European Commission

Children 2018

European Road Safety Observatory
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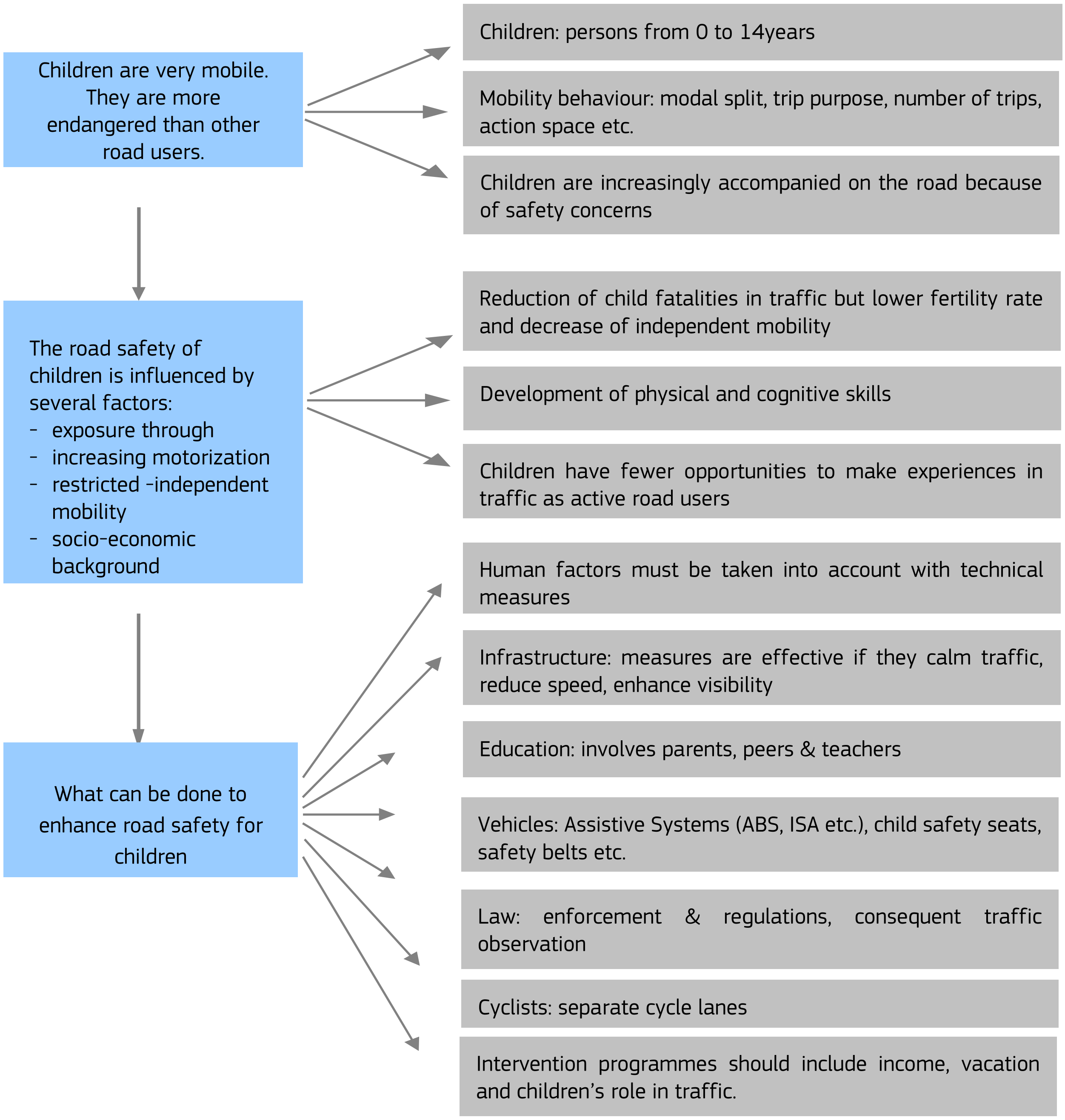
Transport

CONTENTS

1 Overview

Figure 1: Overview of aspects of children in road safety



Child fatalities in traffic

Within Europe, numbers of child fatalities in traffic are decreasing alongside a falling birth rate. This decrease is further affected by improvements in safety for children as car passengers.

While cars are becoming safer for children as car passengers, the highest risk of fatality for children is still as car passenger followed by as pedestrians and as cyclists. Research indicates that children from lower socio-economic backgrounds are more likely to be injured in traffic incidents.

Due to diverging national definitions, traffic casualty data are not always easy to compare across countries. The fact that child crash rates vary not only between the EU Member States but also between national regions makes comparisons even more difficult. Data about the exposure of children as road users are rare but the increase in motorisation generally results in an increased risk of traffic crashes.

Modal split

Children are very mobile; however, most of their travel is connected with journeys to school or for leisure purposes. Children are, along with elderly people, the most vulnerable road users.

Little is known about the modal split of children's travel but research shows that traffic density and the distance travelled to school or childcare facilities are important factors influencing the choice of transport mode for children. In the last 30 years parents have restricted the independent mobility of children to an increasing extent because of traffic safety concerns and the absence of suitable play spaces. More often than not, parents now drive their children to a destination, thus reducing their autonomy and opportunities to develop important skills such as how to behave in road traffic and how to make use of public space or explore their environment.

Differences in children's physical and psychological skills depend on their age and other influencing factors. In fact, greater levels of physical activity diminish the risk of falling or other injuries related to motion.

Development of skills

Children who travel mainly by car are less successful in negotiating road traffic as pedestrians, public transport users or cyclists. Parents are role models. Their behaviour in traffic, their choice of mode, their attitudes and interactions influence the behaviour of their children.

The ability of children to develop risk awareness and, therefore, to perceive traffic situations as dangerous is largely dependent on age. Inactive children are less healthy and their psychomotor development and also their attentiveness are negatively affected.

Children between 8 and 14 are easily distracted and therefore are at higher risk around traffic. Although the psychomotor skills of male teenagers are well developed, their tendency towards risk-taking exposes them to the risk of being involved in road traffic crashes. This is especially true of young cyclists.

Regardless of parental restrictions, or their stage of development, all young people have an urge to be physically active which can lead to problems when trying to ensure that road infrastructure is supporting safety (e.g. when crossing the street). This needs to be taken into account when planning traffic infrastructure in areas used by numbers of children.

Measures for enhancing safety
Intervention programs aimed at enhancing traffic safety for children have to take account of socio-demographic factors such as income, location and their role as road users. Measures are more likely to be effective where appropriate account is made of human factors. Successful educational measures take account of the influence that parents, peers and teachers have over younger people.

Many positive safety effects of infrastructure design affecting children are already known. For example, the provision of separate facilities for pedestrians and cyclists, speed management and traffic calming measures, such as speed humps and other physical self-enforcing measures, and also the improvement of visibility conditions at junctions and/or the reduction of parking spaces all ameliorate the risk of traffic crashes for children. In vehicles, driver assistance systems such as ISA are of known benefit. In addition to these systems, children as car passengers need to be protected through the use of child safety seats and safety belts. However, some of the protective measures provided by airbags designed for adults in a normal seating position pose a serious threat to children sitting in rearward facing child seats. Research shows that the use of rearward facing restraints provides the best protection and should be used up to an age as high as possible (although not used adjacent to frontal passenger airbags). (See ERSO Vehicle Safety web text).

The most effective measure to protect children as pedestrians is to reduce the speed of motor vehicles. For young cyclists, separated cycle lanes are a reasonably protective measure and the use of bright helmets and light-reflecting clothing help to improve conspicuity. Properly enforced laws and regulations need to be reinforced by continuing to make young people aware of the potential dangers of the road environment thus avoiding a false sense of security. (See also ERSO Roads, Speed and Speed Management web texts).

2 Introduction

Children in road traffic are defined here as persons aged from 0 to 14 years. The group aged between 0 and 4 years are considered as babies and toddlers, between 5 and 10 years is the pre-puberty phase and between 11 and 14 is the puberty or early adolescence phase.

Each phase within childhood is characterized, and consequently defined, by distinctive levels of physical and psychological skills. Children cannot therefore be considered a homogenous group of road users, as their abilities or their mode of transport choice differ considerably.

Data about the mobility patterns of children as road users in general is scarce. In fact, little is known about children under the age of six years because most of the statistical data starts with children at this age and older. Children in different age groups are often merged and the varying behaviour of children of different age groups neglected, e.g. longer distances travelled by older children or their greater access to different modes of transport. There are only few scientific projects that provide information about the mobility patterns of children.

However children, generally, are along with elderly people the most vulnerable road users in road traffic (Ausserer et al., 2014) making it very important to obtain good data about children`s participation in the traffic system so that appropriate strategies can be implemented. The United Nations' Universal Declaration of Human Rights specifically requires that children are entitled to special care and assistance.

The UN Convention on the Rights of Children is of key relevance for road safety. Children are vulnerable in road traffic for many reasons which can be categorised in three main groups:

- The causes lie within the child due to a lack of necessary skills to interact safely in traffic.
- The causes lie within other road users (especially car drivers, due to a lack of special care and consideration).
- The causes lie within traffic planning and traffic regulation due to a lack of child-friendly infrastructures, regulations and assistance for children.

The American Academy of Pediatrics has also published a comprehensive policy statement on Child Passenger safety (American Academy of Pediatrics, 2011).

The following chapters will give an overview about childrens' needs in road traffic. The first chapter gives an insight into some accident data. The seat belt usage and social aspects of traffic safety are discussed as well as the question if a decrease in accident rates reflects an increase in safety.

In chapter 3 an outline of children's mobility behaviour will be given, about the number of trips, trips purposes, choice of transport modes and how the preconditions of being independently mobile has changed.

