bifida and Hydrocephalus web site, 2001). The bones fail to close around the spinal cord, causing loss of feeling and paralysis below the damaged region. People with the condition usually need mobility aids, such as wheelchairs, to help them get around.

Children are generally educated in mainstream schools. Improved medical management of this condition means that both life expectancy and quality of life are increasing for people with spina bifida.

Eight million people in the UK are affected by arthritis, including three million who experience significant disability due to this group of diseases (Arthritis Research Campaign web site, 2001). This includes one in every thousand children, amounting to more than 14,500 children in the UK (Arthritis Research Campaign web site, 2001). Arthritis-related diseases include osteoarthritis (the most common joint disorder), rheumatoid arthritis, soft-tissue rheumatism, lupus and gout. With some types of juvenile arthritis there is increased risk of eye disease which, if undetected, can lead to significant vision loss. The seriousness of juvenile arthritis ranges from systemic illness, which makes the child extremely unwell, to swelling and pain in one or more joints. Eventually, the disease usually goes into remission, but this may take many years. In the meantime, social activities and chances to get out and about independently are obviously just as important for these children as for their non-disabled peers (Arthritis Research Campaign web site, 2001).

About 30,000 children and adults in the UK suffer from muscular dystrophy or related conditions (no separate figures are available for children alone) (Muscular Dystrophy Campaign web site, 2001). Several dystrophy diseases affect children, the most common of which is Duchenne Muscular Dystrophy (DMD). Almost exclusive to boys, DMD is an inherited disease which causes progressive physical impairment due to the breakdown of muscle tissue. While DMD does result in a shortened life span, it is considered desirable to give children with the disease the same sorts of life experiences and expectations as other children (Muscular Dystrophy Campaign web site, 2001).

People with cerebral palsy or brain damage due to head injury may experience 'spasticity' or abnormal contraction of muscles controlling the joints (Moving Forward web site, 2001). People with spasticity have difficulty walking. The muscles in their legs may be tight and stiff, or may contract uncontrollably, causing pain. Movements may be slow and clumsy, lacking precision or grace. Independent mobility therefore presents special challenges for people with conditions leading to spasticity.

Cerebral palsy (CP) is a physical impairment due to injuries to the brain, either before birth or in early childhood. About one in 400 children are affected by cerebral palsy and this proportion is increasing (Scope web site, 2001). No separate figures are available for adults. Not all people with CP have problems with spasticity; some have poor postural control, balance problems, shaky or unwanted movements or difficulties with speech. In some cases the condition leads to moderate or severe learning difficulties. Depending on the site of the damage within the brain, CP may also be associated with impaired vision, hearing loss or epilepsy.

Multiple sclerosis affects the central nervous system. It is the most common neurological disorder affecting young adults, and there are an estimated 85,000 people with the condition living in the UK. Three-quarters of these

experience some spasticity, which affects their ability to move around smoothly and easily (Moving Forward, 2001).

7.2 Impacts on mobility and safety

People with physical disabilities may find it difficult or impossible to walk and some will use mobility aids such as calipers, crutches and/or wheelchairs.

The effects of physical disabilities on a person's ability to travel independently and safely will depend to a large extent on the nature of the impairment. There are obvious limitations associated with the use of crutches, calipers or wheelchairs. People who use these mobility aids may not be able to move as quickly as others and so may take longer to cross a road. Uneven surfaces, narrow and obstructed foot-ways, crossing points without dropped kerbs, streets lined with parked cars, and even other, faster-moving pedestrians (and cyclists on shared cycle tracks/foot-ways) present hazards. A person seated in a wheelchair may be lower than, for example, a standing adult, and therefore potentially less visible to motorists.

7.3 Accident risk

The evidence on accident risk is very limited. One study (Christoffel *et al.*, 1996) found that among children aged 5-8 years, those who were more developed physically were more likely to be involved in pedestrian accidents. This finding may be due to possibly greater exposure to the road environment among more active children.

In Sweden, 15 (3%) of 446 adults with cycling injuries claimed that dizziness, vertigo, fainting or 'some other physical disability' was an important cause of their accidents (Lind and Wollin, 1986). As this definition of physical disability is unusually broad and rather vague, it is impossible to relate it to the prevalence of such disability among the population at large.

These studies and others relating to accident risk among disabled children and adults are discussed more fully in Appendix B.

7.4 Remedial measures

7.4.1 Research findings

No evaluations of road safety materials for physically disabled children or adults were identified during this review. A brief description of related findings is below.

Virtual reality training has been used to encourage the development of spatial skills in physically disabled children and to assess and train users of electric wheelchairs (see Rose *et al.*, undated, for a review).

Children with physical disabilities may have less experience at making decisions and taking responsibility for themselves. They may in some cases / situations have a parent or carer pushing their wheelchair and so may not need to pay as much attention to traffic as able-bodied children (Owen McGhee, personal communication, August 2001). Therefore these children may need extra help and encouragement to develop these skills. For example, parents could provide a running commentary of their road crossing strategies.

7.4.2 Road safety education materials

Where mobility aids are required, these need to be used competently in order to negotiate roads safely. Road safety rules form part of all the wheelchair training schemes identified during the course of this review.

Five training resources for wheelchair users were identified. Two of these were aimed specifically at children, one at adults only, and the others at both adults and children. Two further schemes are under development.

The wheelchair proficiency scheme distributed by RoSPA (Wale, 1999) is intended as a starting point for the development of training and assessment schemes suitable for the specific needs and local circumstances of adult and child wheelchair users. As such, it does not provide detailed guidance on methods of teaching the road safety skills required at the Silver and Gold levels of the scheme. At the Silver level, users are expected to have a working knowledge of the Green Cross Code and relevant parts of the Highway Code and to understand that their chair could pose a danger to pedestrians. Advanced skills such as rear wheel balancing, mounting and dismounting from kerbs and going up and down hills are included at the Gold level, along with safety behaviours such as using pedestrian crossings, climbing into the wheelchair from the floor and using the wheelchair in a shopping area.

The Association of Wheelchair Children scheme is based on the RoSPA framework which has been adapted and extended to accommodate children's needs and incorporate additional skills. This is a practical course taught in a school playground or other safe outdoor location. Road safety issues particular to wheelchair users are addressed, including difficulties with kerbs and parked cars, dealing with pedestrians, crossing the road and recovering from trips and falls. An explicit aim of the training is to provide children with the skills to assess risks and deal with them confidently, with the goal of maximising each child's potential to be independently mobile (Owen McGhee, personal communication, August 2001). No tailored road safety materials are used.

Staffordshire County Council's wheelchair training programme is based closely on the RoSPA scheme. It consists mainly of practical training conducted by schools, with assessments carried out by the RSOs from Staffordshire County Council. There are three levels of awards: Bronze, Silver and Gold. At Bronze level, children are tested on an obstacle course within the school. At Silver and Gold levels, children travel to local shopping centres and perform a series of tasks (such as going into shops and asking prices of certain items, looking out for other pedestrians, using pedestrian crossings, etc) with the assessor trailing them at a distance.

The EPIOC (Electric Powered Indoor Outdoor Chairs) training manual developed at Leeds City Council also draws on the RoSPA framework. It too emphasises the need for road safety awareness, including a knowledge of the Highway Code, hazard recognition on roads and foot-ways, conspicuity and the particular vulnerability of people in wheelchairs when moving about in traffic. The manual provides detailed guidance on teaching each of the skills in the syllabus, including suggestions for road safety training.

Recommended methods include the use of videos and literature, discussions of road and foot-way safety, verbal rehearsal of safety strategies and using a scale model to demonstrate strategies and manoeuvres. It is assumed, however, that RSE materials designed for non-wheelchair-users will be equally appropriate for this group and no special resources are offered or recommended. Practical training involves selecting safe crossing points and learning to judge traffic speeds and use pedestrian crossings.

The Class 3 vehicle training programme was developed for the Mobility Unit, Department for Transport, and endorsed by RoSPA (Brady, 1995). It aims to provide practical skills and theoretical knowledge for users of motorised vehicles with a maximum speed of eight miles per hour. Such vehicles are only used by adults. Road safety awareness is raised in the theoretical part of the course (Part 2) and trainees are given the opportunity for supervised practice in both pedestrian and (quiet) road traffic situations.

RoSPA has acknowledged that its proficiency scheme – based on cycling and Class 3 wheelchair training schemes developed more than 20 years ago – is now out of date. It is taking an advisory role in a new national wheelchair training scheme for children currently being developed by Whizz-Kidz. This three-year project, funded by the Department of Health (under Section 64), began in July 2001 with a survey of wheelchair services to determine what training is currently provided (Sarah Jeffkins, personal communication, 12 December 2001). This survey highlighted problems with the existing RoSPA framework including the fact that it assumes a certain level of physical ability without which it is impossible for children to earn even the lowest level (Bronze) award. It is hoped that the new scheme will eventually receive RoSPA's endorsement.

Road safety education will be a key element of the proposed new scheme (Sarah Jeffkins, personal communication, 12 December 2001). Advisers to the research team include road safety researcher Professor J Thomson of Strathclyde University and former Road Safety Officer Linda Morrison-Allsop, now of RoSPA, plus therapists and representatives from educational charities and parents groups. The team is considering innovative ways of providing and supporting the road safety training including games and the use of model road environments. The six-week training syllabus was expected to be piloted from Easter 2002.

The new Mobility and Independence Training Course run by Northamptonshire County Council caters to adults with a range of disabilities, including those who use wheelchairs. The scheme is described in more detail in Section 4.4.2 and in Appendix A.

No schemes were found targeting physically disabled non-wheelchair-users.

7.4.3 Engineering measures

In the street environment, a number of measures have been in place for some time to assist physically disabled people. These include the widespread use of dropped kerbs and guidance on reducing other types of mobility handicaps (IHT, 1991). This guidance is currently being updated by

Cranfield University. The revised guidelines will cover issues such as:

- footway widths, gradients and materials;
- seating;
- positioning of street furniture;
- dropped kerbs;
- bus stop design;
- transport building infrastructure.

The new guidance will help highway authorities and others to prepare for their duties under Part V of the Disability Discrimination Act (1995).

The positioning of crossings, particularly light controlled with a pedestrian phase, help improve the safety of all disabled people. PUFFINs (Pedestrian User-Friendly Intelligent) crossings are particularly advantageous to physically disabled children and adults who may walk slower than others as they extend the crossing phase until the pedestrian has crossed the road. Equipped controlled crossings are mentioned in numerous Local Transport Plans (LTPs) as a way in which local authorities can enhance the safety of physically disabled pedestrians. Other provisions within LTPs include the use of dropped kerbs, handrails and ramps, guard rails and reducing foot-way obstructions. In Shropshire there are plans to improve provision for disabled cyclists who often use non-standard bicycles.

8 Hearing impairment

8.1 Prevalence

Based on figures from 1996, the Royal National Institute for Deaf People (RNID) estimates that a total of 8.6 million adults have hearing loss (RNID web site, 2000). Around 2.3 million adults or 6.6% of the population aged between 16 and 60 years have some degree of hearing impairment. Of these, 102,000 are severely or profoundly deaf. In addition, hearing loss affects 47% of people aged 61 to 80 years; over this age, the proportion rises to 93%.

There are between 23,000 and 25,000 children aged 0-15 in the UK who are permanently deaf or hard of hearing. Of these, about 8000 are profoundly or severely deaf. Around 16,000 were born deaf or became deaf in the first few years of life, amounting to a rate of 13 in every 10,000 children (RNID fact-sheet, 2001).

Hearing impairment is often accompanied by other disabilities. An estimated 23,000 people in the UK are deafblind (Sense web site, 2001). Figures for children alone are not available. It is estimated that 45% of severely or profoundly deaf people aged under 60 years have additional disabilities, usually physical.

In the UK, children's hearing is generally tested at about eight months and again at six years of age. Despite this, many children suffer intermittent and often undetected hearing loss, sometimes for long periods, due to a condition known as glue ear (otitis media with effusion). Glue ear is most common in children aged between two and five years, but can continue to the age of eight years. A recent study at Oxford University estimated that one in

five children in the UK have fluid in their ears – and, therefore, poor hearing - for more than half of the first five years of their lives (Pring, 2001).

Recurrent glue ear affects children's ability to communicate. Speech may be delayed, and these children may not develop good listening skills. Even after recovery, they tend to have poorer language and reading levels than their peers. If left untreated, the condition can occasionally lead to permanent hearing loss.

8.2 Impacts on mobility and safety

Listening obviously plays an important part in detecting approaching vehicles and in traditional means of teaching road safety (videos, talks by police officers, class discussions, practical pedestrian training).

Undetected hearing loss from conditions such as glue ear may place children at greater risk of injury in a road accident. They, and the adults responsible for them, may not recognise the need for extra vigilance when checking for approaching traffic. Glue ear may also cause a child to feel dizzy, which may affect their safety when cycling or while walking along narrow foot-ways.

Mothers interviewed by Gregory (1995) described the problems they faced in trying to teach their deaf children of 3-4 years old about danger on the road. It was difficult to get and keep the child's attention and to convey the concept of danger. Warning shouts were of no use, so parents felt they had to be extremely vigilant. One described an incident in which the mother and child were halfway across a road when the child saw a car in the distance and suddenly started to run back to the kerb. She didn't look and only her mother's restraining hand prevented her from being knocked down by a car passing behind them. Another mother commented that her daughter knew she had to look for cars, but she didn't do this every time: *'and therefore I have to be so very, very careful. She's very quick. She's over before you can get to her.'* (Gregory, 1995, p64).

Although training very young children who are profoundly deaf undoubtedly presents special challenges, it seems unlikely that the behaviours described above are unique to children with hearing impairments. There is evidence that even children with normal hearing have difficulty processing auditory information about vehicle distances and movements (e.g., Pfeffer and Barnecutt, 1996). Children under eight or nine years old tend to rely on limited, mainly visual, cues in deciding when to cross the road (Ampofo-Boateng and Thomson, 1989). Even when they are very diligent in looking for approaching vehicles, they may do so at the brow of a hill, on a bend or from between parked cars, where their view is restricted and their visual checks are therefore inadequate.

Because of the poorer visual search skills of children generally, it seems reasonable to hypothesise that hearing-impaired children would be less able than hearing-impaired adults to compensate for their lack of auditory information by careful checking before crossing the road.

8.3 Accident risk

This review did not find any studies relating to accident risk among hearing-impaired adults. Three studies were identified in which the accident risk of children with hearing impairments was compared with that of children with normal hearing.

In New Zealand, researchers conducted structured interviews with the parents of 190 children aged 0-15 years killed or injured as pedestrians and 479 controls randomly selected from the child population (Roberts and Norton, 1995). Children with hearing impairments had close to twice the risk of pedestrian injury of children with normal hearing. When the researchers removed from the analysis 30 cases in which sensory deficit was less likely to be a factor (as these children were struck by a vehicle while they were on a controlled pedestrian crossing), the risk of injury for hearing-impaired children increased to twice that of non-hearing-impaired children. Both odds ratios were marginally non-significant, however.

Christie (1995) observed a higher incidence of hearing impairment among the 152 road-accident-involved children in her sample than in the control group of 483 children. Nine of the children who had been injured as pedestrians had hearing problems, ranging from slight impairment (three children) to unilateral deafness (three children) and more severe deficits (two children). One child was described as suffering from glue ear periodically. In total, six per cent of the accident-involved children had hearing impairments, compared with less than one per cent of controls. As numbers were very small, no statistical tests were carried out.

Interviews with about 380 children who had been involved in pedestrian accidents in Scotland found that 14 (3.6%) had hearing difficulties (MVA, 1989). This proportion was significantly greater than the incidence of hearing impairment in the general population of school children (0.1%).

These studies and others relating to accident risk among disabled people are discussed more fully in Appendix B.

8.4 Remedial measures

8.4.1 Research findings

No evaluations of road safety measures specific to children or adults with hearing impairments were identified. A summary of relevant research findings pertaining to children is provided below (no related research was obtained for adults).

There is some evidence, albeit limited, that parents of children with permanent hearing loss attempt to compensate for their lack of auditory information by taking extra care to teach them to look carefully before stepping off the kerb (Gregory, 1995). Some parents of children with glue ear are given information by doctors and health visitors on the need to be careful on the roads and in other situations in which a lack of auditory information may place the child at greater risk of injury.

Teachers and parent volunteers guiding the children through pedestrian training on school grounds or at the roadside will need to make special efforts to ensure that

deaf and hard-of-hearing children understand instructions. The RNID (2000) advises that communication might be enhanced in the following ways: attracting the child's attention before speaking; bending down to the child's level; speaking clearly but not shouting or exaggerating mouth movements; and reducing background noise as much as possible. Specially trained teachers will obviously be aware of these requirements but it is important to consider the ways in which road safety training materials and methods may need to be tailored to meet the needs of children with hearing impairments.

8.4.2 Road safety education materials

Two resources specifically designed for children with hearing impairments were identified. Both were videos with subtitles (one also had signing) and were around ten years old or older. One of these, 'Look Out, Look Out for Oscar' (Ridler, 1990), used an eagle owl at a nature reserve in Staffordshire as a road safety mascot. Children from a local school for the deaf were filmed in the classroom discussing road safety and in the traffic environment demonstrating safety strategies. Key messages were presented in simple subtitles. The Northern Ireland Deaf Video Project in the early 1990s produced a two road safety videos, one aimed at deaf children and the other at deaf teenagers. Both use signing and subtitles throughout and include translations from signed to written language of key vocabulary.

Informal comments from Road Safety Officers and others interviewed during the review suggest that mainstream RSE materials are often considered suitable for training hearing impaired children. The extent to which mainstream materials are used and their effectiveness with hearing impaired children is, however, unclear.

Swindon Borough Council has sent Road Safety Officers on a sign-language course in order to improve services to children with hearing impairments in mainstream schools (Margaret Tester, personal communication, 1 March 2002).

Materials designed for people with learning and communication difficulties, employing Makaton or other systems of symbols and signing, may also be useful for children with hearing impairments. These include the Makaton guide to road safety currently under development (see Section 4.4.2 and Appendix B) and the set of videos and workbooks produced by Grangewood Video Productions (see Appendix B). This set comprises six videos with signing, addressing road safety topics such as the Green Cross Code, crossing where there is an island, using zebra and pelican crossings and subway/footbridge.

Mulberry House, a supportive housing project provided by the RNID for deaf and deafblind adults, offers training in road safety and use of public transport among other life skills programmes for clients (RNID web site, 2002). Residents are encouraged to take up hobbies outside the home, including sport and going to pubs and restaurants. Some attend courses at local colleges and adult education centres. It seems likely that similar life skills training is offered at such facilities throughout the UK.

8.4.3 Engineering measures

Pelican crossings provide visual cues – red and green man – which help hearing-impaired people to decide when to cross the road. However, it is important to avoid encouraging over-reliance on the green man alone. In this respect, PUFFIN crossings are particularly useful because the green/red man is positioned on the same side of the road as the pedestrian, thus encouraging them to look towards the oncoming traffic. Traditional green/red men signals are placed on the opposite side of the road. No other engineering work specifically designed to protect or enhance the mobility of people with hearing impairments was identified.

9 Vision impairment

9.1 Prevalence

There are an estimated 1.07 million vision-impaired people in the UK, of whom 24,200 are under 16 years of age (ONS, 1996). About eight per cent of blind and partially sighted people were born with vision impairments (RNIB fact-sheet, 2001). There are many different causes and degrees of vision impairment. Around 5% can see nothing at all, but many of those registered as blind can distinguish between light and dark. For some people, the visual field may be complete but very blurred. Others see only parts of the field, with blanks in other areas. Different types of vision loss have different implications for mobility and therefore for road safety.

An estimated six in ten vision-impaired people have multiple disabilities, and many have more than one additional disability (RNIB fact-sheet, 2001). No separate figures are available for the number of children with other disabilities in addition to their vision impairments.

The majority of vision-impaired children attend special schools, but around six per cent are educated in the mainstream, and this trend is increasing (Davis, 2001).