Chapter 4 deals with children's development in relation to road safety and in chapter 5 measures and inventions how to improve children's traffic safety are discussed.

The text concentrates mainly on children as active road users (see Erso Vehicles web text for detailed technical discussion on child occupant safety child restraints etc.). Much money is put into research to improve children's safety inside the car as passive road users. But the aim of every traffic policy should also be to improve the traffic conditions for children as active road users, in order to support the independent and sustainable mobility of children.

3 Size and nature of road safety problems for children

3.1 Child deaths and injuries

Road traffic injuries are the second leading causes of death in children between 5-14 (WHO, 2008). In 2015, within EU-28, about 26.100 people (not children only) died in road accidents. Although there is a downward trend in Europe, (i.e., from 160 fatalities per 1 million inhabitants in 1991 to 51 fatalities per 1 million inhabitants in 2015) there is still much scope to improve road safety for children (European Commission, Care database).

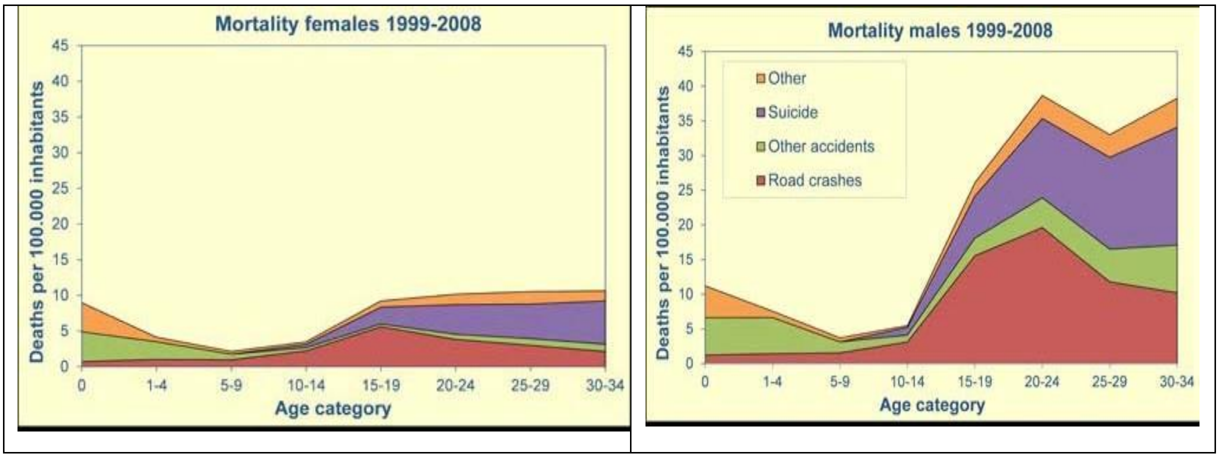
In Europe, in 2015, 654 children under the age of 15 died in road traffic. The number of children killed annually in road traffic crashes fell approximately by 50% between 2006 and 2015 in the

EU countries (ERSO Traffic Safety Basic Fact on Children, 2017). Besides the number of child fatalities has decreased gradually as a proportion of all fatalities which may indicate that safety is improving drastically. But the falling birth rate across Europe is another possible explanation or the fact that children are more often accompanied in road traffic and are less often independently mobile.

3.2 Age and gender

Figure 2 below shows no difference in the number of boys and girls killed until the age of 14. However, at age 14 the number of road fatalities amongst children rises steeply and with remarkable gender differences. Almost three quarters of all children who die at the age of 14 are boys. The number of road fatalities rises further during teenage years. Young adolescents aged between 10 and 17 years tend towards more risky behaviour. This is attributed to their stage of physical and mental development and tendency to respond to peer pressure. Lack of experience and their higher exposure to risk also contribute to the high numbers of road fatalities in this group. Male teenagers, in particular, are at high risk of being killed on the roads.

Figure 2: Unnatural death per 100.000 inhabitants by cause, age and gender during the period 1999-2008 in the Netherlands



Source: SWOV, 2012, Fs Adolescents intraffic

3.3 Mode of transport

In 2015, in the EU about 48% of child road fatalities were car occupants, 30% were pedestrians and approximately 13% were cyclists. The range of modes varies with age and gender presumably reflecting the travel choices of boys and girls as they grow older (ERSO Traffic Safety Basic Fact on Children, 2017).

Statistical data in the Netherlands indicate that child cyclists in the 12 to 14 age groups have the highest mortality rate followed by the 10 to 11 age groups. Even though the mortality rate in general increases with age it does not do so as rapidly as for children as pedestrians and as car passengers (SWOV, 2009). Data from Vienna illustrate that children up to the age of 9 are at high risk as pedestrians. In 2013 48% of all children between 0-9, killed in a traffic crash, were pedestrians. This figure declined by 16% in the age group 10-19 to 32% (Ausserer et al. 2014). All fatal crashes involving children as active road users are collisions with a motor vehicle. Collisions with obstacles occur only in fatal car crashes.

Road fatalities among older children and teenagers (aged between 10 and 17 years) in the Netherlands, during the period 1999 to 2008) show that 26% died as car passengers, 27% as moped riders and 35% as cyclists (SWOV, 2012). When analysing European accident figures there are significant differences between countries. In 2010 in Greece more than 70% and in the Czech Republic about 60% of all injured children under the age of 15 years were hurt in cars while in other European countries the percentage is much lower (e.g. Netherlands 4%, Belgium 22%, European Average 46 %). In the Netherlands the number of injured children as cyclists is more than two times higher than that of pedestrians while the pattern for instance in Romania, Ireland or UK is the opposite (Broughton et al. 2012).

The number and structure of crashes in the EU countries differs considerably due to variations in use of transport modes, travel behaviour and traffic density.

The use of European and national level crash figures alone are not sufficient to fully assess problems and recommend countermeasures. A survey by the German Automobile Club (ADAC) showed that there are also significant differences in the nature of accidents at the local level. Accident statistics in towns with more than 20.000 inhabitants, in one German federal state, show that worst performing towns are 10 times riskier for children compared with the best performing ones (ADAC, 2012).

This indicates that it is necessary to compare accidents on a European and on a national level in order to identify and highlight the main problems and to discuss programmes on political and organisational levels. Education, training programmes and campaigns must address the national problems. As a follow up it is important to work locally to upgrade the safety on local networks such as roads, cycle lanes and footpaths, and implement the programmes and campaigns.

3.4 Use of safety belts and child restraints

Statistics indicate that most children killed as car passengers are either not wearing a seat belt or have an incorrectly fastened restraint (KFV, 2005).

The safety gain from seat belt use and appropriate child restraint use is enormous. Chaloupka-Risser (2014) points out that a crash at 50km/h without child safety seat is equivalent to a free fall from a height of 10 m and that a collision at only 15km/h without a child safety seat can be fatal for children. Rearward-facing systems have been shown to reduce injuries between 90% and 95%, while forward-facing systems have been shown to have an injury reducing effect of approximately 60%. The use of child safety seats has been shown to reduce infant deaths in cars by approximately 71% and deaths to small children by 54%. (See ERSO Vehicles web text).

According to a study, for children aged between 4 and 7 years, booster seats reduce injury risk by 59% (Committee on Injury, Violence, and Poison Prevention, 2011).

In 2007, the Austrian Road Safety Board (KFV) observed approximately 2.000 children as passengers in cars in urban areas of Austria in order to analyse the use of child or passenger restraint systems. The survey showed that 20% of the children used neither a seat-belt (for children with a height of more than 150 cm) nor a special safety-seat for smaller children. A study by the ÖAMTC (Austrian Automobile and Touring Club) in 2010 showed that 40% of all children were not appropriately secured and restrained when travelling as car passengers. Studies in the USA indicate similar figures. 38% of the children aged 12 years and younger who died in a crash in 2013 were not buckled up (NHTSA 2015).

An observation in the Netherlands in 2008 showed a lower figure of 12% (SWOV, 2010).

An Austrian study in 2007 showed that head injuries could be reduced by using safety seats with a seat back. 44% of seriously injured children were more seriously injured than the driver of the car and the severity of these injuries could be reduced by up to 30% using appropriate child and passenger restraint systems. The study also pointed out that boys are more often secured with the car seat belt, even if this is not appropriate for their age, than girls (37 % boys and 27 % girls). Boys are also more likely to be protected with a booster seat with seat back than girls (29 % boys: 16 % girls) (Spiter, 2007).

It is not only important to use child safety seats, but to use them correctly. A study in the USA found that 72% of nearly 3.500 observed car and booster seats were misused in a way that could be expected to increase a child's risk of injury during a crash (NHTSA 2006).

3.5 Traffic safety and social equity

There are many indicators that the socio-economic background of persons and especially of children has an impact on their safety in traffic (Eurostat). Statistics show that children whose parents are from lower income groups are more frequently involved in traffic crashes (Bundesministerium für Gesundheit, 2008). The child road traffic injury mortality rate per 100.000 population in Europe in 2004 was 1,5 times higher for children from low and medium income (LMIC 8,3) families than for children from high income families (HIC 5,2; WHO 2008). Families from lower socio-economic backgrounds (and their children) more often live in areas with high traffic density and are therefore at higher risk of being involved as traffic casualties (Limbourg, 2008). A German study showed that teenagers up to 17 years from poor socio-economic backgrounds are more often involved in crashes (1,6%) than teenagers from better socioeconomic backgrounds and higher education levels (1,1%). The involvement of children from poor socio-economic backgrounds in crashes (1,1%) is twice that of better off children (0,5%) (Holte, 2010). Austrian data shows that young persons (aged between 0 and 14 years) from migrant backgrounds are involved in pedestrian crashes more often than others (30% with migrant backgrounds, 14% without) (Breuss, 2010).