9.2 Impacts on mobility and safety

The road safety risk of vision-impaired people will be affected by the degree and type of vision loss. The person's ability to see vehicles and identify safe crossing points will be affected to some extent. Central vision loss affects visual acuity and so can make it more difficult for people to detect potential hazards in their path (RNIB fact-sheet, 2001). Conditions which reduce peripheral vision, such as retinitis pigmentosa (sometimes referred to as 'tunnel vision'), also create problems with navigating safely and require greater searching for obstacles when walking.

Several mobility aids are available to blind and partially sighted people. The most commonly used aid is a long white cane. About 170,000 people in the UK use a long cane and this technique requires specialist training from mobility or rehabilitation officers. These canes are swung from side to side to locate hazards and obstacles in the path of the user. Some have a rolling tip, which enables them to keep in constant contact with the ground. If the cane has a red stripe, this means the person also has hearing

difficulties. In addition, there are around 4000 working guide dogs trained by the Guide Dogs for the Blind Association (GDBA). Guide dogs are only available to those aged 16 years and over, and the person must be reasonably active, as the dogs need exercise. Short guide canes may be used by people with some residual vision to help orient themselves in the pedestrian environment.

A recent study by the GDBA, in which 500 vision-impaired people were interviewed, found that a quarter never left their homes alone. This figure rose to nearly one third of those aged over 65 years (GDBA, 2001). The vast majority – 88% - of those surveyed claimed never to have received mobility training. Of those who had been trained, 84% said it had improved their skills and independence. From these figures, it was estimated that at least 200,000 adults in the UK could benefit from outdoor mobility training.

Organisations which provide advocacy for the rights of blind people, such as the European Blind Union (EBU; RNIB web site, 2002) and Blind Citizens of Australia (BCA; BCA web site, 2002), have highlighted mobility and safety problems caused by poor lighting, poorly maintained footpaths and obstructions in the footway, such as advertising signs, parked vehicles and overhanging branches. In a 1995 policy statement on pedestrian safety, the BCA made recommendations for enhancing safety through better lighting, colour contrasts, tactile surfaces (see 9.4.3) and legislation to ensure that footways are not cluttered. The organisation pointed out that a person's ease of movement in the environment is often taken as an indication of competence, and that blind and vision-impaired people have the same desire (and right) to appear personally and professionally competent as do sighted people.

An experimental study in Canada demonstrated that motorists are actually more likely to stop at an uncontrolled crossing for a blind pedestrian than a sighted one (Harrell, 1994). Apparently, the cues of disability – the pedestrian's dark glasses and white cane – activated motorists' sense of social responsibility to help the disabled person cross. This type of behaviour at uncontrolled crossings may not always be advantageous to the vision-impaired pedestrian however, since a following car might proceed to over-take or a car on the opposite carriageway fail to detect the vision-impaired pedestrian or fail to stop and allow them to cross safely. Interestingly, motorists were no more likely to stop if there were two blind pedestrians waiting, suggesting that the effect was not just due to the greater conspicuity of the blind person with their cane and glasses. Most successful at stopping the traffic was a blind pedestrian with a sighted companion. The author argued that this combination reduced the potential 'costs' of stopping, in particular the risk to the blind pedestrian if motorists in other lanes failed to stop at the crossing. Even in this condition, however, one in five motorists who were first to arrive at the crossing where the pedestrians were waiting did not stop to allow them to cross. This illustrates why it is undesirable to encourage motorists to treat blind pedestrians differently from other road users. Not all motorists can be relied on to give priority to blind pedestrians all the time; therefore it is safer for vision-impaired people not to expect this treatment.

Many blind adult pedestrians are not confident that traffic will stop for them at crossings (Johnson and Petrie, 1998). In another recent survey, in-depth telephone interviews with 349 blind and vision-impaired adults revealed a great deal of concern about the safety of pedestrian crossings (Thomas, 1998). Three-quarters of the respondents felt it was essential that all crossings should be audible, and a further 21 per cent felt this was desirable. Cyclists on foot-ways, parked cars and other obstacles on the foot-way, access to information and assistance from public transport staff were also raised as relevant issues affecting blind and vision-impaired people travelling alone. Despite the difficulties, seven out of ten respondents had travelled independently in the previous two years.

The dangers to vision-impaired people in the road environment were also acknowledged in a series of interviews in New Zealand with four vision-impaired children aged between 6 and 16, their mothers, and six vision-impaired adults (Higgins, 1999). Nevertheless, participants insisted that orientation and mobility (O&M) training was an essential part of a child's education and should begin early. Indeed, one stated that *'failure to provide orientation and mobility instruction to children who are blind is disabling because movement and individual freedom are restricted'* (Higgins, 1999, p. 576). For these people, independent travel was a major achievement, providing a sense of pride, freedom and personal control. One woman described an early experience of independence: *'I was in charge and could go as fast as I wanted to go, and I knew that I could get home quite safely even though it was raining. So I felt really good that day. Quite a high really.'* (Higgins, 1999, p. 565).

Participants also suggested that professional O&M support should be available to parents. Such support would help parents allow and encourage their vision-impaired children to venture out on their own and put their skills into practice. They believed that young people and their parents should take responsibility for learning to be competent independent travellers. A person's 'capacity to be mobile' was the biggest challenge to be met if they wanted to be included in mainstream society (Higgins, 1999, p. 574).

Apart from its obvious benefits for future employment and social interaction, the ability to travel independently also has wider effects on a child's development, providing opportunities to experience and explore the world rather than rely on 'second-hand' accounts. This experience feeds into their development and learning including language, literacy and understanding of concepts (GDBA, 2001). The opportunity to assess and understand risks, solve real-life problems and take some responsibility for one's own welfare enhances personal development and raises self esteem.

The RNIB's report on its 1988 survey of blind and partially sighted children noted that mobility skills were the only part of the 'extended curriculum' of daily living skills that were widely recognised and included in education timetables (Lane, 1993). Even so, only 26% of children in the survey had received formal orientation and mobility instruction. These were generally the children with the lowest residual vision. Half the parents of the other children did not favour training, perhaps because

they did not understand the advantages for children with more residual vision (Lane, 1993).

9.3 Accident risk

One study examined the relative risk of pedestrian accident involvement among children with impaired vision. Roberts and Norton (1995; who also examined risk relating to hearing impairment, see Section 8.3 above) found that vision-impaired children had four times the risk of accident injury as children with normal vision. This increased to five times the risk, when the 30 cases injured while on a controlled pedestrian crossing were removed (see Section 8.3 above). Both probability ratios were statistically significant.

Related evidence comes from a study of vision-impaired adults who were interviewed about any accidents they had ever had while travelling or walking (Gallon, Fowkes and Edwards, 1995). Accidents while crossing the road were reported by 89 (29 per cent) of the 302 respondents. There were 36 accidents resulting in injury, of which 17 had occurred during the previous five years. When compared with pedestrian injury rates in the general population over the same five-year period, people in the vision-impaired sample had a significantly higher risk. Interestingly, a quarter of the road crossing injury accidents reported by vision-impaired people in this sample happened on controlled crossings – a much greater proportion than the national average of nine per cent (Gallon *et al.*, 1995). This could suggest that the vision-impaired adults interviewed in the studies discussed above were right to be concerned about their safety on pedestrian crossings. However, it should also be noted that vision-impaired people are much more likely than others to choose to cross at a designated road-crossing if available.

These studies and others relating to accident risk among disabled people are discussed more fully in Appendix B.

Preparing clients to manage risks associated with travel is a fundamental responsibility of orientation and mobility instructors (Banja, 1994). Training itself creates risks, both during the period of instruction (e.g., during the first solo journey) and afterwards when the client puts his or her new skills into practice. It has been argued that clients have a right to have such risks explained to them, even though this may deter them from undertaking training (Banja, 1994). In order to assess the risks to individual clients, instructors need information about the accidents and injuries clients suffer during and after training, characteristics of the client and the environment that affect risk and the risks imposed on others (including motorists) by the presence of a vision-impaired pedestrian. Banja (1994, p408) warned, *'unless O&M professionals are sufficiently aware of the nature, severity and probability of risks associated with their clients' behaviors, they are severely handicapped in defending themselves against accusations of negligence or unprofessional conduct should their clients experience harm'*.

9.4 Remedial measures

9.4.1 Research findings

To cater for children with vision loss, written materials used in road safety education, and other aids such as maps, may need to be presented in alternative ways such as large print, audio cassette, electronic disk, or Braille/tactile formats. In mainstream classrooms, such children will need extra time to assimilate information and may need to rest their eyes regularly (Davis, 2001).

Recent research at 17 schools in the North-West of England showed that vision-impaired children in mainstream classrooms performed best when certain practices were followed. These included: using non-visual as well as visual means of presenting information; using suitably adapted teaching materials, not just for the vision-impaired child but for the whole class; positioning the child so that he or she can interact more easily with classmates; and involving the learning support assistant in a variety of ways, including working with other children as well as the target child (Davis, 2001).

The literature search located only one experimental evaluation study concerning the teaching of road safety skills to vision-impaired children. Four vision-impaired children aged 7 to 11 years were trained to navigate a doll around a wooden model designed to represent the environment directly around their school (Budd and LaGrow, 2000). The knowledge gained through this classroom-based training generalised to the real environment, as measured by the children's ability to answer questions and perform tasks, such as finding routes, in the region of the school.

Training took place in three discrete stages, progressing from the concrete to more abstract ideas. It involved allowing the four children to touch and manipulate the components of the model, assemble and reassemble them, and move dolls and toy cars through the model environment. Concepts such as roads, foot-ways, kerbs, pedestrians, driveways and some traffic signs and signals were introduced in the first stage. The children used the corresponding pieces of the model to make basic road and foot-way layouts. The second stage covered traffic lanes, one- and two-way traffic, pedestrian crossings, junctions, rights of way and parking. Children again made road layouts and then moved dolls and cars around these to demonstrate the concepts they had learned. The third stage introduced students to directions, landmarks and reference points, destinations and route planning and was followed by the navigation task, using a doll to represent the child in the immediate vicinity of the school. Two to four training sessions were required for each stage of the training before each child was able to demonstrate understanding of the key concepts during the roadside tests.

The authors discussed the advantages of using a model to teach vision-impaired children about the road environment. Those children with little or no vision were able to explore road layouts and demonstrate traffic flows and routes by touch while those with some residual vision could also explore visually the model more easily and efficiently than they could a larger-scale environment. The model was interactive and could be used in play activities

which would consolidate the concepts learned during training. It could be adapted to suit local environments, was convenient and enabled children to explore the road environment safely before venturing into real traffic situations (Budd and LaGrow, 2000).

A single case research design was used in this study, which means that results cannot be generalised to populations beyond the four children involved. The extent of the children's previous experience of the road environment and road safety training was unclear. Only one used a long cane for travel, which suggests that three had a reasonable level of residual vision. Before training began the children were assessed for prerequisite skills such as knowledge of body, spatial and positional concepts and understanding of shape, direction and laterality. Any gaps in knowledge were rectified through individual instruction. Further research is needed to test whether the model is an effective teaching method for children with similar and worse levels of vision, intellectual ability and pre-existing skills in mobility and orientation. It would also be useful to compare its effectiveness in this group with other groups, such as children with multiple disabilities including vision impairments.

An understanding of the road environment is a key element in road safety training for vision-impaired children. Tactile maps and diagrams are often used to teach spatial awareness and route finding (Ewan Simpson, GDBA, personal communication, September 2000). Three-dimensional models offer certain advantages over two-dimensional maps. First, children have difficulty in reading maps. Asked to describe familiar routes through their schools from memory and, later, using a conventional or tactile map, sighted and vision-impaired children all had greater difficulty and provided less accurate route information in the map condition (Edwards, Ungar and Blades, 1998). More importantly from the perspective of road safety education, models can be used to illustrate basic concepts such as the idea that there are spaces reserved for different types of traffic (footways, cycle and bus lanes, lanes for vehicles travelling at different speeds or turning in different directions), that traffic volumes and speeds vary, and that some crossing places are safer than others.

Late-blinded people – that is, those who have had some experience of receiving and interpreting visual information – perform better than early-blinded people on tasks requiring the storage and processing of spatial information (Guth *et al.*, 1989; Herman *et al.*, 1983). There is evidence that vision-impaired adult pedestrians are less able than sighted pedestrians to draw on accurate, detailed memories of spatial environments when navigating (Hollyfield and Foulke, 1983). In another study, blind adult pedestrians who noticed multiple cues to their location were less likely to fail to detect a street and to step unintentionally off the footpath into the roadway than those who relied on less detailed spatial information (Bentzen and Barlow, 1995). It is unclear whether results from these studies conducted with adults can be generalised to vision-impaired children. To the extent that this is possible, the results suggest that safety for vision-impaired children and adults may be enhanced if they can be trained to encode richer, more

detailed memories of road environments, and that their ability to achieve this may be affected by the timing of their vision loss. Further, *'blind pedestrians who are learning to travel independently should be given enough practice to establish firmly the habit of remembering to remember space'* (Hollyfield and Foulke, 1983, p209).

Spatial awareness is only one of the skills that people with vision impairments must develop in order to travel safely and independently. Orientation and mobility trainers help students learn to use their residual vision to best advantage when navigating outdoors. Clients with little or no vision may be taught to use the long cane to check the footpath ahead for obstacles and distinct changes in level. Other techniques include using traffic sounds to align oneself correctly for road crossing and to judge gaps in traffic (Sauerburger, 1999).

With repeated opportunities to walk in a real traffic environment, vision-impaired adults learned to make judgements about the position and alignment of their bodies with respect to the roads they were about to cross (Guth *et al.*, 1989). Experienced travellers were able to use all the available information from passing traffic. The ability to use even 'glimpses' of the paths of passing vehicles to position oneself in space is an advantage when traffic is heavy and traffic sounds are therefore confused (Guth *et al.*, 1989).

Guided experience is also the key to a technique developed by Sauerburger (1995, 1999) for helping vision-impaired people judge whether gaps in traffic are sufficient for them to cross safely. This technique acknowledges that on some roads it is impossible to see or hear traffic well enough to be able to cross safely, given that vehicles are becoming ever quieter and roads wider. Student and trainer conduct exercises in a variety of roadside locations, with the trainer providing feedback on the accuracy of the student's judgements.

The studies discussed above (Guth *et al.*, 1989; Sauerburger, 1999) highlight the benefits of repeated and carefully supervised opportunities to experience real traffic conditions. Taken together with the experimental study reviewed earlier (Budd and LaGrow, 2000), the limited available evidence suggests that an effective road safety education programme for vision-impaired children and adults should incorporate both classroom elements and roadside training.

Other factors which may be important, but were not tested in the studies reviewed above, are the person's age, other disabilities, and the support available from professionals, family/carers and others. These are discussed below.

Ellis (1991) has pointed out that, unlike adults, children cannot be expected to learn all the relevant mobility and orientation techniques at one point in their development. Instead, training should be tailored to their levels of maturity, abilities and needs, and should be part of an ongoing process of assessment, teaching, monitoring and evaluation. Describing a mobility programme designed for vision-impaired children at a special school in the west of England, this author emphasised the need to ensure that children did not just learn specific routes but instead

developed a set of skills which could be applied as needed in all travel situations. To realise these aims, individual training sessions began in the school grounds and immediate locality and later moved on to less familiar areas.

In contrast, Bailey and Head (1993) advocated an individually tailored training programme focused on one or two specific routes that the child was likely to use regularly. The O&M trainer would begin by identifying elements of the task which the child was performing poorly or unsafely, and these would become the target of intensive training. For example, having noted that a child was unable to cross the road safely, the instructor would break this task down into steps and devise strategies and prompts to help the child learn. According to the authors, this method was particularly appropriate for children with vision impairments in addition to other severe disabilities, as this group has difficulty in generalising skills from one context to another.

These contrasting opinions emphasise the importance of taking differences in the type and extent of disability into account when designing a training programme. While providing a set of mobility skills or 'tools' may be essential for people with vision impairments alone, those with moderate or profound learning difficulties in addition to their poor vision may never be able to integrate such skills with other behaviours and apply them in their daily lives. Ellis (1991) in fact acknowledged these differences when he described how training was adapted for students with learning disabilities. These children, he believed, may never be fully independent travellers and so the mobility syllabus was *'largely irrelevant to their needs'* (Ellis, 1991, p8). In this respect, Bailey and Head (1993) took a more optimistic and ambitious view: that children with multiple, severe disabilities including visual impairments could learn to be safely, if not independently, mobile at least on a few, regular journeys. Ellis (1991) also mentioned that children at the school who had physical as well as visual impairments received modified, structured mobility training but no details were given.

It is notable that both approaches provide opportunities to learn safe mobility skills in a functional sequence and in the context of the real road environment under normal traffic conditions. Another key element of both approaches is an attempt to ensure that students are constantly supported by carers and professionals. At the special school, mobility staff communicated with other teachers, parents and mobility specialists within each child's home area to ensure that the skills learned in training sessions were constantly implemented, monitored and reinforced. In the individual training model, the child was able to practise the skills every time he or she made that journey with carers or trainers. The child and his or her parents were motivated to practise, because the skills formed part of a meaningful set of behaviours. Finally, these writers all took the view that such training provides valuable opportunities to interact socially, participate in the local community and gain skills that are worthwhile, even if the child never attains completely independent mobility.

In summary, the literature suggests that the following needs to be considered when developing road safety education for people with vision impairments:

- Road safety education methods and materials developed or tailored for vision-impaired people will need to take into account the extent, nature and timing of the vision loss. These variations affect the sensory information available to the person, the teaching methods most appropriate for the person, and the ways in which he or she encodes and processes spatial information.
- Studies with vision-impaired adults have highlighted the benefits of repeated and carefully supervised opportunities to experience real traffic conditions. It is unknown, however, whether these findings generalise to children with vision impairments as little research has been conducted specifically with this group.
- Roadside training provides opportunities to learn skills in context, in a functional sequence, and to interact with the community. The emphasis of training may vary – from a set of general road safety strategies to the particular skills required on a specific route - according to whether the trainee has learning difficulties in addition to his or her vision impairment.

9.4.2 Road safety education materials

Awareness of road safety is one of the issues covered in client assessments by the RNIB's Mobility Assessment and Training Service (RNIB web site, 2001). Other issues include use of residual vision in mobility, spatial and environmental awareness and the use of sensory clues and independent travel skills. Children are assessed individually to identify current skills and recommend appropriate mobility aids and training. Blind children will need to learn the long-cane technique, while children with some residual vision will benefit from learning to use their vision to best advantage in developing orientation skills.

Road crossing techniques are a major aspect of orientation and mobility training. According to a lecturer who trains future orientation and mobility instructors at the GDBA School of Vision and Rehabilitation Studies in Surrey, road crossing relies heavily on developing hearing skills and use of residual vision (Andrew Dodgson, GDBA, personal communication, 11 March 2002). Once basic cane techniques have been mastered and the client can detect the dropped kerb edge, skills in listening and judging traffic distances, directions and speeds are developed through extensive practice at the roadside. Road crossing is generally taught first at very quiet locations, progressing to locations with occasional traffic and eventually to busy traffic. The length of training varies between clients, and achievement depends to some extent on the client's motivation and needs as well as their pre-existing ability.

For children, training generally begins with cane techniques and specific routes to school and around the home environment. Road crossing is taught in much the same way as for adults. Children who have been blind since birth may have had less opportunity to develop an understanding of roads and traffic, and may therefore be less

aware of hazards. 'Hands-on' activities, such as exploring the interior and exterior of vehicles, and use of model cars and tactile maps, may be used to explain some concepts. Where such tactile referencing is used, however, it is important to help the child make explicit links between the model or map and the corresponding items in the real world.