Analyses from Germany showed that the psychomotor development of children from migrant backgrounds or poorer socio-economic background is worse than for children from well-off backgrounds (Limbourg, 2008). Female teenagers with low social status and migrant background have the highest deficits in physical activities as the German child and youth survey of 2008 shows (Robert Koch-Institut, 2008). Studies in the US showed that urban communities with more ethnic minority and lower-income residents generally lack specific features that support walking, such as clean and well-maintained sidewalks, trees and nice scenery. This leads to lower physical activity levels among children and adolescents (King et al. 2000; Owen et al. 2004).

The situation is even worse in less developed countries. Nantulay and Reich state that 96% of children who are killed in traffic crashes living in less-developed countries (Pokriefke, 2011).

3.6 Do decreased crash rates reflect improvements in safety?

Diverging national definitions make it difficult to compare data on traffic casualties across countries. For instance, the national registrations of injury data for road crashes show different under-reporting percentages for different subcategories (Hvoslev, 1994). In European countries, persons who are fatally injured in a road crash are defined as a road fatality if they die within 30 days whereas in many other countries this is not the case.

Fatality rates are widely used as an indicator of traffic density but without reference to categorisation based on international standards. Many countries do not have or use thoroughly assessed exposure data, specifically about walking, cycling or travel patterns (Nilson, 1997).

Some countries have introduced travel surveys in order to estimate the average number of kilometres travelled by different road user groups within national boundaries. These travel surveys are carried out periodically (every 5-10 years), but do almost always exclude children under 6 and sometimes between 6 and 15 years, as already mentioned in chapter 2. At the same time, an assessment of the dangers children face from motor vehicles in public spaces has to be derived from data which includes the number of registered cars or the total number of motor vehicle kilometres in a country or region. In general, the motorisation rate for cars is increasing in all European member states except Germany and the UK. In line with this the number of vehicle kilometres is also increasing (Eurostat). Increased car traffic endangers children especially as non-motorised road users. In contrast, an increase in pedestrians and cyclists within the public space is likely to reduce collisions between cars and cyclists (Jacobsen, 2003)

As mentioned above, the number of children killed on the roads is decreasing, but this positive development can mostly be attributed to better car safety for children as passengers. However, the consequences of better crash design for vehicle occupants for the safety of other road users are not clear. The compatibility between vehicles of different sizes and between vulnerable users and protected motor vehicle occupants is a critical issue. (See Erso Vehicles web text for discussion). For example, SUVs (Sport Utility Vehicles) are considered as safe vehicles for drivers and passengers, but studies show that they cause severe safety risks for other road users which are increasing. The German Federal Highway Research Institute found that crashes between SUVs and other road users have more severe consequences than crashes involving smaller passenger cars (BAST, 2006). Data from the USA shows that the probability of fatalities rises by 45%, and serious injuries by 11% if a SUV hits a pedestrian or bicyclist (White, 2002). This will have an inevitable effect on children.

3.7 Summary of key facts

- Decreasing number of child fatalities in traffic but also decreasing number of children
- The safety of vehicles has improved but there are compatibility issues for vehicles of different masses and between vehicles and non motorised users
- Highest percentage of child traffic fatalities is for children as car passengers, though they bear a lower risk than child pedestrians or cyclists
- Children from lower socioeconomic backgrounds have a higher risk of becoming traffic casualties
- Boys are more often involved in accident fatalities than girls
- Data about the exposure of children as road users is scarce

4 How mobile are children?

The Latin word mobilitas means motion, flexibility, and mutability. Being mobile, is a basic precondition for steps in the child's development. Mobility, however, can be seen as a two- edged sword: on the one hand it helps children to explore the world; on the other hand it exposes them to risks. It would be wrong, however, to reduce children's independent mobility to diminish their risk of dying in an accident. On the contrary measures have to be taken to promote autonomous mobility of children by providing a child-friendly traffic environment. As outlined in the last chapter, children do die in road accidents as passive and active road users. This means there are still measures necessary to decrease children's risks. Taking measures implies to know as much about the target group as possible. However, good comparable data of children's mobility behaviour is lacking. Especially small children are often neglected in mobility research. As pointed out in the introduction hardly any statistical data is available on mobility behaviour of children younger than six years old. So at the beginning of this chapter it can be stated that there is a need of good mobility data on the situation of 0-14 years old.

4.1 Number of journeys

In general, children are highly mobile. On the one hand they carry out fewer trips per day compared to other age groups, because they do not have obligatory ways, like shopping. On the other hand they are out of house more regularly: A study in 2004 indicated that 90% of Austrian children between 6 and 15 years left the house on a working day, while this share in the total population was lower with 82% (Herry Consult, 2004). The trends for journeys amongst teenagers and older children show greater frequency and longer duration which may be due to greater distances between high schools and work places. Data from Switzerland (Sauter 2008) shows that children aged between 6 and 9 years on average have 3.5 trips per day, while children aged between 13 to 15 years have 3.9 trips per day on average.

4.2 Reasons for journeys

Beyond the age of 6, 70-75% of journeys are to and from school whilst most other journeys are concerned with leisure activities. (Bundesministerium für Verkehr und Innovation, 2009). Data from Austria (2006) indicate that most children aged between 4 and 12 years generally walk in their leisure time although distance is an important factor. The shorter the distance, the more children walk and cycle. A study in Davis, California showed that when children live within 800 metres of a facility (e.g. a soccer field), 60% of them cycled to it whilst only 10% of children who live 2,4 to 6,4 km did so. This has important implications for city and urban planning (Ginsburg & Miller, 1982). Furthermore, the choice of traffic mode depends on whether or not children are accompanied to a leisure facility. Children accompanied by adults are mainly taken by car, while children who are not accompanied often use bicycles, scooters or public transport (Daschütz, 2006)

4.3 Choice of transport mode

Little is known about the differing modes of children's travel. Some data about modes of travel for school children is available at national level, but none at European level (Bundesministerium für Verkehr und Innovation, 2009).

Austrian data show that children aged between 6 and 14 years undertake between 34% and 49% of all their journeys as pedestrians with 12% to 16% of all journeys as passengers in cars (depending on the size of the community and public transport facilities). In urban areas with good public transport, the percentage of public transport travel is high (45%), while in smaller cities and rural areas the percentage varies from 32% to 37%. Overall, the percentage of journeys by bicycle is between 5% and 7% (Bundesministerium für Verkehr und Innovation, 2009).

There is some data available about the modal split of journeys to school and child care facilities. In Belgium, children use active transportation modes (e.g. cycling and walking) on their way to school (59%) more often than children in other European countries (29%). A Belgian study showed that the distance to school is the main deciding factor between walking and cycling. Children are more likely to walk to school if the facility is within a radius of 1,5 kilometres of their home. The same study showed that the distance criterion for cycling is up to 3 kilometres compared with adults at up to 8 kilometres. This shorter cycling distance for children can be explained, in part, by the safety concerns of parents (D'Haese et al, 2011). In Switzerland, cycling to school among 6 to 14 year olds has decreased by almost 20% between 1994 and 2005 (European Cyclist Federation, 2012), while data from the UK shows that the car use on the school run has doubled in the last 20 years. During the morning traffic peak almost one in five cars is on the school run. This represents a considerable crash risk as well as contributing to congestion and pollution. For children, travelling by bus is 7 times safer than travelling by car (TIS, 2004).

A national study in Austria showed that less than half of parents in Vienna and Lower Austria take their children to child day care facilities on foot (48%) with one third using the car to take children to kindergarten (Ausserer et al, 2010). On the other hand, a German study indicated that traffic density influences the choice of transport mode. In 2002, it was found that, in rural areas with lower traffic density and in city centres with traffic calmed areas, 78% - 89% of children walked to school unaccompanied by an adult. In areas with high traffic density the figure was only 65% (Limbourg, 2008).

There is also little in-depth analysis of the mobility of younger children during leisure time. In 2002 in Austria, 22% of all journeys of persons over 6 years of age were for leisure although variations in relation to location were noted. Children living in rural areas who have access to public transport made more journeys in leisure time (roughly 21%) than children in areas with poor access to public transport (roughly 17%). The highest percentage of children making journeys during leisure time was found in Vienna and other urban areas with high quality public transport system (roughly 24%) (Herry Consult, 2004). Further data of this type is essential in order to assess the crash risk of children.

4.4 Children's activity environment

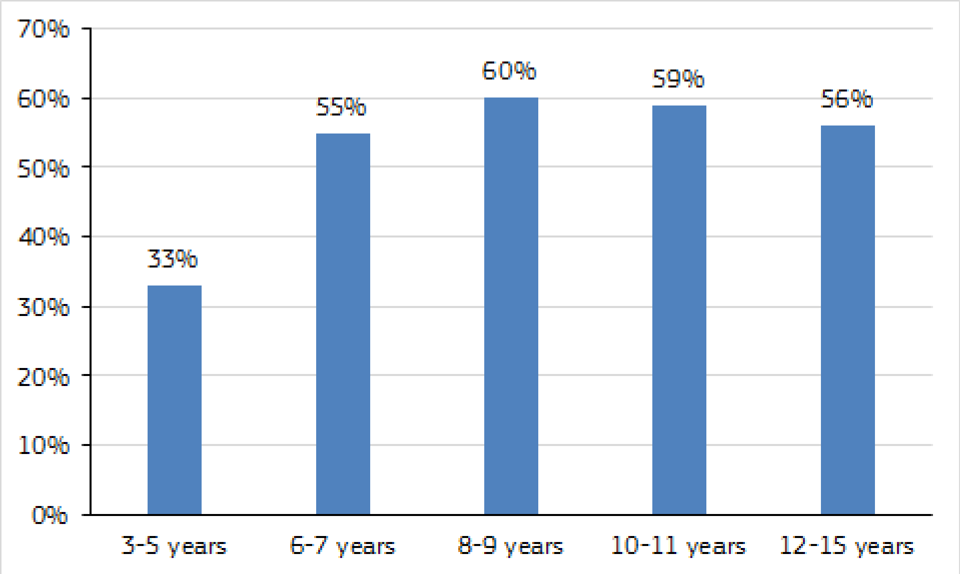
Knowledge about the environment in which children are active is limited but it can be assumed that it is more limited nowadays than in the past as indicated by the decreasing number of unaccompanied journeys by children and the increase in car traffic (Limbourg, 2008).