One resource aimed at vision-impaired children was identified. This was a booklet setting out a curriculum for mobility training in schools (Essex County Council, 1997). The skills to be taught at each age level, from pre-schoolers to infants, juniors and secondary school students, are listed in the booklet but no details of suggested training methods is provided. Traffic awareness is introduced at the infant level and the Green Cross Code at the junior level. Secondary school pupils are trained to use pedestrian crossings, learn traffic light sequences, practice road crossing at various types of junctions and are introduced to route planning.

A project currently under way at the University of Birmingham is examining the mobility needs of vision-impaired children. The project aims to establish key mobility and independence skills required by children and young people with vision impairments, identify ways in which these skills can be delivered within and beyond the school curriculum, as well as examining issues around the training and funding of mobility specialists. The report will describe how mobility services are delivered in the UK but it will not address specific teaching strategies (Sue Pavey, personal communication, December 2001). This one-year project, funded by the Department for Education and Skills, GDBA, RNIB and OPSIS (the National Association for the Education, Training and Support of Blind and Partially Sighted People), was due for completion at the end of 2001 with the final report to be released in spring 2002.

Cycling may be a feasible means of transportation for some people with low vision, providing they have adequate residual vision and good auditory perception. According to a rehabilitation counsellor who also had 20 years' experience as a low-vision cyclist, proficient low-vision adult travellers who have good mental mapping skills can be successful at navigating and safely negotiating their way through the road environment on a bicycle (Connor, 1992). People with central vision losses tend to have fewer problems than those whose peripheral vision is impaired. Poor peripheral vision, for example, due to glaucoma or retinitis pigmentosa, can create difficulties in detecting hazards and maintaining a straight line of travel. Cycling may be less feasible for adults who have less sight or who are congenitally blind than for those who lost their sight later in life, due to poorer spatial memory skills.

Connor (1992) describes some of the problems low-vision adult cyclists may encounter, including child pedestrians and child cyclists, vehicles entering the road from driveways, sudden changes in street surfaces due to water, utility covers and pot holes, and parked vehicles with protruding ladders or timber that may not be detected. He makes a number of suggestions for assessing one's capability for low vision cycling and for maximising safety while travelling. He is less confident that children with low

vision can become safe cyclists. Such children may have problems with balance and understanding of traffic concepts and road rules. Connor (1992) recommends that serious investigation by parents and professionals is needed in order to assess a child's potential for safe cycling.

9.4.3 Engineering measures

As discussed above (Section 7.4.3), road safety engineering measures are provided by Local Authorities for people with disabilities generally, but not for disabled children specifically. However, consideration is often given by local authorities to the provision of road crossings and tactile paving in the vicinity of schools for vision-impaired children.

The Disabled Persons Act (1981) requires highway authorities to '*have regard to the needs of disabled persons when considering the desirability of providing ramps at appropriate places between carriageways and foot-ways*'. However, vision-impaired pedestrians rely on the kerb up-stand as a cue to tell them they are about to step into the carriageway. For this reason, the blister tactile paving surface is recommended for use at dropped kerbs or when traffic calming measures raise the level of the carriageway to the height of the foot-way (Department of the Environment, Transport and the Regions, 1998). Other tactile paving surfaces relevant to this study include:

- The corduroy hazard warning surface (most often used at the top and bottom of steps).
- Platform edge (on-street) warning surface (used to denote the platform edge of LRT systems).
- Segregated shared cycle track/foot-way surface and central delineator strip (used to let vision-impaired people know they are entering/leaving this facility and helps them keep to the pedestrian half).
- Guidance path (used to help people negotiate areas where traditional cues such as a property line or kerb edge are not available).

The blister surface is widely used by local authorities. Other means to help vision-impaired people negotiate the roads safely include the use of audible and tactile signals at pedestrian crossings that identify the pedestrian phase, rotating cones (a tactile feature beneath the push button supplementing the audible 'cross' signal), and contrasting foot-way surfacing. PUFFIN crossings will also assist vision-impaired pedestrians as they extend the pedestrian phase until the person is across the road and the green/red man is positioned nearer to the person and therefore may be visible by some. These engineering measures are likely to assist in the safe, independent mobility of both children and adults.

In a number of countries a locating sound is used to help guide vision impaired people to the pedestrian control box at light controlled crossings. TRL Limited was contracted by the DfT to investigate the possibility of using such a sound in the UK, but was unable to find a sound that was easy to locate whilst not presenting an annoyance to others. The DfT has therefore decided not to pursue the use of locating sounds for the moment.

Some installations designed to improve the appearance of the street environment or to slow traffic or deter entry to a calmed area can actually create difficulties for vision-impaired people. For example, the use of coloured paving can make it difficult for people to accurately locate the start of a carriageway, or may present the illusion of an obstacle in their path (Duncan-Jones, 2001). Entry points into traffic calmed areas or home zones may have all the elements of an assisted road crossing yet not be intended for use in this way. Street corners with the kerb flush with the carriageway on the radius can also be hazardous, as people may find it difficult to line themselves up accurately with the opposite foot-way.

Such difficulties can be overcome if highway engineers are encouraged to develop a greater appreciation of the needs of vision-impaired people (Duncan-Jones, 2001). Where guidance is available (e.g. DETR 1998), it is especially important that it is applied consistently, putting across the same messages.

Acknowledging the dangers to vision-impaired people, several local authorities have incorporated measures in their Local Transport Plans (LTPs) to reduce foot-way obstructions and clutter. For example, Cheshire's LTP emphasises 'appropriate design of street furniture', Hampshire intends providing visibility bands on such installations and Hertfordshire's plan involves minimising street furniture on pedestrian routes. Other measures proposed by local authorities include adopting design standards for foot-ways which incorporate 'unobstructed widths' (Suffolk), providing rigid barriers with tapping rails to protect pedestrians from excavations and road works¹ (Hampshire) and stricter policing of bylaws to prevent parking of vehicles on foot-ways (Hertfordshire).

10 Dual sensory impairment

Perhaps the greatest road safety training challenges arise with deafblind people. While in the past such people would have spent most of their lives in institutions, the current emphasis on 'care in the community' means that safety has become a more relevant issue. Charities such as Sense (the National Deafblind and Rubella Association) and Deafblind UK provide activities and support services aimed at enabling deafblind people to become genuinely involved in their communities. For example, residents of Sense facilities in Scotland take part in outdoor sports and leisure, travel on public transport and use local shops and cafes. These activities are structured, but clients are then given the choice of going out in their own time. Some more able trainees at a Sense project in the west of England spend four days a week in a sheltered workshop setting, followed by a day with a mainstream employer.

Deafblindness, or dual sensory impairment, creates problems in communication, mobility and gaining access

¹ Under Section 65 of the New Roads and Streetworks Act 1991, undertakers are required to ensure that streetworks are properly signed and guarded, having particular regard to the needs of disabled people.

to information (Deafblind UK web site, 2001). People lacking either clear hearing or sight face extreme difficulties and danger in finding their way and crossing roads. In addition, deafblindness may be associated with poor balance.

Literature from the charities suggests a current move towards ‘lifestyle planning’, a more individualised approach to helping deafblind clients choose ways of living and relating to the community that meet individual needs and preferences (Todd, 2000). Teaching life skills – including road safety – to deafblind people relies on utilising unconventional means of communication. Considerable sensitivity and ingenuity is required by staff working with these clients. It may be very difficult to know whether a person understands something, or even whether he or she enjoys or dislikes a particular experience. One tutor acknowledged that, ‘*staff may have little to work on beyond their client’s subtle use of body language*’ (Todd, 2000).

The reviewers were unable to identify any research on road safety issues in this population, nor were there any road safety engineering measures or education materials specifically designed for deafblind children or adults.

11 Discussion

11.1 Prevalence of disabilities

Information on the prevalence of disabilities amongst children and adults is not routinely collected and so precise numbers are not available. Estimates are available, however, from population surveys and from charities dealing with specific conditions leading to learning difficulties or physical impairments. These indicate that a substantial proportion of children and adults are living with disabilities, often with multiple impairments, so the potential audience for specialised road safety training is large. A summary of the figures identified from various sources is given in Table 1.

Table 1 Prevalence of disabilities in the United Kingdom

<i>Disability</i>	<i>Prevalence*</i>	<i>Source</i>
All		
All	1 in 5 adults	1996/97 Follow-up to the Family Resources Study (Grundy <i>et al.</i> , 1997)
Severe disabilities	40 in 1000 adults	1996/97 Follow-up to the Family Resources Study (Grundy <i>et al.</i> , 1997)
All with Special Educational Needs	1 in 5 children	DfES, 2001
Learning		
All	3 to 6 in 1000 people	Foundation for People with Learning Difficulties
All	20 in 1000 adults of working age	Labour Force Survey, Autumn 1999
Autistic spectrum disorders with learning disabilities	2 in 1000 people	National Autistic Society
Down’s syndrome	1 in 1000 children	Down’s Syndrome Association
ADHD		
All	30 to 50 in 1000 children	National Institute for Mental Health (US)
Physical		
Wheelchair users	8 to 12 in 1000 people	RoSPA
Spina bifida	120 births/year	Association for Spina Bifida & Hydrocephalus
Juvenile arthritis	1 in 1000 children	Arthritis Research Campaign
Arthritis diseases: significant disability	5 in 1000 people	Arthritis Research Campaign
Muscular dystrophy	1 in 2000 people	Muscular Dystrophy Campaign
Cerebral palsy	1 in 400 children	Scope
Hearing		
Severely or profoundly deaf	3 in 1000 children; 3 in 1000 adults aged 16-60 years 170 in 1000 adults aged 61+ years	Royal National Institute for Deaf People
Glue ear (intermittent)	1 in 5 children aged 0-5	Pring, 2001
Vision		
All	3 in 1000 people	ONS, 1996
Dual sensory		
All	4 in 10,000 people	Deafblind UK

* Where indicated, this refers to a sub-group of the population (e.g. children only).

The proportion of disabled people in the population increases sharply in older age groups. It has been estimated that nearly half (48%) of all disabled people in the UK are aged 65 years and over, and three in 10 are over 75 years old (Grundy *et al.*, 1997). According to the RNIB (2001), 70% of vision-impaired people are over 75 years old, which means that one in six people of this age have difficulties with seeing. The proportion with impaired hearing is even greater: 47% of people aged 61-80 years have some hearing loss, and this rises to 93% of those aged 80 years and over (RNID, 2000). This compares with just 7% of people aged between 16 and 60 years.

Learning disabilities and ADHD are most prevalent in children and both types of impairment present real challenges for road safety. Physical disabilities due to cerebral palsy and other causes also affect significant numbers of children and adults. In addition, around 50,000 children have vision or hearing impairments. Among adults, 673,000 are severely or profoundly deaf (RNID, 2000) and an estimated one million have sufficient vision loss to be eligible for registration, although only a third of a million are actually registered blind (RNIB, 2001). Overall, the prevalence of various types of disability is broadly similar, and as there does not appear to be one major cause of impairment, prevalence statistics do not appear to be a useful indicator of priority for tackling road safety issues. It does seem, however, that significant numbers of people have some form of impairment and so their road safety does need to be considered.

11.2 Road accident risk

The extent to which these various disabilities affect a person's safety on Britain's roads remains unclear. However, traffic and the risk of road accident injury are significant barriers to independent travel for disabled children and adults. Blind and vision-impaired pedestrians report a wide range of concerns including worry about crossing the road. Parents of deaf children have also highlighted the difficulties of road safety training for this group.

Whilst it seems intuitively obvious that disabled children and adults are at increased risk of road accident involvement, few studies have attempted to quantify this risk and most of these involve small sample sizes. In order to estimate accident risk it is necessary to have information on both exposure and accident statistics. National databases (e.g., STATS19, National Travel Survey) do not routinely record disability and general information on the walking and cycling habits of disabled children and adults is not available. It is possible that exposure of children is limited as they may be more likely to be accompanied by a carer as a pedestrian, be transported to school rather than walk or cycle (particularly if it is a special school), or may be residential at school. It could even be argued that exposure should be controlled in order to minimise risk. However, whilst lack of exposure might effectively reduce accident liability, it could also delay the development of road safety skills, which will be needed as children become more independent.

Although the evidence to date is limited, it appears that hearing or vision impairments and learning difficulties,

particularly ADHD, are associated with increased likelihood of injury in road traffic accidents. This indicates a need for more careful thought about the special vulnerability of these groups and the strategies that may help address the extra risks and difficulties they face. However, it is not possible to state that people with other forms of special need are at less risk because the data are not available.

Whilst information on accident risk is limited, there is a range of factors relevant to specific types of disability which could arguably increase the risk of accident involvement as a pedestrian or cyclist. An impairment in the ability to see and/or hear traffic has obvious disadvantages. In addition, an undetected hearing impairment in early life may mean that both the child and their carer do not realise the need for extra caution. Physical impairments may lead to a greater exposure as people may take longer to cross the road. Wheelchair users may be less likely to be noticed by drivers, possibly because some wheelchair users will be less tall than other pedestrians and are therefore not in the drivers usual line of sight. Previous research on motorcyclists has investigated the hypothesis that, if drivers are not expecting to see a type of road user, they may be less likely to notice them (Thomson, 1980; Hurt, Ouellet and Thom, 1981). Learning difficulties affect a person's ability to learn how to be a safe road user and ADHD can lead to inappropriate, impulsive, road user behaviour. Evidence from general accident-involved child populations shows a high incidence of situations where impulsive or distracted behaviour contributes to the accident circumstances (MVA, 1989). Children who are particularly prone to these conditions can therefore be expected to be more at risk.

Given the lack of research in this area, there may be other, as yet unknown, factors affecting a person's likelihood of being a road accident casualty. The extent to which children and adults compensate for their impairments and whether these compensation mechanisms do indeed reduce accident risk is also not known.

11.3 Engineering measures

The review identified no engineering measures specific to disabled children but widespread use of measures for disabled people in general. These mostly relate to facilities at road crossings but also include a wide range of measures to reduce clutter and obstructions on foot-ways, provide ramps and dropped kerbs to improve access and provide tactile paving surfaces to enable safe and independent travel.

'Barrier-free' or 'seamless' travel for all pedestrians is a consistent theme in Local Transport Plans (LTPs) and most county authorities appear to have considered the needs of mobility-impaired people in drafting these documents. Indeed, a minimum requirement of LTPs is a clear commitment to meeting the needs of disabled people (DETR, 2000). In addition, in preparing a good LTP, local authorities are expected to consult with organisations representing disabled people, co-operate with transport operators to improve mobility opportunities, and consider how their proposals and initiatives will affect the mobility of disabled people. There should be evidence that those

involved in developing the LTP have received disability awareness training (DETR, 2000). A summary of LTP-based proposals to improve safety and access for people with disabilities is included in Appendix A.

Improvements to crossings or other engineering measures designed to benefit disabled people are likely to have a positive influence on the safety of all road users. Arguing this case, one Australian researcher used the example of crashes at junctions in rural and urban Queensland, in which drivers aged 80 and over were disproportionately involved (King, 2000). He hypothesised that this could be at least partially due to changes in eyesight, which deteriorates with age. Engineering measures, such as better lighting at junctions, would benefit not just the very old but all drivers over the age of 40, when crash involvement at junctions (compared with between junctions) begins to climb steadily. King (2000) suggested that if the proportion of crashes at junctions could be reduced to that observed among drivers aged 25-39 years, the total driver casualties at junctions could be reduced by 9%. *'In this way, a special needs user group can act as the tip of the iceberg, drawing attention and funding to problems which might not have been attended to otherwise, and which have benefits beyond the special needs group'* (King, 2000, p363).

11.4 Road safety training

A recent survey of road safety units in England, Wales and Scotland found that provision of road safety education for children with disabilities is *'patchy, with no cohesive policy or code of practice'* (Ardill, in press). While some Road Safety Units had team members with a special interest or background in this area, and were able to be proactive in providing travel and road safety training, others lacked resources or staff or claimed there was little demand for such services. The author (Ardill, in press) noted that several small projects involving travel or road safety training for young people with learning difficulties had been funded recently through small grants. These projects were, however, necessarily limited in scope, duration and geographical range, yet the need for adequate safety training was country wide and ongoing.

This is reflected in the present review where little academic work on designing and evaluating road safety training for disabled people has been identified. Where it is considered, it is generally added into existing mobility training (e.g., orientation and mobility training for vision-impaired people, wheelchair training or life skills training for those with learning difficulties). It is not clear whether the lack of materials in this area relates to a perception that these people seldom will be out on the roads by themselves or whether it simply reflects a lack of resources. There is anecdotal evidence from the Road Safety Officers contacted during this review that existing resources are often modified to meet the needs of individual clients. It is interesting to note that no road safety education interventions have been designed for children with ADHD despite the fact that increased accident liability has been established in several studies.

Very few evaluation studies have been conducted to assess the effectiveness of training schemes for disabled people. These have focused on just two areas: learning difficulties and vision impairments.

A number of road safety training studies have been undertaken with people with learning difficulties. However, much of the research was conducted in the United States, where the road environment and traffic conditions differ in many ways from those typically experienced by pedestrians in this country. One of the major priorities in RSE for people with learning difficulties is ensuring that the skills learned in one context are able to be generalised to other settings. This may be a particular challenge for those working with people who have profound learning disabilities and those with vision loss in addition to learning difficulties. Researchers have raised concerns about the ability of such people to transfer skills acquired in the classroom or at one roadside training location to their everyday journeys. One study has demonstrated that training in a virtual environment is extremely motivating for people with learning disabilities and that the skills acquired will transfer to the real world (in this case, from a virtual to a real kitchen). Transfer occurred regardless of whether the appearance of the real and virtual worlds matched exactly. Further research is needed to determine whether these findings apply to roadside pedestrian training.

Whilst training can be effective, what is less clear is whether disabled children can be trained to respond to rapid changes in traffic situations, as many of the impairments limit the child's ability to rapidly assess risk or to modify their planned behaviour. In this respect there may be similarities with the problems experienced by older pedestrians in general, who are very conscious of the need to exercise care but who are often involved in accidents involving unexpected events such as reversing or high speed vehicles. This suggests consideration could be given, as with elderly pedestrians, to planning exposure to limit the likelihood of encountering these situations.

Mobility training programmes designed for adults with learning difficulties cannot necessarily be applied with equal success to children with similar disabilities. Training may need to be more adaptable and ongoing. Children differ from adults in that they cannot be expected to learn all the skills they need at one point in their development. Some disabled children may not learn things in the usual or 'correct' developmental sequence. Bearing these points in mind, it is a matter of concern that so few evaluations have been conducted with children as participants.

Only one study was identified in which a road safety training resource for vision impaired people was evaluated. Other research papers described methods used in orientation and mobility training, or results of experimental studies to test the ability of vision-impaired pedestrians to navigate outdoors and make safe decisions about road crossing. The limited available evidence suggests that an effective road safety education programme for vision-impaired children and adults should incorporate both classroom elements and roadside training.

11.5 Social inclusion

It is worth noting that training that involves real-world experience has value regardless of whether an individual ever becomes fully independently mobile. Developing appropriate social behaviour, interacting with non-disabled people and enhancing safety while travelling in the company of others are all worthwhile goals which may be met through practical pedestrian training in the person's usual environment.

Travelling independently provides many benefits besides the obvious practical ones. Interviews with people who have experienced life with disabilities vividly illustrate the meaning of independent mobility in terms of enhanced self-esteem and opportunities to exercise choice and develop a sense of personal responsibility (e.g., Higgins, 1999). Professionals report improvements in social behaviour among children and adults with learning difficulties who have had travel training (e.g., Grossmark, 1983). The freedom to make decisions and interact with others in the community are valuable aspects of growing up which all children should experience to the extent that they are capable. Even those who will never be able to travel unaccompanied will benefit from an increased awareness of risk and opportunities to take some responsibility for their own safety. Independence and choice are words often used amongst charities working with disabled people today. Reflecting and perhaps also shaping the aspirations of children with disabilities and their parents, they emphasise the value of mobility and life skills training in order to prepare their clients for lives as full, enriched and independent as possible.

11.6 Improving the effectiveness of educational materials

Whilst a number of road safety education packages exist for disabled people, particularly children, it has not always been acknowledged that their effectiveness will be affected by the nature, degree and age of onset of the disability and, if the client is a child, their developmental stage. The extent to which clients have experience of previous training and the road environment will also affect their ability to learn the necessary skills and knowledge. Support from their family/carers will also be relevant in ensuring the lessons are supported in their home environment. The importance of these factors means that much can be learned from the case studies and small-scale experimental evaluations that dominate this field of research. This is because RSE training may need to be tailored to a larger extent than with non-disabled children. Nevertheless, there is still a need for more evaluation studies comparing techniques and programmes and assessing their suitability for different groups within the population of disabled people.

Where road safety education materials are designed specifically for disabled people, they need to take account of accepted good practice in road safety education. They will also need to address issues pertinent to all types of disabilities. These include:

- special safety considerations during training (risk assessments);
- needs of parents of disabled children for support, information and perhaps training to reinforce the materials and training;
- empowering disabled people. That is, encouraging people who have possibly had little experience of taking responsibility or exercising choice to make accurate assessments of risk and confident decisions about their own safety, and to put these skills into practice in their everyday lives.

Variations and combinations of disabilities also should be catered for. For example, people with moderate or profound learning difficulties may have particular problems in generalising road safety skills beyond the training situation, so effective training programmes will ensure that trainees know when and where to apply their new knowledge. The content and sequence of training programmes may need to be adapted for people with multiple disabilities, especially if these include learning difficulties.

Any road safety training provided must conclude with a realistic assessment of each participant's risks and capabilities. In this respect, academic measures of success such as percentage of task components performed correctly or statistically significant differences between trained and untrained people are of relatively little use. Instead, assessments must be based on clients' individual progress and ability to make sound decisions consistently in all the contexts they are likely to encounter on their travels.

11.7 Summary

It cannot be assumed that disabled children and adults are an insignificant minority, or that they have no need for road safety education because they'll never travel independently, or that materials developed for non-disabled children will necessarily suffice for disabled children and adults. Careful consideration should be given to the additional dangers faced by these groups and to their particular difficulties in understanding, internalising and implementing road safety training. For all children, road safety education is less about learning rules than about learning to assess risks and make decisions about their own safety. Disabled people will require more help with risk assessment and may well face greater risks. They will also need more encouragement and practice at making decisions.

12 Conclusions

Each form of disability makes it more difficult in different ways for people to learn to deal safely with the road environment. In many cases it is unlikely that these people can achieve the same degree of skill as other children and adults. But mobility and independence is particularly highly prized by these groups, and therefore should be encouraged wherever possible. Whilst it seems likely that disabled people are at increased risk of road accident involvement, it is not possible to establish the most at-risk groups as there has been insufficient research in this area.

Most of the research effort has been concerned with the development of programmes and materials to help improve the road safety of disabled people. However, whilst some useful findings have been identified (particularly for children and adults with learning difficulties) there has been little research on training/education for other types of disability. Where materials exist, their use is not widespread. Road safety advice for disabled children and adults is offered by local authorities and care groups. However, given the lack of research on the topic, much of this advice is based on practical experience or general road safety practice. A wide range of engineering measures intended to enhance safety and access for people with disabilities are proposed or have been implemented by local authorities. The effectiveness of these facilities will be maximised where they are used consistently, within road environments that have been designed with disabled people in mind.

13 Recommendations

The following recommendations are made.

- 1 In order to guide policy formulation, more information should be sought on both the exposure and accident liability of disabled people. Such information would not only help identify the priorities but also aid understanding of the issues. The most cost-effective way of achieving this would be to build questions into national surveys such as the National Travel Survey² and STATS19. Alternatively, specific mobility surveys could be carried out via, for example, the various charities. Specific surveys could also identify whether the higher risks apparent in the road environment are mirrored by increased risk in home and leisure environments, for these people.
- 2 Road safety education resources for people with learning difficulties should be evaluated with a view to recommending the use of one or more interventions to practitioners.
- 3 Guidance should be issued to Road Safety Officers and other practitioners on the availability of existing resources, and also on how to tailor existing non-specialised measures for use with / by disabled children and adults.
- 4 Guidance should also be issued to carers to both increase awareness and also to help them reinforce lessons on road safety skills and knowledge at home.
- 5 Policies such as lowering traffic speeds are likely to be of particular benefit to disabled people. Local authorities should continue to be encouraged to consider in their Local Transport Plans the need for special engineering measures, particularly in the vicinity of special schools.

² The National Travel Survey includes questions on travel difficulties, which can be combined into a variable which gives some indication of the number of disabled travellers. These questions apply only to adults, however; no data are collected on disabled child travellers.

14 Acknowledgements

The authors acknowledge the co-operation of the many experts contacted during the review who provided useful comments, experience and details of their current work. The meta-analysis in Appendix B was provided by Gordon Harland. The authors would also like to thank David Lynam for his technical input to the report.

15 References

- Ampofo-Boateng K and Thomson J A (1991).** *Children's perception of safety and danger on the road.* British Journal of Psychology, 82, 487-505.
- Ansell F, Smart B, Smith M and S Sterling S (Undated).** *EPIOC assessment, training and testing manual.* Leeds: Leeds City Council Road Safety Unit.
- Ardill S (2002).** *Travel training.* Draft version of article for *Newscheck*.
- Backett E M and Johnston A M (1959).** *Social patterns of road accidents to children.* British Medical Journal, Feb 14, 409-413.
- Bailey B R and Head D N (1993).** *Providing O&M services to children and youth with severe multiple disabilities.* RE:view, XXV, 57-66.
- Banja J D (1998).** *The determination of risks in orientation and mobility services: ethical and professional issues.* Journal of Visual Impairment and Blindness, Sept-Oct, 401-409.
- Beck N, Warnke A, Krüger H P and Barglik W (1996).** *Hyperkinetisches Syndrom und Auffälligkeiten im Strassenverkehr: eine fallkontrollierte Pilotstudie.* Z. Kinder-Jugendpsychiat, 24, 82-91.
- Bentzen B L and Barlow J M (1995).** *Impact of curb ramps on the safety of persons who are blind.* Journal of Visual Impairment and Blindness, 1995, July-Aug, 319-328.
- Beresford B (1995).** *The needs of disabled children and their families.* York: Joseph Rowntree Foundation.
- Beveridge S, Chambers M, Hudders W, Stiell B and Wiegand P (1997).** *Promoting independent wayfinding.* The SLD Experience, 18, 11-12.
- Budd J M and LaGrow S J (2000).** *Using a three-dimensional interactive model to teach environmental concepts to visually impaired children.* RE:view, 32, 83-94.
- Child Accident Prevention Trust (CAPT) (Undated).** *Accidents and children with special needs.* Factsheet. London: Child Accident Prevention Trust.

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

Christoffel, K K, Donovan M, Schofer J, Wills K, Lavigne J V and Kids 'n' Cars Team (1996). *Psychosocial factors in childhood pedestrian injury: a matched case-control study.* *Pediatrics*, 97, 33-42.

Connor M (1992). *Low vision bicycling.* *Journal of Visual Impairment and Blindness*, February, 111-114.

Coventry City Council (Undated). *Look at me.* Coventry, Coventry City Council.

Davis P (2001). *Clearer vision.* *Times Educational Supplement on Special Needs*, 6 April, 12.

Department for Education and Skills (2002). *Special educational needs.* www.dfes.gov.uk/sen.

Department of the Environment, Transport and the Regions (1997). *Childhood accidents and their relationship with problem behaviour. Final report.* London: Department of the Environment, Transport and the Regions.

Department of the Environment, Transport and the Regions (1998). *Road safety education in schools – Primary Schools.* London: Department of the Environment, Transport and the Regions.

Department of the Environment, Transport and the Regions/Scottish Office (1998). *Guidance on the use of tactile paving surfaces.* London: Department of the Environment, Transport and the Regions/Scottish Office.

Department of the Environment, Transport and the Regions (2000). *Guidance on Full Local Transport Plans.* London: Department of the Environment, Transport and the Regions.

Department of Transport, Local Government and the Regions (2001). *A road safety good practice guide.* London: Department of the Environment, Transport and the Regions.

Disability Discrimination Act (1995). *ISBN 01005450952.* London: The Stationery Office.

Disability Rights Commission (2001). *Strategic Plan: Executive Summary 2001-2004.* www.drc-gb.org/drc/default.asp.

DiScala C, Lescohier I, Barthel M and Li G (1998). *Injuries to children with attention deficit hyperactivity disorder.* *Pediatrics*, 102, 1415-1421.

Dowe S (1990). *BATOD response to NDCS 'Safety to School' document.* *JBATOD (Association Magazine)*, Jan, 4.

Duncan-Jones B (2001). *Modern road crossing designs and visually impaired people.* *Municipal Engineer*, 145, 185-190.

Durham County Council (Date unknown). *Teaching road safety skills to people with learning disabilities.* Durham, Durham County Council.

Education Act (1993). *ISBN 0105435937.* London: The Stationery Office.

Edwards R S Ungar and Blades M (1998). *Route descriptions by visually impaired and sighted children from memory and from maps.* *Journal of Visual Impairment and Blindness*, July, 512-521.

Ellender P (1997). *The colour-coded safety pack.* Orpington: Goldcrest Publications.

Ellis R (1991). *Teaching mobility to visually impaired children in a special school.* *British Journal of Visual Impairment*, 9, 7-9.

Essex County Council Education Special Needs Support Service (1997). *Mobility training in schools.* Chelmsford: Essex County Council.

Essex County Council Highways and Transportation (Undated). *Traffic education for special needs pupils.* Chelmsford: Essex County Council.

Farmer J E and Peterson L (1995). *Injury risk factors in children with attention deficit hyperactivity disorder.* *Health Psychology*, July, 14(4) 325-323.

Gallon C, Fowkes A and Edwards M (1995). *Accidents involving visually impaired people using public transport or walking.* Project Report PR82. Crowthorne: TRL Limited.

Gayton W F, Bailey C, Wagner A and Hardesty V A (1986). *Relationship between childhood hyperactivity and accident proneness.* *Perceptual and Motor Skills*, 63, 801-802.

Gregory S (1995). *The deaf child and his family.* Cambridge: Cambridge University Press.

Grossmark R (1983). *Independence skills: learning to use the bus.* *Mental Handicap*, 11, 113-114.

Guide Dogs for the Blind Association (2001). *Orientation and mobility module resources.* Hindhead: GDBA School of Vision and Rehabilitation Studies.

Guth D A, Hill E W and Rieser J J (1989). *Tests of blind pedestrians' use of traffic sounds for street-crossing alignment.* *Journal of Visual Impairment and Blindness*, Nov, 461-468.

- Harrell W A (1994).** *Effects of blind pedestrians on motorists.* Journal of Social Psychology, 134 (4), 529-539.
- Heiden J M (1989).** *A ten-year follow-up study of former students at the Wisconsin School for the Visually Handicapped: 1978-1987.* RE:view, XXI, 81-87.
- Herman J F, Chatman S P and Roth S F (1983).** *Cognitive mapping in blind people: acquisition of spatial relationships in a large-scale environment.* Journal of Visual Impairment and Blindness, April, 161-166.
- Higgins N (1999).** *'The O&M in my life': Perceptions of people who are blind and their parents.* Journal of Visual Impairment and Blindness, Sept, 561-578.
- Hollyfield R L and Foulke E (1983).** *The spatial cognition of blind pedestrians.* Journal of Visual Impairment and Blindness, May, 204-210.
- Horner R H, Jones D N and Williams J A (1985).** *A functional approach to teaching generalized street crossing.* JASH, 10, 71-78.
- Hurt H, Ouellet D and Thom D (1981).** *Motorcycle accident cause factors and identification of countermeasures. Volume 1: Technical Report.* Cont. No. DOT HS-5-01160, US Department of Transport, NHTSA.
- Institution of Highways and Transportation (IHT) (1991).** *Reducing mobility handicaps: towards a barrier free environment. IHT revised guidelines.* London: IHT.
- Johnson V and Petrie H (1998).** *Travelling safely: the problems and concerns of blind pedestrians.* The British Journal of Visual Impairment, 16, 27-31.
- Jones G, Jordan R and Morgan H (2001).** *All about autistic spectrum disorders.* Mental Health Foundation.
- Keigan M and Stone J (2002).** *Adolescent children's road deaths: Analysis of police fatal accident files.* Project Report PR/SE/426/2001. Crowthorne: TRL Limited. (Unpublished report available on direct personal application only)
- King M J (2000).** *The iceberg principle: the knock-on effects of addressing the safety of 'special needs' road users.* Proceedings of the Road Safety Research, Policing and Education Conference, Brisbane, Queensland, Australia, 359-364.
- LaGrow S, Wiener W and LaDuke R (1990).** *Independent travel for developmentally disabled persons: a comprehensive model of instruction.* Research in Developmental Disabilities, 11, 289-301.
- Lane A (1993).** *Blind and partially sighted children in Britain: the RNIB survey, Volume 2. A summary.* The British Journal of Visual Impairment, 11, 9-11.
- Lewis, J, Brown D J and Powell H M (2000).** *Development of a virtual environment to teach independent travel skills to people with a learning disability.* Proceedings of the 12th European Simulation Symposium, ESS2000, Hamburg, Germany, (Ed. D P F Moller). 385-389.
- Li G, Baker S P, Fowler C and DiScala C (1995).** *Factors related to the presence of head injury in bicycle-related pediatric trauma patients.* The Journal of Trauma: Injury, Infection and Critical Care, 38, 871-875.
- Lind M G and Wollin S (1986).** *Bicycle accidents.* Acta Chir Scand Suppl, 531, 1-47.
- Marchetti A G, McCartney J R, Drain S, Hooper M and Dix J (1983).** *Pedestrian skills training for mentally retarded adults: comparison of training in two settings.* Mental Retardation, 21, 107-110.
- Matson J L (1980).** *A controlled group study of pedestrian-skill training for the mentally retarded.* Behaviour Research and Therapy, 18, 99-106.
- McGhee O (Undated).** *Manual wheelchair course.* North Woolwich, Association of Wheelchair Children.
- Meltzer H, Smyth M and Robus N (1989).** *OPCS surveys of disability in Great Britain, report 6. Disabled children: services, transport and education.* London: The Stationery Office.
- Mencap (2001).** www.mencap.org.uk.
- MVA Consultancy (1989).** *Must do better. A study of child pedestrian accidents and road crossing behaviour in Scotland.* Edinburgh: Scottish Office.
- National Autistic Society (2000).** *How many people have autistic spectrum disorders? Fact sheet.* London: National Autistic Society.
- National Deaf Children's Society (1989).** *Safely to school. School transport for deaf children.* London: National Deaf Children's Society.
- Office of National Statistics (1999).** *Labour Force Survey of Great Britain, Autumn 1999.* London: The Stationery Office.
- Office of National Statistics (2001).** *Statistics of education: special educational needs in England, January 2001.* Issue No. 12/01, November 2001. London: The Stationery Office.
- Oxfordshire County Council Environmental Services (Undated).** *Footsteps. A traffic awareness programme.* Oxford: Oxfordshire County Council.

- Oxley J, Fildes B, Ihsen E, Charlton J and Day R (1997).** *Differences in traffic judgements between young and old adult pedestrians.* Accident Analysis and Prevention, 29 (6), 839-847.
- Packer L (2000).** *ADHD files: Wait ... is my insurance paid up?* From www.tourettesyndrome.net, last updated December 2000.
- Page T J, Iwata B A and Neef N A (1976).** *Teaching pedestrian skills to retarded persons: generalization from the classroom to the natural environment.* Journal of Applied Behavior Analysis, 9, 433-444.
- Pfeffer K and Barneclutt P (1996).** *Children's auditory perception of movement of traffic sounds.* Child: care, health and development, 22(2) 129-137.
- Phillips S and Todman J (1999).** *Pedestrian skills training for children with learning difficulties.* International Journal of Rehabilitation Research, 22, 237-238.
- Phillips S R (1995).** *Everyday skills pack – road safety.* Dundee: Dundee Healthcare NHS Trust.
- Pless I B, Taylor H G and Arsenault L (1995).** *The relationship between vigilance deficits and traffic injuries involving children.* Pediatrics, 95, 219-224.
- Pountney J (1993).** *Street Scene for people with learning disabilities.* Birmingham: RoSPA.
- Pring F (2001).** *Muffled messages.* Times Educational Supplement on Special Needs, 6 April, 13.
- Read J H, Bradley E J, Morison J D, Lewall D and Clarke D A (1963).** *The epidemiology and prevention of traffic accidents involving child pedestrians.* Canadian Medical Association Journal, 89, 687-701.
- Ridler A (1990).** *Look out, look out ... for Oscar.* Stoke on Trent: Stoke on Trent City Council.
- Roberts I and Norton R (1995).** *Sensory deficit and the risk of pedestrian injury.* Injury Prevention, 1, 12-14.
- Robertson J (Undated).** *A life skills manual: personal safety.* Bicester: Winslow Press.
- Rose D, Brooks B and Elliot-Square A (Undated).** *The use of virtual reality in occupational training of people with learning disabilities.* London: University of East London/Mencap.
- Royal National Institute for the Blind (2001).** *Factsheet: Frequently asked questions about blindness.* www.rnib.org.uk.
- Royal National Institute for the Deaf (2000).** *Estimated percentages of the UK population who are deaf or hard of hearing, 1996. Estimated numbers of deaf and hard of hearing adults in the UK, 1996.* London: RNID Information Services.
- Royal National Institute for the Deaf (2000).** *Fact sheet: glue ear.* London: Royal National Institute for the Deaf.
- Rusch F R and Heal L W (Unpublished).** *Investigating students' ability to cross intersections utilizing cognitive strategies in a CAVE Automated Virtual Environment.* USA: University of Illinois. (Unpublished report available on direct personal application only)
- Sandels S (1970/1995).** *Young children in traffic.* Reprinted in Injury Prevention, 1995, 1, 112-115. First published in British Journal of Educational Psychology, 1970, 40, 111-116.
- Sauerburger D (1999).** *Developing criteria and judgment of safety for crossing streets with gaps in traffic. Practice note.* Journal of Visual Impairment and Blindness, July, 447-450.
- Sauerburger D (1995).** *Safety awareness for crossing streets with no traffic control.* Journal of Visual Impairment and Blindness, Sep-Oct, 423-431.
- Scope (2001).** *An introduction to disability issues. Factsheet.* Milton Keynes: Scope.
- Sheppard D and Pattinson M I M (1987).** *Interviews with elderly pedestrians involved in road accidents.* Research Report RR98. Crowthorne: TRL Limited.
- Strauss D, Shavelle R, Anderson T W and Baumeister A (1998).** *External causes of death among persons with developmental disability: the effect of residential placement.* American Journal of Epidemiology, 147 (9), 855-862.
- Sturmer R (2000).** *Stride ahead in safety.* Northorpe: LBV Television.
- Taylor P D and Robinson P (1979).** *Crossing the road: a guide to teaching the mentally handicapped.* Kidderminster: British Institute of Mental Handicap.
- Thomas A (1998).** *Within reason. Access to services for blind and partially sighted people.* London: Royal National Institute for the Blind.
- Thomas R (1988/1998).** *Crossing roads safely.* Perthshire: Grangewood Video Productions, 1988. (Booklet revised and re-printed in 1998 with illustrations by Steve Earl.)

Thomson G (1980). *The role of frontal motorcycle conspicuity in road accidents.* Accident Analysis and Prevention, 12, 165-178.

Todd H (2000). *Making a reality of community involvement.* Talking Sense, 46.

Transport Statistics (2001). *National Travel Survey: 1998-2000 Update.* London: Department for Transport, Local Government and the Regions.

Vogelsburg R T and Rusch F R (1979). *Training severely handicapped students to cross partially controlled intersections.* AAESPH Review, 4, 264-273.

Wale C (1999). *A framework towards developing wheelchair proficiency schemes for manual and electric wheelchair users.* Birmingham: RoSPA.