The theoretical 'activity environment' of toddlers and young children up to 6 years is approximately 100 metres, for children between 6 and 12 years from 330 to 400 metres and for older children and teenagers between 800 and 1.000 metres (Daschütz, 2006).

Studies of children in their residential environment in Hamburg, Germany, in the 1980s, showed that 70% of the observed children stayed within a radius of 100 to 150 metres of their living quarters. Most of the children observed were between 6 and 14 years of age. Children whose parents were from a working class background were over-represented, while girls and children less than 6 years old were under-represented (Daschütz, 2006).

The frequency of children playing outside their residence depends on the quality of the residential environment. Data from Switzerland (1994) showed that only 10% of the children who lived in an environment perceived as dangerous and less attractive (due to traffic and/or congestion) played outside, while 55% of the children who lived in safer and more attractive environments played outside for two hours per day (Hüttenmoser, 1994). A more recent study from Germany (2000) analysed whether children play or do sports (e.g. cycling, riding a scooter) on the pavement or in the street. They found that, between the ages of 3 and 5 years, only 33% were active in this way. This increased to 55% for children between 6 and 7 years and rose to roughly 60% for older children (see Figure 3) (Funk & Fassmann, 2002). In Austria, despite the scarcity of public play spaces, half of the children surveyed played outdoors several times per week. Although safer indoors, children's development and knowledge of their environment is restricted if not allowed to play outdoors (Limbourg, 2008).

Figure 3: Children's play and sport in public spaces in the year 2000



Source: Funk & Fassmann, 2002

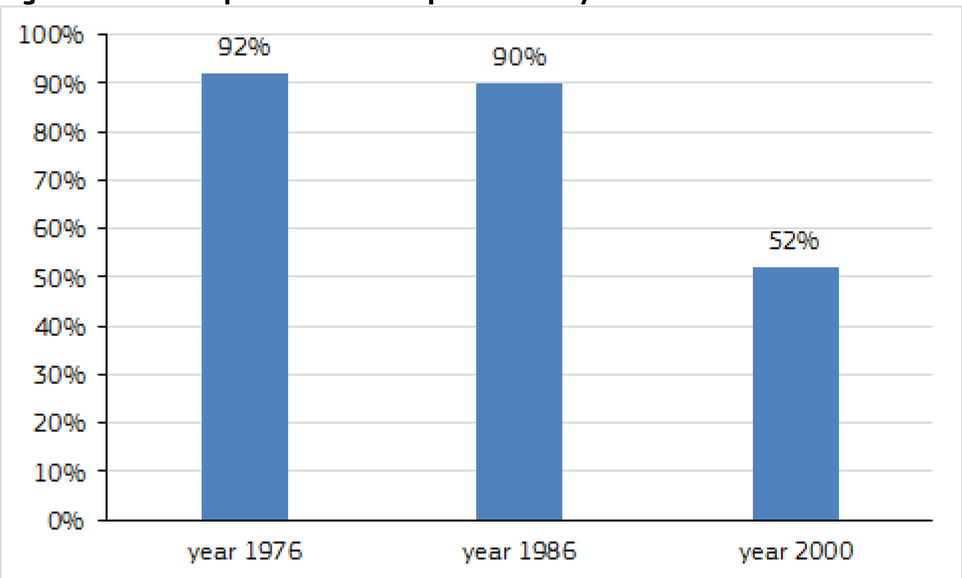
4.5 Gender differences

The scope of the activity environment is greater for boys than for girls. Muchow (1998) wrote that it seemed not to be in the "nature" of girls to roam; this might be due to girls having less time to play because they have to help with the housework. These continuing differences in scope of activity, but not necessarily for the same reasons, are confirmed by more recent data from Austria (2006) showing a correlation between activity radius, age and gender. (Daschütz, 2006).

4.6 Children as accompanied road users – unintended consequences

Towards the end of the twentieth century parents began to restrict the independent mobility of children because of traffic safety concerns. More people began to travel greater distances due to continuing urban development thus increasing car traffic and fear of involvement in traffic crashes (Daschütz, 2006). In the 1970s in Germany, 92% of children aged between 6 and 13 years walked to school on their own or together with classmates. By 2000, the number had dropped by 40% to 52% (see Figure 4, Funk & Fassmann, 2002). Data from Great Britain confirms the decreasing number of unaccompanied school journeys due to increasing traffic safety concerns. The number of primary school children in England who walked to school dropped from 1971 to 1990 from 81% to 63%, while the number of chauffeured children increased from 9% to 34% among school children. 20 years later (2010) still 60% of the English primary school children walked to school and 30 % were chauffeured, but the share of children who are accompanied on their school trips, whether as pedestrians or as users of other modes of transport, has increased from 64% in 1990 up to 77% in 2010 (Shaw et al. 2013).

Figure 4: Unaccompanied school trips of 6 to 7 year old children between 1976 – 2000



Source: Funk & Fassman, 2002

According to several studies (Böhler 2006, SKL 2012, Carver et al. 2013, Forster et al 2014) safety concerns are one of the main factors preventing independent mobility of children.

The presence of adults also influences the radius of the child's activity environment. Children who are unaccompanied venture further. Depending on the distance between their destination and where they live, children and their guardians use different transport modes. Children who are driven in a car have a smaller activity radius than children who travel by public transport, scooters, by bicycle or on foot (Daschütz, 2006).

Accompanying children on their daily journeys can have both positive and negative consequences. An Austrian study shows that children, aged up to 8 years, living in urban environment are often not allowed to cross even the least dangerous streets alone. The consequence of this protectiveness is that they develop less independence, fewer motor- sensory skills and are therefore restricted in their mobility. Furthermore they are at risk of not developing appropriate road traffic behaviour (Daschütz, 2006).

4.7 Changing social conditions and the impact on life quality and safety

The fact that there are only rare opportunities for children for discovering their environment physically actively and without being accompanied by an adult person keeps children from training their imagination, and from extending their physical competence and capabilities (Hillman 2006).

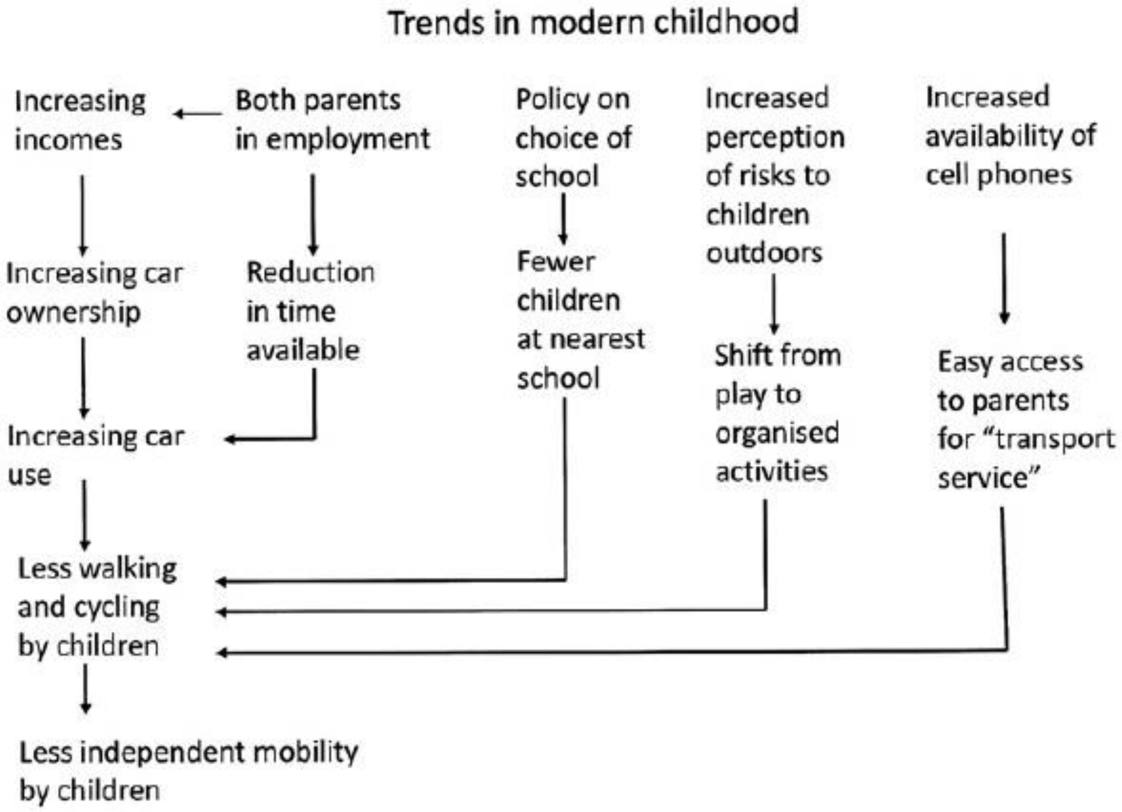
Several studies indicate that physical activity diminishes the risk of falling and of other injuries related to motion (Hundeloh, 1997). Physical activity supports the development of strength, coordination and perception which are the basis of day to day tasks (such as being a road user). The development of these skills is important not only in children but also in adults (Hübner, 1997). Children need to use their skills so that they can estimate what is physically possible and safe for them and they need enough space to practice and develop skills without being restricted or endangered by traffic (Rümmele, 1993).

Activities such as riding a bicycle, using a scooter or walking support the development of important, transferable skills. Several studies indicate that children's ability to perform even the simplest psychomotor activities is diminishing due to lack of opportunities for physical activity (especially in larger cities). Further deficiencies are noted in psychomotor development. 56% of 6 year olds in the Ruhr area of Germany, had coordination and motion deficiencies when tested (Limbourg, 2008).

When an adult drives, the child's role as car passenger is passive and opportunities for learning are restricted by the adult's need to concentrate on the road. It is also worth noting that the increased use of cars potentially endangers children who are not transported to school by car. A German study showed that drivers in these circumstances generally do not adapt their traffic behaviour to the presence of other children (e.g. stop the car at a stopping restriction zones) (Limbourg, 1997). Furthermore, studies of child day care centres in Frankfurt showed that in kindergartens where children were physically active and supported in psychomotor activities there was a significant decrease in the crash rate (50%) (Limbourg, 2008).

A comparative study of children's mobility in Denmark, Finland, Great Britain and Norway (Fyhri et al. 2011) points out several social trends, which contribute to an increase in car use and a decrease in physically active mobility. In 2005, 42% of the parents in urban areas in Finland stated that they perceive traffic too dangerous for a 7 year old child moving independently, although most of the traffic around schools is generated by the parents themselves. The increase of car use not only is a consequence of the traffic safety concerns of parents, but it is also a consequence of a more "urban" lifestyle with regard to children's leisure activities, many of which might be reachable only by car (Fhyri 2011).

Figure 5: Social trends influencing children's mobility (taken from Fyhri et al., 2011)



4.8 Summary of key facts

- Children are very mobile
- Most frequent journeys are to and from school and in leisure time
- Transport mode choice depends on traffic density, distance to school/ child care facility
- Independent and active mobility is increasingly restricted because of parent's safety concerns
- While travelling by car is safer for child passengers than walking or cycling, the serious consequences include less independence; restricted development of skills and a higher risk of falling
- Use of the car endangers children who are not transported by car

5 "Children are not small adults" – the developmental and psychological aspects of traffic behaviour

Children and teenagers experience the road and traffic environment differently from adults. Their physical and psychological development mitigates against full understanding of the complex inter-dependences involved in participation in road traffic. Teenagers also tend to display more risky behaviour as road users than adults because of factors such as failure to perceive danger, impulsiveness or social background (SWOV, 2012 Fs Risky traffic behaviour among young adolescents).

Children need certain abilities and skills in order to handle various traffic situations. They must learn to recognise and anticipate dangerous situations and understand the principles of road traffic. They must also judge the intentions of other road users and not be easily distracted by multiple stimuli. These abilities and skills are acquired in a developmental process starting in early years and progressing through childhood into teenage years.

In this section, the developmental processes relevant for safe traffic behaviour are discussed briefly. The age categories used should only be considered as rough guidelines as each child has its own “tempo” for developing skills. In addition, the developmental process depends largely on experience. Children who are mostly transported by car are less able to negotiate road traffic successfully than those with experience as pedestrians, cyclists or public transport users (Limbourg, 1997).

5.1 Child cognitive development in relation to road safety

Adults have a highly sophisticated way of perceiving the outside world which enables them to record and digest information from their environment. Depending on age, the ability of children to perceive information develops differently (Pieper, 1990).

The theories of Jean Piaget are often considered when trying to explain children’s behaviour patterns in road traffic that differentiated between the following four levels of development (Neuman-Opitz, 2008):

Sensori-motor Level (up to the age of 2)

In this stage children focus on coordination of awareness and movement. This is the basis for future thinking processes. Studies note that children are at increased risk of pedestrian injuries in driveways and other relatively protected areas during this stage (Robert et al, 1995). Two factors might contribute to this risk. Firstly, children at this stage are more drawn towards rather than away from moving vehicles and secondly’ the concept of an object’s permanence is not yet fully developed. Thus, a vehicle parked in a garage may not exist if it cannot be seen from where the child is sitting (Schieber & Thompson, 1996)

Pre-operational Level (approx. 2-6 years)

Up to the age of 6, children have an egocentric view of the world. Their own perceptions, feelings, expectations and fears dictate their actions. At this level of development, children are barely able to project themselves into the role of another person. For example, at this stage, if a child sees a car they will assume the car-driver sees them as well. Dangerous perceptions are also likely at this stage, for example, “The quicker I am the sooner the risk will pass” or “As long as I’m in between parked cars, a car can hit me”.

In addition, the sensory functions of children are not fully differentiated at this point. They do not distinguish between basic and negligible features. They are easily distracted and cannot concentrate on two different tasks (e.g. playing with a ball and dealing with traffic when the ball runs into the road). Their attention is often centred on one characteristic to the exclusion of other features that are sometimes more important. For example, a child may be more interested in the colour of an oncoming car rather than its speed or proximity. They are not yet able to create logical links. An awareness of perspective (e.g. that the form and the shape of an object depends on the perspective of the observer) is missing. They are not able to combine two separated perceptions into one (e.g. size and distance indicating that an oncoming car is getting bigger).

Concrete operational Level (approx. 6-12 years)
From the age of six, children begin to be able to put themselves in the position of other people. They are still not able to cope with abstract concepts (e.g. time or speed) but can deal with concepts which are tangible (e.g. distance to school, size of a car). At this stage 'traffic education' can be attempted but in actual or simulated conditions rather than theoretically in a classroom.

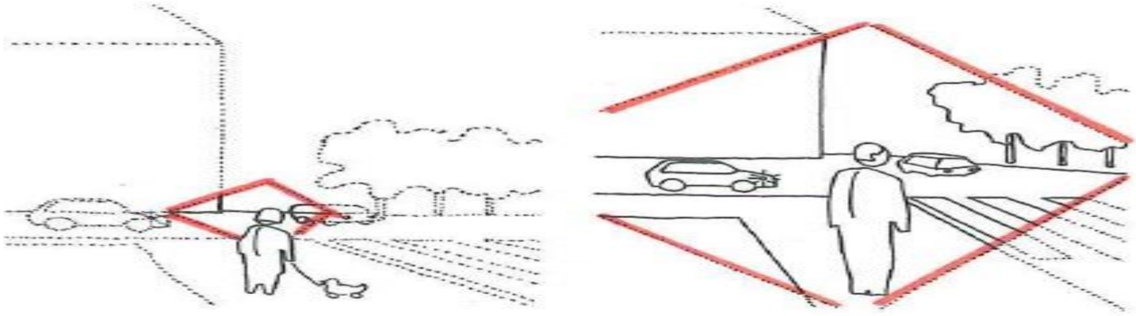
Difficulties arise when dealing with complex or combinatorial situations which require simultaneous processing of more than one feature. A child will have problems determining whether it is safe to cross the street between two parked cars (learned as dangerous) when the cars are located on a crossing (learned as safe).

Formal operational Level (approx. 12 years of age and over)
At this stage children are able to think abstractly. They are in the position to detect, assess and avoid risks. They generally understand the complex rules of traffic and practice them even in an unfamiliar locality. Traffic education can be attempted using films, models or other theoretical instructions.

5.1.1 Visual Perception

The perception of brightness and colours is well developed by the age of five. Even though for some children the naming of colours at this age might be difficult, recognizing the colours and understanding the meaning of signalling systems is, in general, a feasible task (Limbourg, 2008). The peripheral perception of children is limited up to the age of eight (Safekids, 2004). Detecting oncoming perils from the side is only partially possible for children (Sandels, 1975).

Figure 6: Field of view of an adult (left) and a child (right)



Source: Sharonov, 1992

The perception of depth of focus is fully developed at the age of nine. Younger children are thus restricted when estimating distances (Zwahlen, 1975).

The ability to assess velocities is linked to the skill of thinking along a timescale. Only from 8 years and older are children able to relate distance covered to time needed. In general, however, the ability to estimate velocities accurately comes between the ages of 10 and 12 years (Cross & Mehegan, 1988). For younger children, velocity can be connected with the design of a car or the noise it makes. For example, they are more careful when a slower, older and noisier car is approaching than a newer, faster, quieter car. In addition children up to the age of 5 are often not able to differentiate between a moving and a stationary car (Limbourg, 1976).

Heinrich & Langosch (1975) showed that nearly all children in primary school know that they have first to look left and then right when crossing a road. Various experiments, however, have indicated that children in primary school are not reliably able to distinguish between left and right (Colborn, 1970). Even some adults have difficulties in determining left and right spontaneously. Younger children often consider the concept of “left and right” to be static and unrelated to themselves. The dangers here are obvious.

5.1.2 Auditory perception

The hearing ability of 3 to 4 year old children is 7 to 12 decibels lower than that of an adult. Only after the age of 6 years old hearing is developed fully (Pieper, 1990). However, it is also possible that six year olds have trouble localising sounds in a room let alone in traffic in order to determine which direction a car is coming from (Safekids, 2004).

In a study of 5 to 10 year old children, Finlayson (1973) found that only children older than 8 years used their hearing in road traffic regularly. It is also the case that children often do not hear noises in road traffic if they are concentrating on playing with their friends or are distracted by other external stimuli. The integration of different senses increases in a linear fashion up to the age of 11 (Limbourg, 2008).

5.1.3 Ability to concentrate and react

Children are easily distracted in road traffic and are only able to anticipate possible risks when their attention is focussed on a dangerous situation. Being distracted is one of the main reasons for road traffic crashes in childhood. According to Wright & Vliestra (1975), up to the age of 5, children’s attention is controlled by events or things that capture their curiosity.

These are, in most cases, non-traffic related objects and occurrences. Between the ages of 5 and 7, children learn to systematically control their attention and this ability is gradually improved and fully developed at the age of 14 (approximately).