Whitfield G (1977). *The Disability Discrimination Act: Analysis of Data from an Omnibus Survey. In-house report 30.* London: DSS.

Wiener W R, Lawson G, Naghshineh K, Brown J, Bischoff A and Toth A (1997). *The use of traffic sounds to make street crossings by persons who are visually impaired.* Journal of Visual Impairment and Blindness, Sep-Oct, 435-445.

Woodward L J, Fergusson D M and Horwood L J (2000). *Driving outcomes of young people with attentional difficulties in adolescence.* Journal of the Academy of Child and Adolescent Psychiatry, 39, 627-634.

Appendix A: Annotated bibliography of RSE resources and engineering measures for disabled people

Reference	<i>Allen, D. Mobility and independence training.</i> Northamptonshire County Council, Northampton, 2000.
Type of resource	Set of notes for trainers.
Target group	Adults with learning disabilities; adult wheelchair users.
Type of training	Practical, roadside training with some classroom activities. The aim is to provide general skills for safety in the road environment which will be useful whether the client is walking, cycling or using public transport.
Description	<p>There are five key sessions. The first three take place at the roadside, beginning with a discussion of travel outdoors in order to assess current awareness of safety issues. This enables tutors to focus future sessions on areas of weakness. Other practical sessions involve developing sensory and decision making skills and identifying hazards and pedestrian crossing facilities. These lessons are consolidated during two classroom sessions, during which clients develop their own 'safety maps' of the area explored in previous sessions, and then review what they have learned and highlight suitable coping strategies. Sessions take place ideally with groups of six to eight clients, although up to 10 may take part if several leaders are available. MAKATON sign language is used with all groups of clients as it employs basic symbols which are easily understood. Each session has a list of key vocabulary. Each client who completes the course is assessed at three levels: (1) Knowledge and attitude; (2) Understanding and practical application; and (3) Hazard awareness and independence. Certificates are issued depending on the level achieved and trainers have the opportunity to recommend additional training if needed. A local Northamptonshire Photoset of local street scenes is currently under development for use in supporting this course.</p>
Comments	<p>The course was launched in September 2000. Course content was developed and trials conducted in the 12 months to August 2001. Feedback collected from participants showed that the vast majority reported increased safety knowledge, independence and confidence. Many asked for further training and/or suggested ways in which highways could be improved to enhance safety. Results from a number of case studies are also available. The county council runs half-day training workshops for tutors. It is expected there will be 50 trained tutors by the end of 2002.</p>

Reference	Ancell, F, B Smart, M Smith and S Sterling. <i>EPIOC assessment, training and testing manual.</i> Leeds, Leeds City Council Road Safety Unit, publication date unknown.
Type of resource	Book.
Target group	Users of Electric Powered Indoor-Outdoor Chairs (EPIOC) of all ages.
Type of training	Classroom and practical including roadside.
Description	Following an initial assessment of the trainee's needs and selection of the most suitable chair, training concentrates on developing basic skills such as familiarisation with controls and basic manoeuvres. Trainees are taught the rules of conduct for using an EPIOC on footways and highways and are encouraged to develop awareness of hazards and safe behaviours. Practical training in pedestrian situations is then provided. The theory component of the course includes knowledge of the Highway Code, including road signs and markings, and an understanding of potential problems on the roads and footpaths. Trainers are urged to provide literature on road safety, use videos, and/or demonstrate strategies and manoeuvres on a scale model. No materials are specifically recommended. Other teaching methods such as verbal rehearsal of safety strategies, discussion of road and pavement safety and using open questions to assess understanding are also recommended. Practical training involves helping trainees identify the safest and easiest places to cross roads. When crossing roads, trainees are urged to be aware of the speed of traffic and to find places with dropped kerbs and a clear view, where they will be seen by motorists. Guidance for training in use of pelican crossings is also provided.
Comments	

Reference	Brady, L. <i>Be safe at 8 mph. A guide to using Class 3 Vehicles.</i> York, Department of Transport/ Disabled Living Centres Council/RoSPA and Leeds Road Safety, 1995.
Type of resource	Booklet.
Target group	Adult users of Class 3 (8 mph) vehicles.
Type of training	Practical roadside training supported by classroom learning.
Description	There are three parts to the training programme. In the first, the user is introduced to the vehicle and works to develop basic control at 4 mph (pedestrian mode) and 8 mph (road mode). Specific skills such as negotiating kerbs and gradients are practised. Homework includes reading the Highway Code, Class 3 vehicle literature and watching a training video. The second part of the programme focuses on the theoretical aspects including roadworthiness of the vehicle, hazards, speed limits and coping strategies. In the third section, users practise skills needed for use of the vehicle in the pedestrian and road environments. A checklist is provided on which trainers can note when each task was attempted, when it was successfully completed, and any comments on the progress of the training.
Comments	

Reference	Coventry City Council. <i>Look at me.</i> Coventry, Coventry City Council, publication date unknown.
Type of resource	Teacher notes (150 pages) and workbooks for pupils.
Target group	Children aged 5-11 years. Not specifically designed for special needs students but information is provided on using the materials with children who have special needs.
Type of training	Classroom
Description	This was a general road safety education resource for use in primary schools. It included materials for infant and junior level pupils. Resources could be photocopied for use in the classroom. Although it was stated on the Rosalind database that this resource was suitable for special needs, I was told by an RSO from Coventry CC that the person responsible for the pack left without completing the special needs section.
Comments	Above information is based on description in Rosalind database (BITER, date) and on an interview with Melanie Statham, Coventry City Council Road Safety Unit, 6 November 2001.

Reference	Divall, D, et al. <i>Makaton guide to road safety</i> . (Currently under development at Newham Borough Council for the Makaton Vocabulary Development Programme.)
Type of resource	Booklet.
Target group	Adults and possibly children with learning disabilities.
Type of training	Classroom.
Description	This resource is intended to provide vocabulary and a starting point for discussion about road safety. There are ten key messages, beginning with roads and traffic, the kerb and the footpath, and working through safe places to cross (including rules for safe use of pelican and zebra crossings) and finishing with emergency vehicles. Each message features a photograph, a few simple and important statements (e.g., 'Traffic can be dangerous!', 'Stop at the kerb before crossing') with the relevant British Sign Language signs and Makaton symbols on the facing page.
Comments	It is hoped that this resource will be the first and most basic in a set of road safety resources using the Makaton language programme.

Reference	Durham County Council. <i>Teaching road safety skills to people with learning disabilities.</i> Durham, Durham County Council, publication date unknown.
Type of resource	Notes for instructors, laminated photographs and drawings illustrating aspects of the road environment, a sheet (which may be photocopied) for recording the progress of one student, and a set of 21 lesson cards.
Target group	Designed for students with learning disabilities at schools and adult centres.
Type of training	Classroom and roadside.
Description	<p>Constant monitoring and frequent reminders and reinforcement are key elements of this training package. To encourage instructors to carry the cards and refer to the lessons frequently, the teaching materials are pocket-sized (A5) and contained within a plastic sleeve. Each lesson card has a record sheet on the reverse side. Dates and outcomes of each training session are recorded in a standard format: a tick indicates the task was completed without help or reminder; codes G, V and P indicate that the student needed gestural, verbal or physical guidance respectively. There is space for comments. Each student's progress through the course is recorded on a master file. Tasks are presented in a structured sequence and the notes for instructors emphasise the importance of following the course in the given order, progressing to the next task only when the current task has been mastered. The course begins with recognition of features of the outdoor environment, i.e., footpath, traffic and roads. Students are introduced early to the importance of finding a safe place to cross. Actions such as stopping at the kerb, looking, listening, choosing a safe gap and crossing safely are then taught and practised. Use of zebra and pelican crossings, pedestrian refuges, subways and footbridges, and public transport are covered later in the course. At each stage a distinction is made between performing a task with help and without help. Suggested teaching aids are listed on each card. These include videos, three-dimensional models, and the picture cards provided in the pack.</p>
Comments	

Reference	Ellender, P. <i>The colour-coded safety pack</i> . Orpington, Goldcrest Publications, 1997.
Type of resource	A set of flash cards which depict safe or unsafe behaviours, plus a game board and playing pieces.
Target group	Young people with learning disabilities, in secondary or tertiary education.
Type of training	Classroom
Description	Green or 'safe' cards include: wearing a bicycle helmet, using a zebra crossing, waiting for the 'green man' light, and stopping, looking and listening again at traffic islands. Red or 'unsafe' cards include: riding a bicycle in the dark with no lights, crossing between parked cars and walking right on the edge of the kerb. Students should first be made familiar with the flash cards through class discussions and regular practice. They should be encouraged to associate red with danger and green with safety. Once they are familiar with the cards, students can begin playing the board game, under supervision. This involves moving playing pieces around a stylised road layout and encountering red or danger squares (which lead to penalties) and green or safe squares (which lead to rewards). The game can be played by up to four students working individually or up to eight working in pairs. It is suggested that the game should be used in the classroom once or twice a week over a long time period. The emphasis on rule learning and repetition is deliberate, as the target group is believed to respond well to rote learning and to obey rules rather rigidly. Gender, ethnicity and disability issues are addressed, for example by depicting characters of different ethnic origins and in non-traditional gender roles. Several cards depict people with sensory or physical impairments in an effort to raise students' awareness of the need for extra care. The definition of sensory impairment includes people using personal stereos or dark glasses.
Comments	Behaviours depicted on the cards were chosen following discussions with the Road Safety Unit at the London Borough of Bromley regarding the situations in which young people with special needs faced particular safety problems. The finished pack was endorsed by the Bromley RSU. The author is an educational consultant who has worked as an external verifier for City and Guilds examining special needs education provision at 20 colleges. The pack was distributed to about 200 schools and colleges.

Reference	Essex County Council Education Special Needs Support Service. <i>Mobility training in schools.</i> Chelmsford, Essex County Council, 1997
Type of resource	Booklet
Target group	Visually impaired children aged 3-17 years.
Type of training	Classroom and practical.
Description	Training focuses on the skills needed within an educational setting and aims to enable children to 'move safely, with confidence and independently'. The booklet lists topics covered in the curriculum but no details of training are provided. The curriculum for pre-schoolers includes traffic awareness but no practical travel training is given. Outdoor mobility is introduced at the primary level. Traffic awareness is covered again in the infant curriculum and the juniors are also taught traffic alignment and the Green Cross Code, along with a basic approach to problem solving. At the secondary level pupils undertake road crossing at various junctions, learn traffic light sequences and use of zebra and pelican crossings, and are introduced to route planning. Pre-work experience training may include the use of public transport. In each case, mobility training begins with observation and assessment. Needs are defined and an individual programme is planned. After agreement on Service Level is reached, one-to-one teaching with a mobility instructor begins. This may be supported by a non-teaching assistant. Progress is monitored and skills are reviewed regularly.
Comments	

Reference	Essex County Council Highways and Transportation. <i>Traffic education for special needs pupils.</i> Chelmsford, Essex County Council, publication date unknown.
Type of resource	Booklet.
Target group	School-aged children with Special Educational Needs (SEN). Intended ‘for all ages’.
Type of training	Classroom and practical.
Description	Nine objectives are described, starting with basic understanding of the road environment and progressing to hazard awareness and safe practices. Each objective is explained in detail and advice on dealing with children of differing ability levels is given. Numerous teaching suggestions are offered. These include classroom activities such as learning vocabulary, examining and discussing a vehicle, drama and role-playing. Practical activities include walks focusing on either listening or observing conspicuous and less conspicuous colours, identifying and observing safe and dangerous places, and using a stopwatch to time approaching vehicles. It is emphasised that young people with special needs require plenty of opportunities to familiarise themselves with the traffic environment and to practice safe behaviours in a protected and supervised situation. It is also noted that for some individuals, training on set routes such as the journey from school to home may be more appropriate. Teaching resources such as games, posters and videos are listed in the booklet.
Comments	

Reference	Leicestershire County Council. <i>Police and road safety pack.</i> Leicester, Leicestershire County Council, 1994.
Type of resource	Computer software, worksheet and workbook.
Target group	Children aged 5-12 years and older children with special needs.
Type of training	Classroom
Description	Designed for the concept keyboard, this resource covers aspects of police work, safety and road safety.
Comments	

Reference	Leicestershire County Council. <i>Sequences.</i> Leicester, Leicestershire County Council, 1994.
Type of resource	Set of coloured cards.
Target group	Children aged 4-7 years and children with special needs up to the age of 14 years.
Type of training	Classroom
Description	The cards depict seven common road safety sequences. It is designed to encourage the development of road-safety-related language skills.
Comments	

Reference	McGhee, O. <i>Manual wheelchair course</i> . North Woolwich, Association of Wheelchair Children, unpublished.
Type of resource	Two-page training record sheet.
Target group	Children (no ages specified) who use manual or electric wheelchairs. Clients usually have spina bifida or cerebral palsy and may have learning difficulties in addition to physical disabilities.
Type of training	Practical training in a school yard or other location considered safe.
Description	The Association of Wheelchair Children is a charity which provides free training courses in wheelchair use for children. All courses begin with assessments of the clients. The skills needed for outdoor mobility are considered to be physical and best learned through practical training. Each course involves about 10 children and their parents and the courses are run all over the UK. The manual wheelchair training course is run over two days and covers back-wheel balancing (so that children can deal with kerbs) and road safety skills, including crossing the road, how to recover from tips and falls, dealing with parked cars, pedestrians etc. Children in electric wheelchairs do a one-day course which focuses on outdoor mobility, including road safety. In each case there is a list of skills to be acquired during the course. The electric course covers many of the skills recommended by RoSPA in its <i>Framework towards developing wheelchair proficiency schemes</i> (described below) though not necessarily in the order recommended. The manual course has quite a different emphasis to the RoSPA course. Very few trainees are considered competent after just one course and some take as many as four or five courses to achieve what the instructors consider an acceptable level of competency for safe outdoor mobility.
Comments	Above description is based on an interview with Owen McGhee in August 2001 and on details from the charity's web site, www.wheelchairchildren.org.uk .

Reference	Northern Ireland Deaf Video Project. <i>Stop, Look, Think! Road Safety for Deaf Children (and) Stop, Look, Think! Road Safety for Deaf Teenagers.</i> Newtownabbey, NIWD/Jordanstown School, 1992.
Type of resource	Video with signing and subtitles. Junior and senior versions.
Target group	Deaf children and teenagers.
Type of training	Classroom.
Description	Both videos use a combination of subtitles, signing and spoken word throughout. They begin with sequences in which children and teenagers are shown in the road environment, highlighting safe and unsafe behaviours. In the junior version, the dangers of traffic are illustrated during a sequence in which a ball bounces onto a quiet road, a car comes around a corner and runs it over and the ball bursts. Crash test footage of a slow-moving car hitting a child pedestrian (dummy) is also shown. In the senior version, one of the teenagers in the 'story' is knocked down by a car after crossing the road while continuing to sign to his friends. Safe places to cross and to play are then shown in the junior version, while the senior video moves on to a discussion about teenagers' actions in the opening sequences of the 'story', with the teenage actors talking about the safe and unsafe behaviours shown. A number of rules for safe travelling are given. Each video ends with a recap of specialised road safety vocabulary including signed to written translations of key words.
Comments	

Reference	Oxfordshire County Council Environmental Services. <i>Footsteps. A traffic awareness programme.</i> Oxford, Oxfordshire County Council, publication date unknown (circa 1991).
Type of resource	Pack containing leaflets, posters, stickers, information for parents and childminders, tutor's guide (2nd ed.), sheets of background information.
Target group	Original version aimed at children aged 5-7 years. Pre-school version for children aged 3-4 years. Tailored versions have been created for childminders and for Travellers/Gypsies. Not specifically designed for special needs but staff work with trainers of children with disabilities to tailor the programme to individual requirements.
Type of training	Practical roadside training, one volunteer tutor to one or two children. Limited amount of classroom time.
Description	It is the policy of Oxfordshire CC that every child is entitled to Road Safety training regardless of special needs, except where the child is not capable of benefiting from training (according to his or her doctor or other consultant). Parents receive a training video and booklet from their health visitors. This is intended to send the message that road safety training is the parents' responsibility. This early training is reinforced at school using volunteer tutors, recruited from the community or parents. Tutors are trained by the council's Road Safety Group. During roadside training, children are encouraged to discover safe practices for themselves, rather than being given instructions. Training takes place in three stages, consisting of 19 'steps', progressing from basic to more complex situations and skills. Each training session lasts approximately 15 minutes and takes place about once a fortnight. Individuals take four to five years to complete the programme. They receive certificates of achievement for completing sections of the course. Children with special needs are expected to reach the same standards of safety as other children in order to receive certificates. Written materials are used mainly as an <i>aide memoir</i> for tutors, instructors and students. Classroom resources are provided to reinforce the practical training.
Comments	Above information is partly based on an interview with Ian Harris, Principal RSO, Oxfordshire County Council, 4 October 2001.

Reference	Phillips, S R. <i>Everyday skills pack – road safety</i> . Dundee, Dundee Healthcare NHS Trust, 1995.
Type of resource	Series of 26 mini videos on three video cassettes with manual, table-top games, photographs and progress records.
Target group	People with learning difficulties (no ages specified).
Type of training	Practical roadside training with classroom preparation and support.
Description	Students are trained individually according to personal action plans, which are agreed upon by both student and trainer. Training begins with assessment and may then take one of two routes: either a Foundation level course, which builds basic knowledge of the road environment, or the person may be ready to go directly to the Road Crossing course. Very detailed instructions are provided on using the videos and other pack materials in assessment, conducting assessments outdoors, creating an action plan, and completing record sheets. The manual provides examples of completed record sheets and other documentation and step-by-step guidance on conducting classroom and roadside teaching activities. Although the programme is designed in stages, it is expected that trainers will adapt and tailor each section to the needs of individual students. Eleven crossing situations are presented in the videos which are intended for use in priming and recapping before and after practical roadside pedestrian training. The photo pack includes examples of safe and unsafe behaviours and crossing situations. The author is working on a new version of the pack which will use CD-ROM technology rather than videos.
Comments	Above information is based on an interview with Stan Phillips (01382 346 045) on 5 November 2001. Mr Phillips no longer works for the NHS Trust in Dundee. He recently completed an M.Phil. degree with a project comparing delivery of RSE to children with learning difficulties by either professionals or carers (see also Phillips and Todman, 1999, in Appendix B).

Reference	Pountney, J. <i>Street Scene for people with learning disabilities</i> . Birmingham, RoSPA, 1993.
Type of resource	Booklet (8 pages)
Target group	People of all ages with learning disabilities.
Type of training	Classroom. It is intended to provide a starting point in road safety education, prior to practical, roadside pedestrian training.
Description	<p>This is a set of five activities using the Street Scene pack of 24 colour photographs (another RoSPA road safety resource, available separately). The aim is to help students develop an awareness of risks associated with being a pedestrian. The first lesson focuses on getting students familiar with the <i>Street Scene</i> photographs. It can be enhanced by taking photographs of the local area in which will students eventually make regular journeys. This is followed by sessions designed to teach and expand road and safety-related vocabulary, which may include a walk during which students identify and tick off on a checklist various items they see along the way (e.g., traffic lights, pedestrian refuge). Lesson three focuses on teaching the concept of ‘danger’. As well as helping students to identify sources of danger in their environment, this section includes a discussion of actions that students can take to keep themselves safe in various situations. In the fourth lesson, students use the photographs to identify safer and more dangerous places to cross the road, and in the fifth part of the course the students examine one of their regular journeys in detail, focusing on the safety aspects. Learning activities may include taking a series of photographs of stages of the journey, especially danger areas such as road crossing points. Guidance notes for each lesson include advice for teachers on preparing the lesson, use of materials, discussion points and ideas for follow-up activities. The <i>Street Scene</i> pack was designed as a flexible resource for use with groups of students. It is accompanied by suggestions for activities appropriate for each age group from parents and professionals to primary school pupils and children with special needs. It does not require literacy. The aim is to ‘encourage discussion about safe road crossing procedures’ (RoSPA, 1993).</p>
Comments	

Reference	Ridler, A. <i>Look out, look out ... for Oscar.</i> Stoke on Trent City Council, Stoke on Trent, 1990.
Type of resource	Video
Target group	Deaf children.
Type of training	Classroom
Description	The film uses Oscar, an eagle owl at a nature reserve in Staffordshire, as a road safety mascot. Film sequences in the park focus on Oscar's sharp eyes, how he turns his head to focus in different directions, and so on. These are interspersed with sequences showing traffic moving through city streets. The camera zooms in to highlight dangers such as fast-moving traffic, vehicles changing lanes or turning, fog which reduces visibility, and emergency services vehicles with sirens. Safe crossing places and safe and unsafe behaviours are also highlighted. The main messages are emphasised in simple sub-titles, sometimes accompanied by a picture of Oscar. Children from the Mount School for the Deaf were filmed taking part in road safety lessons in the classroom and demonstrating safe behaviours outdoors in the traffic environment.
Comments	

Reference	Robertson, J. <i>A life skills manual: personal safety</i> . Bicester, Winslow Press, publication date unknown.
Type of resource	Book
Target group	Not clearly specified. Book is intended for use by occupational therapists, teachers and other professionals engaged in preparing people for independent living in the community.
Type of training	Classroom
Description	Three pages of the 'Safety in the Community' section of the book are devoted to road safety. The objectives of this chapter are to draw attention to the vulnerability of pedestrians and cyclists and provide basic rules to enhance safety while walking or cycling. Facts and figures on accident and injury rates among cyclists and pedestrians are given, followed by lists of rules for safe behaviour. These include warnings about conspicuity, the Green Cross Code, impact of hoods and radio headphones on the ability to hear traffic noise, etc. Rather than specific, practical guidelines, many of the rules are of a general nature (e.g., for cyclists: 'It is safer to assume that a motorist has not seen you, even if you have right of way. It is especially important to allow for this at a junction.' (p. 53). One teaching strategy is suggested. Trainers are advised to involve students in designing a board game in which players travel from the 'start' to 'home' along a street, with squares either rewarding safe behaviours (e.g., 'Cross road by subway – move on five squares') or penalising dangerous behaviours (e.g., 'Dash across road to catch a friend – miss a go').
Comments	

Reference	Safety Centre (aka 'Hazard Alley'), Milton Keynes
Type of resource	Film set with 12 scenarios designed to teach children through experience about dangers on the roads and in other environments. Children tour the centre with volunteer guides. It includes a street scene with a Zebra and a Pelican crossing.
Target group	Children aged 7-11 years, special needs students of various ages, adults and special needs students doing NVQs, adults undertaking health and safety training.
Type of training	Practical training in simulated environment.
Description	Tours take an average of two hours, but for special needs groups this is often reduced to an hour or less. Staff are guided by the clients' carers according to what length of time they can cope with and which scenarios may be appropriate. For example, some clients may only tour the home, fire and road safety scenarios. Children are presented with various potentially dangerous situations (e.g., railway tracks, electricity substation). The intention is to teach them why these things are dangerous and how they should react. In the road safety scenario this includes learning about speed and stopping distances, the value of seatbelts, the importance of cycle training, bicycle maintenance and cycle helmets, conspicuity of various colours and materials in daylight and darkness, and strategies for crossing the road safely including use of pedestrian crossings. Advisory packs are sent to teachers in advance. These provide advice on preparing the class for the visit and also contain many ideas for follow-up activities linked in with National Curriculum work. For road safety, these include: safe route planning, reaction times, forces (seatbelts), visibility of different materials, stopping distances and speed, and devising ways to teach the Green Cross Code to younger children. The advisory pack also suggests sources of further help for teachers (e.g., RoSPA, RSOs). The pack is not tailored to special needs but some activities will be suitable.
Comments	Above information is based partly on an interview with Keith Wheeler, 2 October 2001. The Safety Centre is a registered charity.

Reference	Scottish Road Safety Campaign. <i>Paving the way.</i>
Type of resource	Resource pack consisting of core and extension materials in the form of tutors' booklets, 29 A4 colour photographs and photograph reference grid, an assessment profile booklet and laminated flash cards.
Target group	People with learning difficulties, from children up to age 65.
Type of training	Roadside pedestrian training, some classroom activities.
Description	This scheme is currently used by Lancashire County Council in the following way. A former Road Safety Officer who now works with a disabled children's trust trains other trainers to deliver <i>Paving the Way</i> . Trainers who complete the course receive a certificate. More than 100 people have been trained to date, and these trainers are employed in the private sector and by Lancashire Social Services Directorate. Lancashire County Council monitors the delivery of the scheme in special schools and colleges. The course is considered a benchmark, rather than a set method of training – trainers are expected to adapt it for their own use according to where their clients are living or studying. Staff from the Road Safety section of Lancashire County Council have an advisory role, encouraging trainers to use the programme and to integrate it into life skills training. The length of the training course varies between students: 'It has to be adapted to each individual's needs and if it takes six months for them to recognise a kerb that's how long it can take. Training should never stop' (Peter Byers, personal communication, 3 October 2001). Clients receive certificates recognising the level to which they have been trained, ranging from being able to recognise and name things in the street (e.g., kerb, pavement) to performing a complicated road crossing.
Comments	Above description is based partly on an interview with Peter Byers, RSO, Lancashire County Council, on 3 October 2001, and partly on information from the Scottish Road Safety Campaign web site, www.road-safety.org.uk . <i>Paving the Way</i> won a Prince Michael Road Safety Award in 1995.

Reference	Staffordshire County Council. <i>Wheelchair road safety award.</i> Staffordshire County Council, circa 1999.
Type of resource	Notes for trainers; certificates of achievement.
Target group	Children using wheelchairs
Type of training	Practical training in school grounds (Bronze level) and traffic environment (Silver and Gold levels)
Description	This training programme is based closely on the RoSPA scheme. It consists mainly of practical training conducted by schools, with assessments carried out by the RSOs from Staffordshire County Council. There are three levels of awards: Bronze, Silver and Gold. At Bronze level, children are tested on an obstacle course within the school. At Silver and Gold levels, children travel to local shopping centres and perform a series of tasks (such as going into shops and asking prices of certain items, looking out for other pedestrians, using pedestrian crossings, etc) with the assessor trailing them at a distance.
Comments	

Reference	Sturmer, R. <i>Stride ahead in safety</i> . Northorpe, LBV Television, circa 2000.
Type of resource	Video
Target group	Adults and young people with learning difficulties.
Type of training	Classroom preparation for practical travel training.
Description	<p>This resource was designed for use by Road Safety Officers in special schools, and by staff in residential homes and adult centres. It extends a photo-based pedestrian training pack, <i>Assessment for Coping in Traffic</i>, which was developed by the same author about nine years ago and distributed by the Royal County of Berkshire. The photo pack is now out of print. The video features six adults with learning disabilities who had received pedestrian training supported by the photo pack. They demonstrate safe strategies for walking on pavements and crossing roads in a wide variety of locations. Messages are simple, short and repeated numerous times throughout the video. They include watching for hazards on footpaths (e.g., driveways, other pedestrians, bus queues) as well as cues for safety such as textured surfaces at safer crossing points. Careful, thorough looking and listening for traffic is demonstrated repeatedly and detailed advice is given on finding safer places to cross and good practice for using pedestrian crossings. Behaviours identified as particular problems among people with learning disabilities, such as walking along the very edge of the kerb, and being attracted to sirens of emergency vehicles, are addressed in the video. It closes with an interview with one of the stars of the show, who explains how pedestrian training has improved her life through greater independence. She advises trainers to let people learn 'at their own pace, to build up their confidence' and not to rush them, but to take care. The main safety messages are then repeated again in a series of 'bullet points'.</p>
Comments	<p>Above information is based on an interview with Rosemary Sturmer, (Babtie Berkshire, 0118 988 1581), 30 October 2001. The author produced the video in her own time on a low budget with sponsorship from a small film company in Lincolnshire which also publishes and distributes the video. There had been 'great demand' for the video but resources for marketing were extremely limited. In 2000 the video won joint first prize in the BP/IHT Road Safety Award for Innovation.</p>

Reference	Taylor, P D, and P Robinson. <i>Crossing the road: a guide to teaching the mentally handicapped.</i> Kidderminster, British Institute of Mental Handicap, 1979.
Type of resource	Booklet (40 pages)
Target group	People with learning difficulties. Age group is not specified but trainees are referred to as 'boys and girls'.
Type of training	Practical roadside training with some classroom activities.
Description	Basic crossing skills are listed and then discussed in greater detail, paying attention to potential hazards and strategies to ensure safety. Trainers are advised to keep detailed records of each students' progress, to lead by example, to give a running commentary of their own road crossing strategies and to reward correct behaviour. Regular opportunities for practice, with occasional reinforcement, are recommended. A suggested teaching plan is provided, but the authors point out that this will have to be adapted according to the students' local environments, language skills and general ability levels. The whole sequence of crossing skills are taught in context and in a logical order. There are eight phases of training, with less physical and verbal support provided at each stage, until the student can perform the whole sequence of skills with minimal supervision. Detailed suggestions for dealing with particular challenges in the training are offered. These include using toys to make a model street, moving toy vehicles about and asking students to indicate when it would be safe to cross. Listening exercises and observation games are suggested and the authors also describe several games for teaching students to obey the instruction 'Stop!'.

Comments

Reference	Thomas, R. <i>Crossing roads safely</i> . Perthshire, Grangewood Video Productions, 1988. (Booklet revised and re-printed in 1998 with illustrations by Steve Earl.)
Type of resource	Booklet and video containing six 'mini-videos' with signing.
Target group	Children and adults with learning and communication disabilities.
Type of training	Practical training in the schoolyard and at the roadside, with classroom activities to prepare for and reinforce practical sessions.
Description	<p>Training begins with a series of exercises to develop co-ordination and physical skills such as stepping on and off the pavement, walking in a straight line keeping the head up, and when and where to look when crossing roads. These are conducted in a school hall or day care centre. Practical sessions focus on the Green Cross Code, crossing where there is an island, using zebra crossings and pelican crossings. For junior school students, skills are practised in the school yard only, while senior and adult students have two sessions on each topic, one in a safe place and the other at the roadside. Each practical session is reinforced by a mini-video which are intended to be used regularly in the class or day centre timetable. Two additional mini-videos – subways and footbridges – are provided for use in theory sessions and to prepare for spontaneous practical sessions should students encounter these facilities during daily activities. All videos feature an instructor and two young people crossing the road using safety skills, with signed and spoken instructions and plenty of repetition. 'Curriculum checklists' listing class work and practical work for each key skill are provided. The training programme is intended to be flexible and stages can be repeated as many times as necessary until the teacher is confident that the students can cross unaided. The booklet also contains assessment sheets which can be copied.</p>
Comments	

Reference	Wale, C. <i>A framework towards developing wheelchair proficiency schemes for manual and electric wheelchair users.</i> Birmingham, RoSPA, 1999.
Type of resource	Leaflet (4 pages).
Target group	Users of electric and/or manual wheelchairs of all ages.
Type of training	Practical with some theory components.
Description	<p>RoSPA's syllabus was developed more than 20 years ago based on proficiency schemes for cycling and Class 3 Vehicle use. It was updated to provide a starting point for those wishing to develop training and assessment schemes suitable for the specific needs and local circumstances of user groups. The abilities and limitations of each client must be taken into account in the design of such training programmes. Overall, the aim of the award scheme is to increase the independence and safety of wheelchair users through progressive training. In order to receive an award, users must demonstrate a minimum set of requirements for competency and safety at three levels: bronze, silver and gold. People who have obtained all three awards are recognised to have achieved high levels of independence and to be able to use their wheelchairs safely and efficiently in all situations they are likely to encounter. They will also have an understanding of wheelchair maintenance. The requirements of the tests must be adhered to, but testing can be adapted to cater for those with special needs. For example, a candidate who does not speak can be tested on the knowledge aspects of the award by using carefully structured questions that require only a nod or shake of the head, or similar. It is suggested that local Road Safety Officers or Police Officers are involved in the examinations in order to enhance the status and credibility of the training scheme. A working knowledge of the Green Cross Code and relevant parts of the Highway Code is expected at the Silver level of both the manual and the electric course. At the Gold level, users must cross roads using pelican and other pedestrian crossings, go up and down kerbs and use their chairs in a shopping area. No suggestions are given for how such road safety skills should be taught. Two examples are given of how the framework can be adapted to suit local needs.</p>
Comments	

List of additional resources identified in search of ROSALIND database (BITER) as suitable for children with special needs. Note that materials defined as suitable were not necessarily *designed* for use with these students. None of those listed have been obtained by the reviewers. Availability is unknown.

Find the Pairs (publication date unknown) is distributed by Hazel Mill Toys Ltd. It consists of 60 cards which are used in a memory game for two or more players. The aim is to strengthen road safety awareness while players compete to collect pairs of cards.

Safe And Sound (1989, out of print) consists of two miniature road systems complete with signs and markings. Published by Galt Educational, it is designed for use on the classroom floor, with one programme aimed at infants and the other at juniors (the complete programme covers ages 3-11 years).

Traffic Signs (1993) and *Zebra Crossing* (1993) are both distributed by Galt Educational (and perhaps have replaced *Safe And Sound*). The first set features two stands and a set of 12 common road signs with suction cups to attach them to the stands. It can be used with the *Zebra Crossing* play mat (and other available items such as a crossing lollypop and traffic lights) for role playing in the classroom. The aim is to increase safety awareness among children aged 3-14 years.

Tufty's New Fire Engine (publication date unknown, out of print) is a set of slides/photos plus notes for teachers or parents, designed for use with children aged 5-7 years. It revolves around the story of Willy, who takes Tufty's new fire engine into the street and gets involved in a crash with Policeman Badger's car.

What Would You Do? (publication date unknown) presents eight situations, each with five possible actions, to stimulate discussion of values and safety among students aged 5-8 years. The aim is to raise awareness of hazards for pedestrians and cyclists. The pack contains eight situation cards and 40 action cards.

Other resources published by Leicestershire County Council which are considered suitable for children with special needs include:

- *Quiz sheets* (1994), a set of multiple-choice questions to test road safety knowledge on such topics as traffic signs, highway code and cycling, for ages 9-14 years;
- *Safety posters* for primary schools (1994);
- *Don't Put Your Life at Risk on the Streets* (1992), an A3-sized picture and workbook for use with groups of students aged 11-12 years, who identify good and bad behaviours and devise a set of rules for staying safe on the road;
- *Playing Safely* (1990) and *Words & Numbers* (1990), two interactive eight-page workbooks for ages 5-7 years, designed to complement each other and to support early road safety education;
- *Match-Ups* (1989), a matching game consisting of four square boards with 36 matching cards suitable for children aged 2-5 years.

Measures that include provision for people with disabilities (from local transport plans)

Northumberland - no reference found

Co. Durham - no reference found

Lancashire - no reference found

Cheshire - *All crossings* - dropped kerbs, tactile surfaces; *controlled crossings* - rotating cone underneath push button to help visually impaired (rotates when 'green man' showing). Appropriate design of street furniture and avoidance of unnecessary clutter and obstruction of footways and pedestrianised areas.

Derbyshire - equipped controlled crossings (as above)

Nottinghamshire - no reference found

Lincolnshire - no reference found

Shropshire - Develop area-wide schemes for dropped kerbs and tactile paving; upgrade controlled crossings; provide handrails and ramps; provide high quality disabled parking spaces. Provision for disabled cyclists who often use non-standard bikes; good design of cycling facilities to avoid conflict between disabled and cyclists (e.g. raised white line to segregate pedestrians and cyclists, tactile paving at all dropped kerbs, removal of barriers and provision of dropped kerbs and ramps).

Strategy to encourage more walking for short journeys, through provision of quality walking routes and wider improvements to the pedestrian environment - many of these improvements to benefit people with disabilities, particularly safer crossings and upgraded footways. To ensure that all new development and highway works consider opportunities for improving access for people with disabilities and do not inadvertently make conditions worse.

Staffordshire - Crossing facilities catering for people with disabilities, e.g. tactile surfaces, dropped kerbs. 'Barrier'-free routes. Improved pedestrian routes.

Leicestershire - no reference found

Herefordshire - no reference found

Warwickshire - Attention to gradients of crossfalls where dropped kerbs are provided. Car park layouts designed for mobility impaired, and consider safety of those crossing car parks. Path access to public transport to be suitable for mobility impaired. Mobility impaired to be considered in home zone design. General improvement of accessibility standards.

Hampshire - design of crossings to cater for people with disabilities: tactile surfaces at uncontrolled crossings (2000 sites treated). All Pelican, Puffin and Toucan crossings have audible warning or tactile devices. High visibility bands on street furniture for partially sighted. Provision for pedestrians, especially those with mobility impairment, including: use of rigid barriers with tapping rails to protect pedestrians from excavations and road works; regular inspection and audit of the signing and guarding to ensure that the quality is being achieved is a key element in the improvements obtained. To ensure that footways and pedestrian areas are clear of obstructions such as advertising boards and overgrown vegetation. Shared use footways: clear highlighting of pedestrian and cyclists' sections. More careful siting of signing - combining items where appropriate. Develop further the dialogue with district councils, walking and disability groups. Disability audit of all new schemes, involving disability groups in the audit process. Take account of mobility impaired when designing new housing estates.

Northamptonshire - General improvement of accessibility standards. Provide accessible infrastructure. Bring all crossings up to standard for use by people with disabilities during lifetime of LTP.

Cambridgeshire - Improve quality of facilities to cater for people with disabilities.

Norfolk - no reference found

Suffolk - Particular needs of mobility impaired people recognised. Remove obstructions to travel, e.g. consider wheelchair users as pedestrians, e.g. provision of dropped kerbs at crossings and junction crossing points. Tactile paving, rotating cones at controlled crossings. Adopted design standards for footways including unobstructed widths, provision of dropped kerbs and footway lighting. Improve surfaces for mobility impaired.

Gloucestershire - Mobility impaired second in priority in road user strategy after pedestrians (in hierarchy of road user categories).

Oxfordshire - Install more controlled crossings with tactile surfaces. Develop disability audit of highway and transport schemes. Vulnerable road user audit to ensure that the needs of pedestrians, cyclists and people with disabilities are considered.

Hertfordshire - provide physical measures using best DTLR Disability Unit advice, with consultation with disabled people and groups. Provide dropped kerbs, pedestrian guard-rails, tactile paving, pelican crossings with beepers and increased lighting; minimise obstructive street furniture on pedestrian routes. Seek to prevent vehicles on the footway by implementing traffic regulation orders, bylaws or physical measures.

Kent - general policy to make controlled crossings disabled friendly (contact said this applies to highway authorities generally).

West Sussex - safety audits include provision for the mobility impaired. Journeys by pedestrians, with or without mobility difficulties, should be 'seamless'.

East Sussex - tactile paving; direct pedestrian routes with minimised gradients, steps and other barriers; properly maintained footway surfaces; pedestrian facility audits; accessibility 'through design'.

Surrey - actively improving facilities for people with disabilities on highway network, e.g. pedestrian crossings with relevant facilities (target 100% after 2001/02). There is a problem installing tactile paving at equestrian crossings as it 'proves to be a hazard for horses'. Audible warning not fitted at these crossings for 'fear of startling the horses'.

Wiltshire - no reference found

Dorset - no reference found

Poole-Bournemouth-Christchurch - contrast marking on steps and changes in levels, provision of dropped kerbs and ramps, centre pedestrian refuges at crossings to ease crossing road for elderly and people with disabilities.

Devon - New sections of footway; new and upgraded pedestrian crossings; pedestrian safety improvements; dropped crossings and other facilities for people with disabilities. Internal walk/cycleway network segregated from traffic circulatory routes and facilitating disabled access.

Somerset - no references found

Cornwall - Improve safety of mobility impaired - no more details.