However, the concentration of modern children is measurably decreasing due to physical inactivity, overstimulation (e.g. diets and lifestyles) and the large amounts of time spent watching TV or playing computer games. These factors also affect older children (8-14 years old) and therefore traffic safety perception may not improve within this age group.

Additionally the infrastructural conditions influence childrens’ actions. Plumert (2007) shows that children (as well as adults, by the way) are willing to accept much smaller time gaps for crossing, when they have to wait for a long time. The “successful” experience of risk taking enhances their willingness to accept risky gap choices (Plumert 2007).

5.1.4 Psychomotor skill development

Motor skills include all haphazard and controlled movements of a human being (e.g. standing, walking, sitting; http://lexikon.stangl.eu/3681/motorik/). A distinction is made between gross motor skills and fine motor skills. Gross motor skills require the activation of larger muscles and make it possible to stand up and move around. They are the basis for developing fine motor skills where smaller muscles are used (e.g. motions like drawing, writing, facial expressions). The term psychomotor refers to the co-ordination of perception (the mental and emotional experience) and movement (Limbourg, 2008). For example a child who learns how to cycle has to coordinate different skills like maintaining balance, using the brakes and holding a steady course at the same time looking out for obstacles and traffic.

In the first two years of life, psychomotor development concentrates on controlling sitting up, locomotion and manipulation. Subsequently, children learn to jump, climb stairs, pedal etc. Pre-school aged children have the psychomotor skills to participate as pedestrians in road traffic. However, Arnberg et al. (1978) record that the ability to cycle is less well developed. Up to the age of approximately 7 years, children have problems in abruptly interrupting an action which they have already started (e.g. to stop running at the kerb). However, a child's urge to be active increases the probability of running or jumping in road traffic (Limbourg, 2008). This needs to be taken into account when planning traffic infrastructure in areas with numbers of children to provide a Safe System environment. Between 6 and 12 years the psychomotor skills of children rapidly increase in quality and quantity. With respect to safe cycling behaviour a significant jump is made between the ages of 7 and 8 and a further big jump between the ages of 13 and 14 (Arnberg et al., 1978). Despite having well-developed psychomotor skills, 12 to 14 year old boys are particularly at risk in road traffic as cyclists due to their higher propensity for risky behaviour (see section 3.2).

5.1.5 The impact of road traffic on the psychomotor skill development

Previous reference has been made to the fact that the scope of the activity environment for children has been reduced in recent decades, whilst at the same time the importance of cars has increased. For example, in Vienna, public parking spaces amount to 7.8km2 per car whilst the playground area for each child is only 0.5km2, a multiple of 14 in favour of the car (Verkehrsclub Österreich, 2012). Earlier sections have also referred to the consequences of parental fears about traffic and public play spaces leading to more accompanied car journeys for children as well as more sedentary home-based activities.

Studies have shown that children who are regularly chauffeured by car are likely to:

- have an impaired state of health due to physical inactivity (increased risk of obesity, diabetes etc.) (Koplan et al., 2005; Limbourg 2008).
- have higher anxiety levels as their opportunities to learn and exercise in natural environment and in playing areas are restricted (Beunderman, 2010).
- be less grounded in their surroundings as they seldom have opportunity to explore the living environment independently (Sauter, 2008).
- carry their road user habits into adulthood and will consequently be uncomfortable with using public transport as adults (Bradshaw and Atkins, 1996).
- be less successful in handling road traffic as pedestrians, public transport users or cyclists which generates safety problems (Daschütz, 2006).
- have fewer motor-sensory skills and show restriction in their physical fitness and flexibility (Daschütz, 2006).

Bös (2003) analysed 54 studies from 1965 to 2002 and came to the conclusion that the motor abilities of children have deteriorated by more than 10% during a 25 year period. This trend has been confirmed in other studies (Dordel, 2000). A screening of 950 six year old children in Germany showed that only 44% had the psychomotor skills expected at their age. The majority of the children had deficiencies in motion and co-ordination (Mannheim, 1999). Experience from cycle safety education indicates that in the 10 years from 1997 to 2007 children had increasing problems with (Günther & Degener, 2009):

- Turning e.g. children are less able to ride one-handed.
- Starting up and braking
- Maintaining balance
- Getting on and off the bike
- Keeping the bike on course

These psychomotor skills deficiencies increase the risk of traffic crashes as well as in other areas of life (Kunz, 1993). The growing numbers of children who display behavioural problems such as attention deficit hyperactivity disorders (ADHD) need to be considered when designing and implementing road infrastructure. The term hyperactive indicates that those skills needed in traffic are impaired (Pieper, 2010). Various studies showed that children with some kind of behavioural problem are more likely to be involved in a crash than those without (Mannheimer, Mellinger, 1967).

5.2 Imitation and role models

The cognitive development of children is an important issue in discussing their safety and related issues. An important part of children's traffic education, however, takes place at home. According to Bandura (1977), most human behaviour is learned by creating a model of behaviour from observing others. One forms an idea of how new behaviours are performed and, on later occasions, this coded information serves as a guide for action. This means children learn rules on how to behave in traffic from parents and accompanying persons whereas traffic education is often simply taught. Parents are role models and their attitudes, mobility and interactions influence their children's behaviour. Safe traffic behaviour from a respected authority figure will have an impact on the child's willingness to imitate safe behaviour (Baumgart, 1998). Children generally stick to rules and like to apply and practice what they have just learned. In other words, good behaviour in traffic has to be practiced with children in real traffic. Everyday excursions like journeys to playschool or to a playground etc. give parents the possibility of exploring public spaces on foot, by bike or by public transport together with their children from early childhood onwards. Learning through experience is the most effective way of establishing risk and safety awareness which can lead to behavioural change.

5.3 Risk awareness

Bukovski (1994) underlines the importance of not making children afraid of traffic. Telling children to take care that they are not run over by a car can make children feel uneasy which could lead to unsafe behaviour. It is important to explain to children that in 'real traffic', cars are faster and harder than pedestrians and car drivers cannot stop instantly.

Limbourg (1997) mentions that risk awareness in children develops in three stages:
- Acute risk awareness: "I perceive risk at the moment of danger" (around the age of 5). In most cases it is too late to avoid a crash.
- Anticipation risk awareness: "I know that a certain situation is dangerous" (around the age of 8) e.g. a child knows that cycling downhill might be dangerous and brakes continuously when riding downhill
- Preventive risk awareness: "I take measures in advance to avoid risky situations" (around the age of 10) e.g. a child makes a detour in order to be able to cross the road safely.

Limbourg underlines that these age categories provide only the roughest guideline and that risk awareness depends largely on the individual child's experience. In addition, several studies indicate that there are different types of personality that support risky behaviour.
Children described as "lively fear naughts" (lively and without fear) are the most prone to crash involvement; also, boys are more willing to take risks than girls (Ginsburg & Miller, 1982).

In the adolescent phase, (from around age 11 or 12 years) the awareness of risk is particularly less pronounced. Even though behaviour is objectively risky, teenagers do not describe it as such or do not relate it to themselves ("This cannot happen to me"). 'Juvenile egocentrism' creates excessive feelings of self-importance. In addition the acquisition of an important role within a group through unsafe conduct might boost self-esteem and thus lead to more risky behaviour in order to gain approval (Limbourg, 2008).

5.3.1 What is considered risky?

In various studies, children aged between 6 and 10 referred to the following situations as dangerous (Limbourg, 1997):

- Reckless driving
- Fast driving
- Not stopping at pedestrian crossings
- Dense and heavy traffic
- Left and right turning cars at a crossroads
- Parked cars on pavements or cycle paths
- Sight obstructions near crossings
- Short crossing times or long waiting times at traffic lights
- Crossings with no assistance
- Running red lights
- Driveways

Similar aspects were mentioned by 10 to 14 year old children in an Austrian study (Oberlader et al. 2014). The teenagers complained about heavy car traffic, long waiting and short crossing times for pedestrians at traffic lights, inconsiderate car drivers who do not give way at pedestrian crossings, pose a threat to pedestrians while turning left or right and do generally not respect traffic rules. The lack of consideration by stronger road users for weaker ones is generally thought of as a safety problem (Ausserer et al., 2009 and 2014). Children have no strategy to deal with this phenomenon.

5.3.2 Crossing a street

In terms of being or playing in the street, children can be injured while standing, walking, or playing on the pavement or at the kerb. However, they are most frequently injured when crossing the street (Schieber et al., 1996)

This task has two phases – pre-crossing and crossing. The pre-crossing phase includes selection of the crossing site, detecting traffic, and choosing the moment to cross. Crossing skills involve motor development and continuous feedback about decisions made. Gap assessment is thereby often erroneous, the more so the younger children are. According to Oxley et al. (2007) younger children (6–7 year olds) are 12 times more likely than older children (8–10 year olds) to make critically incorrect (and frequently unsafe) crossing decisions based on erroneous gap assessment.

In general, children's behaviour when crossing the street differs from that of adults. The following differences were indicated in various studies (Schieber et al. 1996, Thompson et al. 2005, Plumert et al. 2012).

- Adults base crossing decisions on the best time to cross; children use the best place to cross (e.g. shortest crossing distance)
- Children cross the road more quickly than adults, often running
- Children use shorter crossing routes than adults (not diagonally)
- Children observe crossing rules more than adults (e.g. don't cross adjacent to a crossing)
- Children's gap choices are less well matched to their road-crossing behaviour. Children and adults choose the same-size gaps but children end up with less time to spare when they clear the path of the approaching car. This has several reasons, like their lower walking speed or the fact that children often walk in groups.
- Children less frequently orientate themselves before crossing than adults. Adults tend to assess the traffic situation before reaching the kerb; children are only able to do it at the kerb and then often only by looking left and right.
- Children tend to orientate themselves towards crossing by following people in front of them (i.e blindly).
- Children crossing with those of the same age behave more riskily then with others.
- Children find it difficult between parked cars to cross. They stop at the kerb, even though they have no view of the traffic situation and cross without stopping at the line of visibility.
- Children react more spontaneously than adults and do not always stop before crossing, e.g. if they want to catch a bus on the other side of the road

Besides children are multitaskers (but not necessarily successfully so), not only when crossing a road. For instance, nowadays the mobile phone is a permanent companion that keeps them distracted from road traffic (Ausserer et al. 2014).

5.4 Summary of key facts

- Children who mainly travel as car passengers are less able to negotiate traffic when cycling, walking, etc
- Children aged between 8 and 14 are at higher risk in traffic
- The mobility behaviour of parents influences the behaviour of children
- Male teenagers are more at risk as cyclists due to their pre-disposition to risky behaviour
- Depending on age, the ability of children to perceive a traffic situation or be aware of differs
- Children have an urge to be active; this needs to be taken into account in traffic planning

6 Issues and interventions

There is no doubt that the cognitive functions used in adulthood are a continuation of those acquired in early childhood (Hübner, 1997). Nonetheless, the competencies and learning processes for each individual are unique, making it an even greater challenge to build intervention programs suitable for every individual's life and for children in particular. However, children represent a target group whose behaviour could be adapted for the purpose of ameliorating traffic safety worldwide. Their susceptibility to mental health "irregularities" are just as common as those perceived in adults (American Planning Association, 2012), with the exception that children are more affected by factors such as traffic and pollution (Spencer & Wholly, 2001).

The main focus of the intervention programs cited here is on socio-demographic factors such as income, location and children's roles in road traffic. Unless human factors (psychology) are taken into account in designing intervention packages, the resulting technologies may fail to adapt to human tolerances thresholds and needs. Children fulfil a variety of roles in respect of their mobility as pedestrians, cyclists, public transport users or car passengers. Children become pedestrians around the age of 5. In fact, between the ages of 5 and 14 years child pedestrian injuries are still the second most common cause of death or severe injury (Safekids, 2004).

Other ERSO web texts set out the interventions which contribute to a Safe System which have high relevance for child safety.

Improving traffic safety for children implies to have different kinds of approaches. Three E´s are discussed in this chapter, areas where interventions can take place: Education, (traffic) Environment and Equipment. Education means providing possibilities for children to improve their skills of moving safely in traffic and at the same time to raise awareness for various aspects concerning traffic. Environment includes the traffic infrastructure and legislation. Equipment deals with appropriate kits for increasing traffic safety.

6.1 Education

The practical implications of developmental theories in both educational and domestic settings play a prominent role in determining the success of educating children on traffic concerns. The main theories which inform the way children interact and assimilate information are those of Vygotski, Piaget, Bandura and Pavlov.

Demographics play a determining role in understanding the characteristics of a location based on population density, traffic density, neighbourhood types, social income, etc.

Children from poorer families are more prone to road traffic crashes. This is because they are less likely to own a car, walk to school every day and play in the streets after school. These behaviours expose them to higher levels of risk. It would be possible to intervene, for example, by making neighbourhoods safer by segregating them from traffic (gated). This could be achieved by making calculated economic decisions (Economics) and integrating expertise (Technology) with the knowledge we have about how children think and assimilate the information around them (Psychology). The top of Figure 7 shows the three main psychological theories on how children assimilate information: Bandura's Social Learning theory, Vygotsky's Socio-cultural theory and Pavlov's Classical Conditioning theory. All three include differences and similarities which can shed light on how to tailor techniques and project plans around the requirements of children. Bandura states that all actions and knowledge are learned through direct observation of the environment in what he determines as an incessant activation of cognitive, behavioural and environmental factors (Bandura, 1977). For example, if children are exposed to the correct behaviour in terms of traffic mobility and how to be sensible road users and citizens, the chances of them assimilating and accommodating the information will increase (Cherry, 2012a) By the same token, people sometimes use the behaviour of others to excuse their own irresponsible behaviour and its consequences (Atterton, 2010). Vygtosky's theory, on the other hand, states that "all the higher functions originate as actual relationships between individuals." (Cherry, 2012b).

Therefore, new strategies or projects aimed at educating children on the dangers they face in everyday life need to give more weight to the influence of parents, peers and teachers. There is a fine line between what can be learned unaided and learning that requires guidance.

Zygotsky calls this the 'Zone of Proximal Development' and the relationship it may have with traffic safety projects is that the education children receive at home and in school, although significantly dissimilar, still determines much of the way in which a child perceives danger in daily situations (Cherry, 2012b).

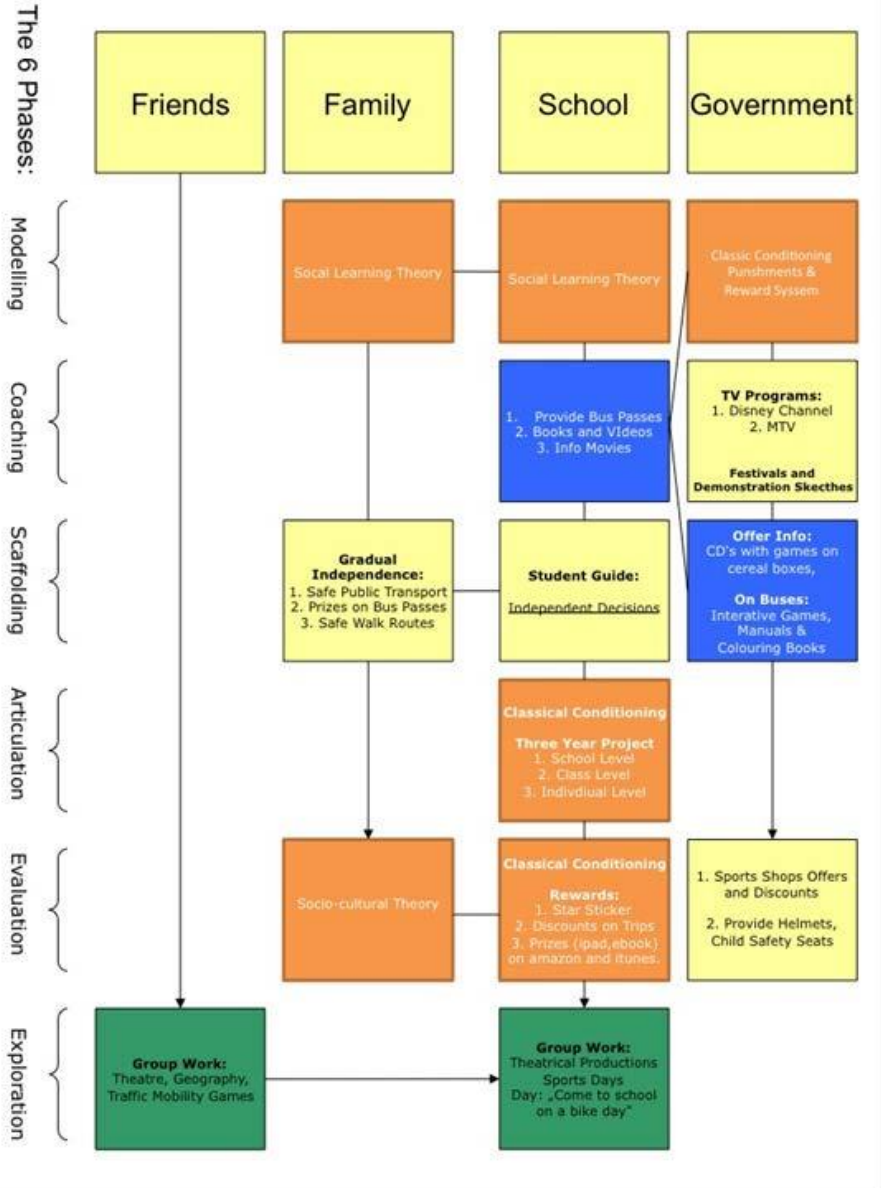
Due to difficulties in ensuring that education at home matches the levels of discipline of that in school, schools and parents need to work together particularly on a subject that may be seen as peripheral but which has life-saving potential. Pavlov's Classical Conditioning theory applies here and states that "development is considered a reaction to rewards, punishments, stimuli and reinforcement." If school and home life are well coordinated towards such dynamics, children will learn better through practical stimuli and will associate certain stimuli/situations with danger, which in turn will prevent them from acting irrationally and underestimating how short term irrationality can lead to long term, severe injuries. By being aware of the major child-learning theories, technology and economics can be applied in the most accurate and holistic manner. This thinking can be incorporated into technologies such as vehicle design and manufacture, urban planning and detecting effective stimuli to inhibit speeding and non-use of restraint systems. For example, by introducing the points system for car drivers for violating certain rules (Keenan, 2008), perceptions of traffic safety were shown to be internalised rather than externalised, thus avoiding the risk of turning responsible behaviour in traffic into a remote concept.

6.2 Educational Systems

The Safe Kids Organisation is a network of associations in the USA which help provide information to families with the aim of reducing fatalities amongst young people. Their programs stretch over a wide range of activities with some focusing on traffic and transport issues. Their initiatives and interventions follow a protocol which has shown to be effective. This requires that they commence by educating the public about dangers faced in everyday activities while promoting statistics about the causes of danger taken from the extensive research they undertake. The Safe Kids Organisation also provides safety equipment such as helmets and child safety seats (Safety Kids, 2004). Another prominent company which focuses on reducing child fatalities is the UK based Children's Traffic Club. Their work, however, is purely concerned with traffic related casualties and the website comprises games and activities aimed at 3 to 4 year olds which they see as the optimum age for intervention. These interventions are designed to they work closely with government bodies. These initiatives have shown the effectiveness of early years intervention and suggest the need for an integrated approach education involving parents, carers, teachers and government bodies

The figure below (Figure 7) is based around a Cognitive Apprenticeship Model by Collins et al. (1989). It comprises six phases which are outlined on the left and shows an intervention program which requires the full collaboration of the 4 main bodies – friends, family, schools and governments – to succeed. The reward and punishment system implemented in schools, domestic settings and public settings encourages the public, in particular young people, to treat traffic and mobility as issues which can lead to severe injury or, in some cases, death. The first three phases (Modelling, Coaching and Scaffolding) can be best controlled and monitored in educational and governmental settings and are essential steps to children gaining an understanding of the dynamics of traffic and safe travel. The final three phases (Articulation, Evaluation and Exploration) ensure that the child is supported in his/her learning whilst being independent; reflecting Vygotsky's social learning theory.