Hartlepool - A Local Walking Strategy, Access and Mobility Strategy and a Cycling Strategy maximising opportunities for pedestrians and cyclists with consideration for the mobility impaired and people with disabilities.

Portsmouth - an emphasis on facilitating more walking and cycling and improvements that particularly benefit people with disabilities. Target: Ensure that all controlled crossings have facilities for disabled people by 2005. In 1999 only 70% of crossings met this target, by the end of 2001 it was expected that 80% of controlled crossings will have facilities for disabled people. A range of low cost improvements, primarily around the city centre, to improve accessibility for people with disabilities and other mobility problems. Minor changes to roads to provide measures such as convenient dropped crossings, pedestrian refuges where a light controlled crossing is not appropriate and textured paving, etc. Strategy shows pedestrians have a high priority and considers needs of those with disabilities and impediments to walking. Audit of superfluous street furniture would have enhanced the strategy.

Ashfield (Notts) - The creation of a satisfactory pedestrian environment, where the public can reasonably expect to enjoy access, is an essential part of the successful development of new housing, shopping, community facilities and, in some cases, employment areas. This is particularly important for those with mobility impairments, including those with prams as well as people with physical disabilities. In such areas there is a need to consider the provision of special facilities such as

disabled parking spaces, access ramps, handrails, flush kerbs, tactile surfaces and signs for the visually impaired. The layout of a site should also ensure the physical separation, where possible, of pedestrian and vehicle circulation areas. Where physical separation is not possible, measures will need to be included to control vehicle speeds to suitable levels (eg The Home Zones concept). The design and location of street furniture, landscaped areas and tree planting, and the general layout of facilities in relation to car parking areas, public transport facilities and taxi ranks will also be important considerations. This policy will only apply to the external environment in general where public access is usually available. It will not apply to the internal design or layout of buildings where existing controls under the Building Regulations include specific provision for pedestrian and disabled access.

General - The New Road and Street Works Act 1991 makes specific provision for pedestrians, especially those with mobility impairment.

Accessibility standards / pedestrian crossing standards should comply with Disability Discrimination Act 1995 during currency of 2001-06 LTPs.

Appendix B: Understanding road accident risk of disabled children and adults

Introduction

There are 14 references that report numerical associations between disability and enhanced incidence of injury in road traffic accidents. These are listed in Table B1.

Nine of these report the data as an odds ratio for the incidence of injury among disabled subjects relative to others, or give the actual data from which an odds ratio may be calculated.

The odds ratio compares the odds for some event in one population with the odds for the same event in another population. If the probability of involvement in injury in some time interval is p , then the probability of non-involvement is $(1-p)$ and the odds of being injured are $p/(1-p)$. If the probability of injury varies between a disabled population (p_d) and a comparison population (p_o) then the odds ratio comparing the two populations is

$$\frac{p_d / (1 - p_d)}{p_o / (1 - p_o)} \quad (1)$$

The odds ratio may be derived either by examining the incidence of injury in a disabled population and in a comparison population or by examining the incidence of disability in an injured population and in an uninjured population. In this latter case the odds ratio is

$$\frac{p_d / p_o}{(1 - p_d) / (1 - p_o)} \quad (2)$$

This can be rearranged to be identical with the form shown as (1) above. Thus the odds ratio has the same form irrespective of whether the investigation compares the incidence of injury in disabled and comparison populations or the incidence of disability in injured and uninjured populations.

Non-reporting bias

In research, there is a temptation only to report significant results. Thus there may have been investigations of the incidence of injury to disabled populations that have not been published in the open literature because the findings were inconclusive. This could mean that the published results are biased in the direction of revealing an effect where there is none.

A simple test is to plot the reported results against the sample size. Because the precision of a statistical determination increases with sample size such a plot should be widely dispersed for small samples but get symmetrically tighter as the sample size increases (inverted funnel shape). A pattern that is not symmetrical and appears to be approaching unity suggests the existence of a non-reporting bias in the data.

Figure B1 shows odds ratios plotted against number of disabled people involved in a road traffic injury accident. Odds ratios for hyperactivity range from 0.9 to 3.2 (9 values), for hearing impairment from 2.1 to 38.2 (3 values) and for sight impairment from 4.3 to 18.1.

There are insufficient data to be confident that the points do fall within a funnel shape converging for large numbers of the disabled on an odds ratio significantly greater than one. The plot suggests that for future research and similar measures of disability the experimental designer should aim for a design that will produce a minimum of thirty disabled persons involved in road traffic injury accidents.

Dosage effects

The spread of the data in Figure B1 may reflect the range of measures used to determine disability. None of the disabilities shown on the graph represents a discrete condition. For example, hearing impairment may range from profound deafness to significant hearing at least over some parts of the frequency spectrum. The classification of a subject as disabled depends then on both the scale used to measure disability and the criterion level on that scale selected by the researcher.

There is some evidence of variations in injury accident involvement across the scale of disability (Woodward *et al.*, 2000, West *et al.*, 1997). Figure B2 shows data from Woodward *et al.*, 2000. These researchers have looked at the relation between hyperactivity measured at age 13 and involvement in driving accidents at ages 18-21. The figure shows an increase in percentage involvement in injury accidents with increasing hyperactivity, in this case assessed by splitting the experimental population into percentile groups.

The variation across Figure 2 corresponds to odds ratios (calculated with the 0-50 percentile as the reference group) ranging from 1.2 for the 51-70 percentile to 3.3 for the 96-100 percentile. It is likely that some of the variation shown in Figure 1 arises from variations in the definition of disability.

It should be noted that the demonstration of a statistically significant variation with the level of impairment (dosage effect) is usually accepted as equivalent to a fully randomised trial involving experimental and control populations.

Other measures of the effects of impairment

Discussion so far has focussed on references that have either reported odds ratio data or provide the frequency tables that are needed to calculate an odds ratio. There are other analysis designs that are equally valid. Pless *et al.*, 1995, compared children injured as pedestrians or cyclists with children injured as passengers. Cases and controls were similar on most sociodemographic and clinical measures but showed statistically significant differences in scores on a scale of hyperactivity, which was completed by parents.

West *et al.*, 1997, interviewed 1,027 children drawn from the list of a South London health centre supplemented by children who had been treated at hospital accident and emergency centres. The analysis was based on Poisson regression and the researchers reported significant rate ratios for both carer and teacher reports of hyperactivity. The parental and teacher scales were multi-point scales: the

existence of a significant rate ratio with value greater than one points to the existence of an underlying dosage effect.

Guohua Li *et al.*, 1995, assessed variations in the incidence of head injury across a population 2,333 children injured because of a bicycle related injury. They found that, with adjustment for age, sex and motor vehicle involvement, children who had pre-existing mental disorders had a significantly increased likelihood of sustaining head injuries. This meant that children with these mental disabilities and who were injured in a cycle accident were likely to be injured more seriously than other injured child cyclists. The experimental design did not test whether the incidence of cycle accidents was higher among the disabled population.

Conclusions

There is sufficient research on hyperactivity to assert that this is a factor associated with increases in road traffic injury accidents perhaps tripling the odds of involvement for the five per cent who register the highest scores on the scales of hyperactivity.

Significant odds ratios have been reported for populations suffering from hearing impairment or sight impairment, in the range 2.1 to 38.2. The spread in these data is probably associated with the fairly low sample sizes investigated and perhaps this means that individually they are none too reliable. Nevertheless the existence of this group of data points, nearly all above the range of the hyperactivity values, points to problems for the hearing or sight impaired that need further investigation.

Table B1 References reporting quantitative data

<i>Reference</i>	<i>Disabilities</i>	<i>Data</i>
*Christie, 1995	hearing impairment learning difficulties chronic illness	Sample 152 children injured as pedestrians by a motor vehicle and 484 control children drawn from schools in the hospital catchment areas. Higher proportion of cases disabled than controls
*MVA Consultancy, 1989	hearing impairment, vision impairment, hyperactivity	Sample about 380 Scottish children injured as pedestrians in RTAs. Incidence of hearing disability in the sample, 3.6%, significantly higher than in national child population. Incidence of vision impairment in the sample, 6.8%, and hyperactivity, 1.0%, presumably not significantly higher than national child population – not stated in report.
*Roberts & Norton, 1995	hearing impairment sight impaired	Sample children under 15 years, Auckland, NZ, 190 injured as pedestrians and hospitalised, 479 matched controls. Odds ratios – hearing 2.08 (95% CI 0.89 to 4.39), sight 4.32 95% CI 1.64 to 11.62). Odds ratios increased slightly by allowing for confounding variables and further increased by removal of 30 cases where children were struck on a protected crossing. Hearing odds ratio remained just non significant in all tests.
*Gallon & Edwards, 1995	Sight impaired	302 sight impaired independent travellers (adults). Subjects report 17 pedestrian injury accidents in previous five years.
Pless <i>et al.</i> , 1995	Hyperactivity	Sample 848 children injured in RTAs, 286 as pedestrians or cyclists (cases), 562 others (controls). Cases scored significantly higher than controls on parental and teacher assessments of hyperactivity.
*Christoffel <i>et al.</i> , 1996	Hyperactivity	Sample 128 children injured as pedestrians, and 128 uninjured children drawn from same hospital catchments. Non-significant odds ratios reported
*Beck <i>et al.</i> , 1996	Hyperactivity	Adult males aged 18 years and over, 10 subjects with hyperactivity, 10 controls. Odds ratio driving accident involvement 1.75, caused accident 2.4. Before getting their driving licences, controls reported an average of 0.3 accidents each (total: one cycling and two pedestrian accidents) while cases reported an average 1.6 accidents each (total: 13 cycling accidents and 3 moped accidents).
*DiScala <i>et al.</i> , 1998	Hyperactivity	Children 5-14 years old, all hospital admitted for injuries, 240 cases with ADHD, and 21,902 controls. Odds ratio pedestrian injury 1.7 (95% CI 1.26-2.26).
West <i>et al.</i> , 1997	Impulsivity Hyperactivity	Children aged 7-15 years, 1027 from South London. Controlling for sex, demographics and exposure variables – rate ratio for traffic accidents: carer reports impulsiveness 1.22 (p .01) carer reports hyperactivity 1.21 (p .02) teacher reports hyperactivity 1.39 (p <.001)
*Woodward <i>et al.</i> , 2000	Hyperactivity	941 out of a 1,265 birth cohort (Christchurch, NZ) with complete measures of attentional difficulties at age 13 and driving outcomes at age 21. Odds ratios for injury accidents vary with percentile: 0-50%, reference; 51-75%, 1.2; 76-90%, 1.8; 91-95%, 3.2; 96-100%, 3.3 Effect is even greater when account is taken of length of time licence held.
*Guohua <i>et al.</i> , 1995	Mental disorder (mainly ADHD)	2,333 children aged <15 years with bicycle related injuries (60 with mental disorder). OR for head injury and mental disorder 2.37 (95% CI 1.32 to 4.26, p<=0,01)
Strauss <i>et al.</i> , 1998	Developmental disability (mild to profound learning difficulties)	Deaths from external causes (accidents, suicide, homicide) among all people with developmental disabilities compared with general population of California, 1981-1995. Raw injury death rates from pedestrian accidents per 100,000 person-years: disabled 8.04, non-disabled 3. Standardised mortality rate (adjusting for age and gender) 2.85 (95% CI 2.17-3.68).
Backett & Johnston, 1959	Intellectual ability	34 children, aged 5 to 14 and involved in a pedestrian RTA, and 34 controls not involved in RTA. No significant difference found – data not reported, test probably chi-square.
Lind and Wollin, 1986	Physical disability (incl. fainting, vertigo)	446 adults injured in cycling accidents in Sweden, not under influence of alcohol. Of these, 15 (3%) claimed dizziness, fainting or vertigo or 'some other physical disability' as an important cause of the accident.

* Odds ratio reported or derivable

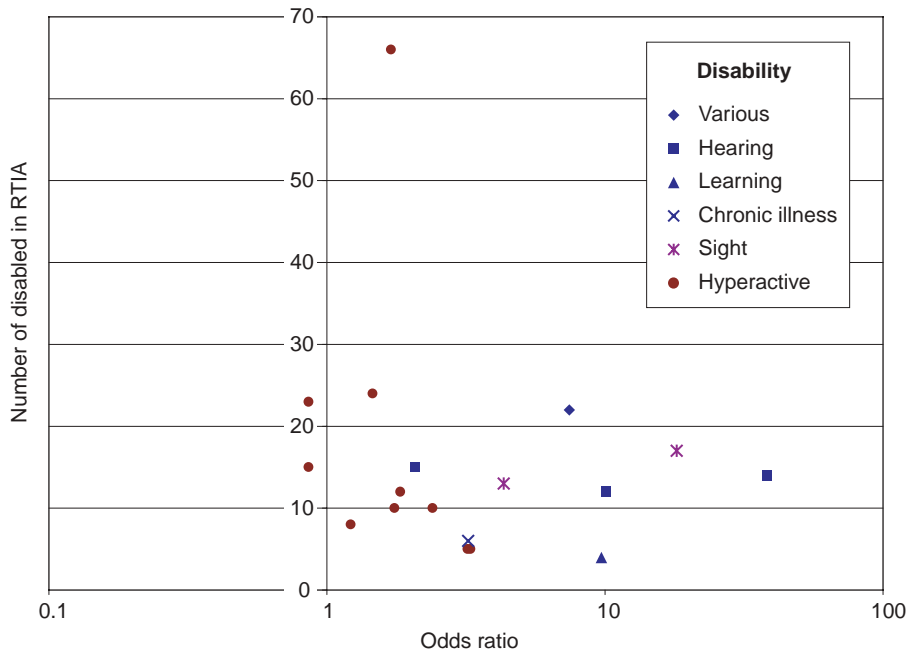


Figure B1 Funnel plot

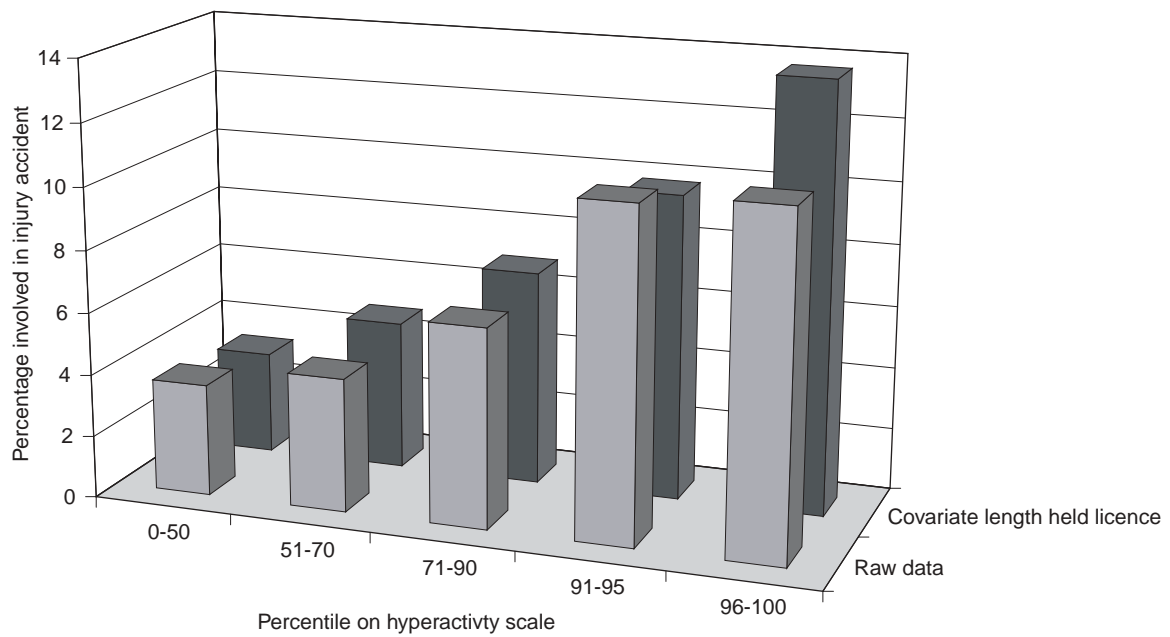


Figure B2 Variation in accident incidence with level of disability (hyperactivity)

Appendix C: Annotated bibliography - evaluating RSE for disabled children

Reference	Bailey, B R, and D N Head. Providing O&M services to children and youth with severe multiple disabilities. <i>RE:view</i> , 1993, XXV , 57-66.
Target group	Children with severe multiple disabilities including vision impairment.
Type of training	Practical training on specific routes using task-and-discrepancy analysis.
Description	<p>The traditional, medical O&M model addresses an individual's various 'problem areas' separately with specialist training in specific skills. This model is less useful with children with severe, multiple disabilities for two reasons: first, they may not master skills in the usual developmental sequence; and second, they have difficulty generalising skills learned in one setting to other settings and integrating the skills with other behaviours. Consequently, basic skills learned in isolation may never become incorporated into their daily living. An alternative approach to O&M training, proposed by the authors, is to teach skills within the context of a meaningful task that the student is likely to perform regularly. One such task may be walking to a shop to buy ingredients for a snack (making a shopping list and preparing the food also form part of the same sequence of training). The O&M instructor first assesses the student's ability to perform all the components of the task and identifies areas in which the student is 'discrepant'; that is, where training is required. This process is called 'task-and-discrepancy analysis'. Discrepancies in important areas of functioning become the focus for the whole team of professionals serving that client, including occupational therapists, physical therapists, speech therapists and O&M instructors. For example, having noted that a child is unable to cross the road safely, the O&M instructor will break this task down further into steps and devise strategies and prompts to help the child learn. He or she can practise these steps, not only with the instructor, but every time he or she walks along that route with her parents or teacher. This method has several advantages, most notably that skills are learned in the correct sequence and in context - the student is not required to generalise skills from another setting. Both the student and his or her parents are motivated to practise the skills because they form part of a meaningful, functional set of behaviours. Performance is tested against the demands of the real situation. Even if the skills are never mastered and completely independent travel remains unfeasible, the child is still better able to participate in his local environment and gains opportunities to interact with non-disabled people in his or her own community.</p>

Reference	Beveridge, S, M Chambers, W Hudders, B Stiell and P Wiegand. Promoting independent wayfinding. <i>The SLD Experience</i> , 1997, 18 , 11-12.
Target group	Children and young people with learning difficulties.
Type of training	No training provided. Study evaluated existing skills.
Description	<p>Young people with learning disabilities may have problems with memory, literacy, interpersonal skills and confidence which can limit their ability to travel independently. For some people, these difficulties are accompanied by physical and/or sensory impairments. To a large extent, children's ability to overcome these difficulties depends on their physical environment (e.g., traffic volumes, lack of pedestrian crossings) and the social support available to them. In the first stage of this 18-month project, questionnaire data were collected from 444 young people with learning disabilities, their parents and their service providers. Information was sought about their levels of confidence, skill, motivation and enjoyment in travelling independently, along with the extent of their experience of independent way-finding. Key staff at all schools, adult centres and colleges in the Leeds and Bradford areas catering for students with learning disabilities were interviewed to determine how way-finding was typically taught, including the materials and strategies used and how this learning was incorporated into the curriculum. Case studies were then conducted with approximately 24 young people, chosen to be representative of a range of experiences. Interviews were conducted to collect data about each subject's home range, degree of independence and short- and longer-term aspirations of the child, his parents and staff with regard to independent travel. Project team members then accompanied each subject on a familiar walk and an unfamiliar walk in order to identify and record their way-finding strategies. A third walk with each subject was also planned. This would be used to focus on strategies for particular tasks, one of which might be crossing the road. In the last phase of the project, materials were to be designed to support young people's learning of independent way-finding skills. These were intended to be trialled at some of the schools and colleges involved in the questionnaire phase of the research.</p>

Reference	Budd, J M and S J LaGrow. Using a three-dimensional interactive model to teach environmental concepts to visually impaired children. <i>RE:view</i> , 2000, 32 , 83-94.
Target group	Children with vision impairments and no learning difficulties. Ages 7-11 years.
Type of training	Classroom
Description	Four vision-impaired children were trained to navigate a doll around a model of the environment directly around their school. The knowledge gained through this training generalised to the real environment, as measured by the children's ability to answer questions and perform tasks, such as finding routes, in the region of the school. In the first of three discrete stages in training, children were introduced to concepts such as roads, footpaths, kerbs, pedestrians, driveways and some traffic signs and signals by allowing them to touch and manipulate the corresponding pieces of the model and to make basic road and footpath layouts with them. In the second stage, concepts such as traffic lanes, one- and two-way traffic, pedestrian crossings, intersections, rights of way and parking were introduced. Children made road layouts and moved dolls and cars around these to demonstrate the concepts they had learned. The third stage introduced concepts such as directions, landmarks and reference points, destinations and route planning. Two to four training sessions were required by each child for each stage of the training, and assessments took place after each training session. The authors discussed the advantages of using a model to teach visually impaired children about the road environment. Children with little or no vision are able to explore road layouts and demonstrate traffic flows and routes tactually, while those with some residual vision can also visually explore the model more easily and efficiently than they could a larger-scale environment. The model is interactive and can be used in play activities which will consolidate the concepts learned during training. It can be adapted to suit local environments, is convenient and enables safe exploration before children venture into real traffic situations.

Reference	Ellis, R. Teaching mobility to visually impaired children in a special school. <i>British Journal of Visual Impairment</i> , 1991, 9 , 7-9.
Target group	Children with vision impairments. Some trainees also have moderate to severe learning difficulties and/or physical disabilities.
Type of training	Practical, beginning in school yard and moving to various roadside locations.
Description	<p>Mobility training for visually impaired children differs in two important ways from that given to adults. First, children cannot be expected to learn all the available skills and techniques at one point in their development. Instead, training must be tailored to their levels of maturity, abilities and needs, and will be part of an ongoing process of assessment, teaching, monitoring and evaluation. Second, mobility programmes for children should be oriented towards learning skills which can be transferred among different settings, rather than learning routes or addressing other specific personal requirements. For example, mobility lessons at a railway station may provide an adult learner with the skills needed to travel independently by train in the future, while for a child learner it is an opportunity to gain and reinforce a wider range of skills in mobility, using sensory information and interacting socially. These lessons will be valuable whether or not the child ever attains completely independent mobility. This report describes mobility training at The West of England School in Exeter, Devon, a school of 150 pupils (in 1991) served by three mobility instructors. Mobility is taught individually in sessions of 20 minutes to two hours duration. Training begins in the school grounds and immediate locality, moving later to less familiar areas in order to ensure that students understand that their skills can be applied in a wide variety of situations and locations. The school also caters for children with multiple impairments including moderate and severe learning disabilities. According to the author, many of these children will never achieve high levels of independent mobility, and so the standard mobility syllabus is 'largely irrelevant to their needs' (p.8). Instead, they are provided with experiences which stimulate their sensory and perceptual development. Physically disabled children at the school receive modified, structured mobility training. Mobility training is supported by links with other teachers at the school, parents and mobility specialists within each child's home area, ensuring that the skills are constantly implemented, monitored and reinforced.</p>

Reference	Horner, R H, D N Jones and J A Williams. A functional approach to teaching generalized street crossing. <i>JASH</i> , 1985, 10 , 71-78.
Target group	Two children and one adult with learning difficulties.
Type of training	Practical roadside training.
Description	<p>The authors raised two concerns with previous studies testing methods of training people with learning disabilities to cross the road safely. First, the dependent variable was often defined as the number or percentage of task components performed successfully. This has limited practical value, as the desired outcome of training is that the student is able to initiate road crossing safely every time. Second, previous attempts to test whether training has generalised beyond the immediate training setting (i.e., the classroom, mock intersection or training site) have used a limited number and type of non-trained intersections. The current study aimed to teach students to cross any street in their home town, a city with a population of approximately 120,000. Subjects were a 12-year-old boy, a 16-year-old girl and a 53-year-old woman, all with profound learning disabilities. Training consisted of walking around a circular, set route with eight intersections (each crossed at least once on the outward and return journeys respectively), with the trainer escorting the student to each street and instructing them to 'cross when you are ready'. Verbal and physical prompts to stop, go, look etc., were provided where needed and correct responses were reinforced with praise and (in the case of one subject) coins. Assistance and feedback were gradually withdrawn over trials as the students' performance improved. Performance was tested on 10 streets chosen to represent the full range of traffic conditions and intersection types subjects were likely to encounter while travelling independently in their home town. Both of the trained subjects (the boy and the older woman) improved from low baseline levels to correct crossing on 85% of the initial experimental trials, increases which were maintained and improved during subsequent experimental trials. The boy reached this level following 15 training sessions (358 trials) and the older woman took 11 training sessions (264 trials). The girl was withdrawn from the experiment before training was completed. By systematically sampling the range of traffic conditions and intersection types subjects were likely to encounter in their daily travels, the experimenters were able to demonstrate that training produced functional, safe behaviour in subjects' normal environments. However, neither of the trained subjects reached a level of 100% correct crossings immediately following the 'general case' training, requiring ongoing instruction. This raises questions about when it is appropriate to terminate training.</p>

Reference	Phillips, S and J Todman. Pedestrian skills training for children with learning difficulties. <i>International Journal of Rehabilitation Research</i> , 1999, 22 , 237-238.
Target group	Children with learning difficulties, aged 10-16 years.
Type of training	Practical roadside with some classroom activities (for details see <i>Everyday skills pack – road safety</i> in Appendix A).
Description	This study looked at the effectiveness of a single road safety education package delivered by two different types of trainers – home-based carers and service providers (i.e., professionals). Students, who were 30 children aged 10-16 with learning difficulties, were divided into two groups matched on age and initial pedestrian safety assessment scores. Both the carer-led and the professional-led groups used a road safety package developed for the Dundee Healthcare NHS Trust, which included assessment methods, instructional videos, table-top games and progress reports for use in training activities. It was unclear whether any roadside training was involved. Following six months of training (the number of sessions per week was not stated), children taught by home-based carers performed significantly better than those taught by professional service providers on both the road safety knowledge test and the road safety skills test. The authors concluded that carer-led training in road safety skills produced significantly greater gains than provider-led training and had the potential to save provider time and expense.

Reference	Rusch, F R and L W Heal. Investigating students' ability to cross intersections utilizing cognitive strategies in a CAVE Automated Virtual Environment. (<i>Unpublished report available from first author.</i>)
Target group	Children with learning difficulties and non-disabled children.
Type of training	Practical training in simulated environment.
Description	<p>This experimental study tested the effectiveness of self-instructional strategies in learning safe road crossing skills. Subjects were 81 children from seven schools, ranging from elementary and middle schools to high schools. Forty-one of the participants were special-education students with a range of learning disabilities, and 40 were general education students. There was random assignment from each of the two ability groups to either the experimental (self-instructional) or control (no strategy) conditions. Students in the self-instruction condition recited four statements before attempting to cross the (virtual) road. These were: 1) <i>Walk</i> to the corner; 2) <i>Look</i> to your left, then to your right; 3) If no cars, then quickly <i>cross</i> the street; 4) <i>I made it</i> (self-reinforcement). Before trials began, students in the experimental group practised the statements when shown photographs depicting situations requiring these responses. All students had the road crossing task described and demonstrated to them and were trained to use the CAVE. Skills learning and testing took place in a Cave Virtual Automated Environment (CAVE). Users stood within the CAVE, surrounded by screens and wearing stereoscopic glasses, and 'moved' themselves through the virtual environment using a 'wand' to switch directions. Three intersections (with either two or four stop signs or traffic lights) were presented. In addition, there were three levels of traffic: simple (no traffic), typical (one car) and complex (three cars). Students' head movements and verbalisations were recorded during testing, along with the number of virtual 'crashes'. Special needs and general education students in the self-instruction condition outperformed controls at the intersection with traffic lights in all traffic conditions. The self-instruction groups also performed better than controls at the two-way stop sign intersection under typical traffic conditions. General education students but not learning-disabled children in the experimental group also did better at four-way stop sign intersections under some traffic conditions. The authors concluded that the self-instructional strategy was modestly successful in teaching students with and without learning difficulties to cross intersections of varying difficulty and type. Of the 26 virtual crashes, 16 involved students with learning disabilities.</p>

Appendix D: Annotated bibliography - road safety education for disabled adults

Reference	Grossmark, R. Independence skills: learning to use the bus. <i>Mental Handicap</i> , 1983, 11 , 113-114.
Target group	Adults with learning difficulties
Type of training	Practical
Description	<p>This case study describes a structured approach to training a person with learning disabilities to use a bus service to travel between her home (a hostel) and a college where she was receiving Life Skills training one day a week. The subject was a 24-year-old woman with learning disabilities who was already able to use and cross urban and rural roads independently. The return journey was broken down into 17 stages including walking to and from the correct bus stop at either end of the journey, paying the correct fare, ringing the bell at the correct time and getting off the bus at the right place. Training took place one day per week over 11 weeks, and a single follow-up observation was carried out by a person unknown to the subject, one month after the last training trial. Correct behaviours were first modelled by the trainer and verbal and physical prompts were given; these were gradually faded as the subject's performance improved. By the fifth training session, the student was performing 13 of the 17 task components independently and by the 11th session she was able to make the entire journey without assistance. These gains were maintained at the follow-up trial (with the exception of pressing the bell, which required some prompting). The authors concluded that this structured approach, which incorporated constant observation and assessment of the student's performance, enabled her to learn independent travel skills without jeopardising her safety. A side benefit was also noted: the student's poor social behaviour, which had been her major problem, improved noticeably as trials progressed.</p>

Reference	Lewis, J, D J Brown and H M Powell. Development of a virtual environment to teach independent travel skills to people with a learning disability. <i>Proceedings of the 12th European Simulation Symposium, ESS2000, Hamburg, Germany, 2000.</i> (Ed. D P F Moller). 385-389.
Target group	Adults with learning disabilities
Type of training	Practical in simulated environment
Description	A research team in the Department of Computing at Nottingham Trent University have undertaken several projects aimed at using Virtual Learning Environments to teach independent travel skills to people with learning disabilities. One such project was developed in co-operation with Mencap as a method of training a group of people with learning disabilities who worked for the charity at the Enter2000 Virtual Reality Conference at the Millennium Dome in London. The travel training software was tailored specifically to the needs of people with a learning disability. The consultation process with Mencap included the formation of a user group, supported by mentors and a facilitator. Group members helped identify important learning objectives to be included in the software package in order to teach them to travel safely by bus from the Greenwich area to the Millennium Dome site. These learning objectives included crossing roads safely, identifying the correct bus and bus stop, monitoring journey progress and dealing with unexpected problems. The virtual environment was custom built from maps, aerial and ground-level photographs and site visits. Researchers from the University of East London (who collaborated on the software package) evaluated the effectiveness and ease of use of the travel training simulator.

Reference	Marchetti, A G, J R McCartney, S Drain, M Hooper and J Dix. Pedestrian skills training for mentally retarded adults: comparison of training in two settings. <i>Mental Retardation</i> , 1983, 21 , 107-110.
Target group	Adults with learning disabilities
Type of training	Classroom or practical (comparison)
Description	The effectiveness of classroom versus roadside pedestrian training techniques were compared in this experimental study. Subjects were 18 adults between the ages of 19 and 59 years who had profound learning disabilities and lived in a public residential facility. They were randomly assigned to the two different training procedures. Groups of three students took part in two 90-minute training sessions twice a week for 20 weeks. Classroom training involved manipulating a doll around a scale model of city streets, while community training was provided at various intersections in the local area. A checklist of 32 pedestrian skills required in six types of crossings at intersections (no signs or signals, stop signs and three types of traffic signals) was used as a basis for both training and assessment. Each student completed three pre-tests and three-post-tests of these pedestrian skills at three intersections in the local community. On all three post-test trials, subjects given roadside pedestrian training performed significantly better than the classroom training group. This indicated that community (roadside) training was more effective than classroom-based procedures in teaching road crossing skills. The authors suggested that future research may consider testing a combination of classroom and roadside training. Safety rules could be taught in the classroom prior to instruction within the environments in which students would regularly travel, thus overcoming concerns about the lack of generalisation of pedestrian skills from the classroom to the real world.

Reference	Matson, J L. A controlled group study of pedestrian-skill training for the mentally retarded. <i>Behaviour Research and Therapy</i> , 1980, 18 , 99-106.
Target group	Adults with learning disabilities
Type of training	Classroom or practical (comparison)
Description	<p>This study compared classroom training, in which subjects moved figures on a scale model of two city blocks, with independence training, in which subjects practised pedestrian skills at a realistic, life-sized intersection. The intersection, which was within the grounds of the hospital unit where the subjects lived, was equipped with specially constructed, movable pedestrian signs and lights (operated by the trainer) so that students could practise with a variety of signs and signals. Independence training was carried out in groups of three, while classroom training was undertaken individually. Subjects were 30 adults (age range 21-55 years) with moderate to severe learning disabilities who were being prepared for community placement following an average 17 years' (range 4-32 years) living in institutions. They were randomly assigned to three groups: those in the classroom and independence training groups each received 30 minutes' training every day for three months, while the control group received no training. Pedestrian skills were assessed before and after the training period by two raters (blind to experimental conditions) at a city intersection. Classroom training was significantly more effective than no training, while independence training was significantly more effective than either no training or classroom training. The author suggested that the social reinforcement and self-evaluation aspects of the practical roadside training were important, along with the fact that the skills were learned in a more realistic context and so were more easily generalised to a genuine traffic environment.</p>

Reference	Page, T J, B A Iwata and N A Neef. Teaching pedestrian skills to retarded persons: generalization from the classroom to the natural environment. <i>Journal of Applied Behavior Analysis</i> , 1976, 9 , 433-444.
Target group	Adults with learning disabilities
Type of training	Classroom
Description	<p>Street-crossing skills are ‘a prerequisite to any activity involving mobility about the community’ (Page, Iwata & Neef, 1976, p. 443). In this study, five specific pedestrian skills were taught in sequence: intersection recognition (choosing a safe place to cross), crossing at pedestrian lights, crossing at traffic lights, and crossing at two different types of stop signs. Five male students with learning disabilities (age range 16-25 years) learned these skills by manipulating a doll on a scale model of city streets, following instructions from the experimenter. Each skill was broken down into a total of 17 components, including walking to an intersection to cross the street (this is considered safe behaviour in the U.S.), waiting for lights to change or for a suitable gap in the traffic, looking both ways, and walking across without stopping. Before, during and after training, skills were tested both on the model and on a city street under normal traffic conditions. Between 14 and 29 training sessions, each lasting approximately 15 minutes, were required to bring all subjects to a safe standard for crossing the road (17/17 correct responses). Skills were checked again – at least three times for each subject – during the two to six-week period following the end of training. These follow-up tests showed that gains in road crossing skills were maintained. Classroom training using a scale model has several advantages for use with learning disabled people. It is not time-consuming or complicated to administer and does not expose students to danger or public embarrassment. However, there are doubts about whether the skills learned this way would generalise to completely unstructured settings such as a student’s regular journey to work or the shops. The authors recommended further research to test for such generalisation of skills. They also warned that parents of learning disabled people may well resist any attempts to train them in pedestrian skills for fear that this may lead to greater exposure to dangerous situations.</p>

Reference	Sauerburger, D. Developing criteria and judgment of safety for crossing streets with gaps in traffic. Practice note. <i>Journal of Visual Impairment and Blindness</i> , 1999, July , 447-450.
Target group	All ages with vision impairments
Type of training	Practical
Description	<p>The author points out the need for a road-crossing strategy for visually impaired people who wish to cross uncontrolled roads (that is, with no signs or signals to stop the traffic) independently. Half a century ago, students undertaking Orientation and Mobility (O&M) training were told it was safe to cross when they could not hear any traffic approaching. In order to give them confidence that they could cross safely, the O&M instructor would measure the time taken for the student to cross the street, and compare this with the time from when the car was first heard to when it passed the student. If the time taken for cars to arrive was longer than the time elapsed while crossing, the student knew he or she had enough warning to get across the road without being struck by a vehicle. Later variations of this technique were known as the Timing Method for Assessing Detection of Vehicles (TMAD). Now, however, cars are generally quieter and roads are wider and busier, and there are not always sufficient gaps in traffic where no vehicles can be heard approaching. The author therefore proposed new criteria for assessing the risk of crossing the road: first, that there are gaps in traffic that are long enough for the person to cross safely; and second, the person can judge which gaps are safe. In practice, this would involve standing by a road for some time, listening, in order to determine whether there are suitable gaps in traffic. If such gaps exist, the person needs to decide whether he or she is able to detect approaching vehicles early enough to be able to avoid them. The second criterion is the most difficult to judge, but students can usually learn it if given feedback about the accuracy of their judgements. The training procedure recommended by the author involves explaining to students that situations exist in which it is impossible to see or hear traffic well enough to cross safely, and then visiting a street with frequent, intermittent traffic and completing various exercises at the roadside. These would include judging the width of the road (either visually or by listening for cars on the other side of the street), observing the traffic and determining whether they can see or hear vehicles with sufficient time to enable them to cross safely; discussing the impacts of background noise on their safety judgements, and using the TMAD procedure to test their judgements and provide feedback. These steps should be repeated in a variety of situations and traffic conditions.</p>

Reference	Vogelsburg, R T, and F R Rusch. Training severely handicapped students to cross partially controlled intersections. <i>AAESPH Review</i> , 1979, 4 , 264-273.
Target group	Young adults with learning disabilities
Type of training	Practical
Description	<p>Three students aged 17, 18 and 21 years, with profound learning disabilities and difficulties in walking, were individually trained in pedestrian skills at a stop-sign controlled crossroads near their school. Training was conducted during 70 20-minute sessions over a period of 3.5 months by a team of six trainers, working in pairs. Working at the roadside, the instructor first told students to 'walk to the corner, stop, look behind you, in front of you, to your left and to your right; if there are no cars coming walk quickly across the street, step up on the kerb and stop' (Vogelsburg & Rusch, 1979). Feedback was also given (e.g., 'Good, you're looking for cars' or 'You didn't look for cars'). This verbal instruction and feedback was sufficient to teach all three students to approach the corner and to walk across the street, but teaching students to look safely and to make a well-timed decision to step off the kerb required three further steps in training: the instructor modelled the behaviour and provided total and (later) partial physical prompts (i.e., guiding the student through the behaviour). Two of the students were unable to look safely without help until the instructions were broken down into two components: looking behind and in front, and looking left and right. When this two-step sequence of instructions was introduced to the third student he, too, improved his safe and independent looking skills. Independent decision making (to step off the kerb) increased for all the students after the trainers began modelling and rehearsing the whole behavioural sequence with them, rather than just the decision-making component. The authors found that instructions linking a small number of behaviours were more effective than longer sequences, and recommended that training efforts should focus on task components that require problem solving and decision-making skills. It was also noted that the students found it very difficult to concentrate on the training when presented with novel situations at the training site (e.g., a small child, a lawnmower or a dog).</p>

Abstract

This study was conducted in order to consider the road safety of disabled people. The report includes a review of the literature and interventions. Remedial measures, including interventions aimed at teaching pedestrian and cyclist skills and engineering work designed to help protect these people and enhance their mobility are described. The report concludes with recommendations for further work in this area.

Related publications

- PR117 *The high risk child pedestrian: socio-economic and environmental factors in their accidents* by N Christie. 1995 (price £35, code H)
- PR82 *Accidents involving visually impaired people using public transport or walking* by C Gallon, A Fowkes and M Edwards. 1995 (price £50, code L)
- RR98 *Interviews with elderly pedestrians involved in road accidents* by D Sheppard and M I M Pattinson. 1987 (price £20, code B)

Prices current at November 2002

For further details of these and all other TRL publications, telephone Publication Sales on 01344 770783, or visit TRL on the Internet at www.trl.co.uk.