Figure 7: Adapted Version of the Cognitive Apprenticeship Model,



Source: Collins et al. (1989)

6.3 Intervention programmes – campaigns

Intervention programmes and campaigns to improve the safety of children and teenagers have been and are being carried out in a number of European countries. However, evaluation data is scarce making an assessment of their effectiveness difficult. In general it is difficult to attribute, for example, a decrease in crash rates to a campaign as they are usually only one part of a group of measures. However, the following three intervention programmes are considered as successful and have been described as exemplary:

6.3.1 "Gehen geht" (walking works)

Gehengeht" is a project by the Lower Austrian Environmental Consulting company (die umwelt beratung). It aims at increasing the safety of children on their way to kindergarten or school. The parents of pre-school children are encouraged, by various means, to use environmental friendly modes for these journeys. The traffic safety of the children was improved in two respects: Firstly, children become accustomed to the traffic environment and learn how to behave safely in traffic and are thus prepared for walking to school on their own. Secondly, traffic is reduced around kindergartens and around schools. In 2007, the project was honoured with the UNESCO award "Commendable UN-Decadeproject" and in 2011 with the Energy Globe Award NÖ.

6.3.2 EUCHIRES (EUrope CHIld REstraint System)

The European Project EUCHIRES is based on the "Armadillo" campaign launched in 2003 in the Netherlands. This successful campaign inspired organisations from other countries to implement the same kind of approach to promote the use of seat belts. The first EUCHIRES campaigns took place in 2005. In 2008, EUCHIRES projects were carried out in 13 different European countries. The main target group was children aged between 7 and 12 years. This age group was chosen because peer pressure is, in general, not yet strong and it is more likely that information and messages will be understood and acted upon.

Parents received information materials at special events but were mainly addressed indirectly. Children were encouraged to remind adults to fasten their seat belts, to buckle them correctly and to make use of appropriate child restraint seats.

The main aims of the EUCHIRES campaign were:

- to increase the knowledge of how to use child-restraint seats correctly;
- to encourage children to "make themselves safe" when going by car;
- to change behaviour with respect to the use of seat belts; wearing seat belt and the use of child restraint seats should become a routine from early childhood on and
- to reduce the number of traffic fatalities due to lacking or incorrect seat-belt use.

There are no results available on the impact of the campaign and the actual use and wearing rates of child restraints seats and seat belts. An evaluation in Poland, however, showed that the message had reached 42% of the children and 35% of parents. 90% of the children said that the campaign was very good (EUCHIRES, 2006).

6.3.3 Car Free Schools

In Denmark the Car Free School was a campaign carried out in six Danish schools in 2009 and 2010. It addressed the means of transport used by families, living in a residential area, for the school run and aimed to make travelling to school a safer activity for children.

Stakeholders such as teachers, school directors and parent governors were involved and took responsibility for the practical implementation of the campaign. In each school a map was created with routes for cycling and walking to school in 2.5 km sections. Those who lived more than 2.5 km away received a free bus card. The map was printed on a flyer which all pupils could take home.
The campaign turned out to be a very effective way to reach the target group. Parents supported the campaign and found the issues covered relevant to their concerns. Travel habits were addressed directly and car drivers were engaged. The campaign had an impact on the infrastructure in the residential area, too. Measures such as traffic calming around schools and giving priority to bikes and pedestrians were implemented as a consequence of the project (Car Free Schools).

6.4 Environment

6.4.1 Traffic calming measures

Traffic control is another approach to protecting vulnerable road users such as children. Although education and affiliated institutions still maintain the leading position in intervention programs, traffic calming interventions are known to be effective. Urban planning, which includes transport planning, has a safety component which reflects the expressed needs of a community (American Planning Association, 2012). Transport planning has the goal to ensure that all viable routes to and from a settlement are protected and safe to use. Traffic calming is described as “changes in street alignment, installation of barriers, and other physical measures to reduce traffic speeds and/or cut-through volumes, in the interest of street safety, liveability, and other public purposes.” (McLeod, 2009). Statistics on the effect of traffic calming show that children who live close to a speed hump are less likely to be hit by a vehicle by a factor of 2 and children near traffic calming devices, in general, are 50% to 60% less likely to have serious injuries or be killed by speeding vehicles.

The objective is that children of school age do not encounter cars in their play areas or in places where they habitually walk. In exceptional cases, vehicles travelling at a maximum speed of walking pace are tolerated. Children from 7 to 12 years should not cross at locations where vehicle speeds exceed 15-20 km/h. For older children, the same principles apply as for unprotected adult road users, i.e. they should not cross at locations where motor vehicle speeds exceed 30 km/h. This applies to routes surrounding kindergartens, schools and to social and other leisure activities.

6.4.2 Crossing measures

Crossing a road is a very complex action for children. However, there are several aspects of infrastructure design that can improve the safety of children when crossing the road. One important factor is to improve visibility conditions at junctions. Children are killed more often than any other age group at crossings where vision is restricted (Johansson, 2004). This study

showed that children were killed at crossings with obstacles to visibility in 36% of cases. This means vehicles should be kept away from pedestrian crossings, public transport stops, cycle lanes etc. As mentioned in section 3 the increase in SUVs on the roads has caused additional safety problems for children. These vehicles are higher than average and it may be safer to restrict parking around fixed crossings to more than the current 5 metres to increase visibility. Additional research work on the effects of SUV on the traffic safety of children is required.
Reducing the number of parking spaces on a given surface (car park or multi-storey garage) is an important measure to improve the children's visibility in traffic.

Another measure is the installation of so called "pavement-noses" at junctions, where the pavement is extended to reduce the crossing distance and improve visibility.

When crossings are signal-controlled there should be separate phases for pedestrians and right or left turning traffic. If this is not possible, the pedestrian phase should start several seconds earlier than the vehicle phase. Crossing distances should be short. Children should be able to cross the whole road at green lights without stopping. Traffic islands at signalled crossings should be avoided as children find it difficult to stop and wait at the traffic island. The waiting time at signalled crossings should be short as children are generally not very patient (Limbourg, 2008; Ausserer et al. 2014).

6.5 Equipment

6.5.1 Vehicle equipment pre-requisites: model types

Legislation and regulation regarding vehicles permitted to travel on roads is largely covered by EU legislation although compliance regimes vary from country to country in the EU. Most countries insist on randomised checks for larger vehicles. EU regulations do not permit any vehicle failing a check to continue to be driven until remedial action has been taken. This is a safety measure to reduce deaths on the road, specifically those of children (TIS, 2004).
Features to be included in a vehicle:

- Improved Emergency Braking Systems can help to ensure that a driver can retain complete control when braking abruptly.
- ESC/ESP: Helps the driver remain in control when a vehicle skids on slippery or icy roads (Department for Energy and Infrastructure, 2012).
- ISA: Intelligent Speed Adaptation aims to support the driver by electronically limiting speed to conform to signed limits. The system can either be advisory (lets driver know about speed limits through GPS), supportive (helps reduce speed by hardening the accelerator pedal) or limiting (directly reduces the speed of car).
- New driver assistance technologies called Intelligent Transport Systems (ITS) are soon to be implemented in a number of European countries. These address three major issues concerning child deaths and injuries:
  - Drink driving related deaths through the integration of Alcohol Ignition Interlocks (AII)
  - Speeding will be reduced with Intelligent Speed Adaptation systems (ISA)
  - Drivers and passengers not using seatbelts through the Seatbelt Ignition Interlocks (SII)

The ERSO web text on Vehicles provides detailed information about vehicle safety recommendations and safety systems.

6.5.2 Protective equipment

Children as pedestrians

There are also more basic and integrative approaches to prevent children from being injured in crashes as cyclists, car-passengers and pedestrians. An integrative approach includes child-friendly infrastructure, training programmes and guarded crossing.

Particular measures such as lollipop women/men have proven to reduce such causalities; however more needs to be offered to provide a safer system for use by children. The implementation of speed humps force the driver to slow down and clear boards which calculate the speed of each individual car. Stricter laws and regulation and introducing more speed cameras will also help as will safer car fronts.

Children as cyclists

For children as cyclists there are some basic technologies which are known to reduce fatalities and injuries. These are wearing of helmets and cycle lane dividers. The literature suggests that children should also be instructed to wear yellow light-reflecting jackets and brightly coloured helmets. Bicycles can be made more conspicuous by attaching a safety flag. Helmets – if properly fitted and correctly worn – cannot prevent crashes but might limit the severity of the head and brain injury in case of an accident. According to a study in the Netherlands one third of the cyclists who are admitted to hospital with serious injury after a traffic crash are diagnosed with head and/or brain injury (SWOV 2012). However, the compulsory use of helmets, on the other hand, could lead to a decline in the use of bicycles (see e.g. Robinson 2006). In any case campaigns aimed at children could be launched which promote a voluntary use of helmets. Besides it is very important to teach children and parents how to wear a helmet correctly. Experiences of children bicycle trainers in Austria had shown that more than 90% of all helmets were not correctly worn. See Erso web text on Pedestrians and Cyclists.

Children as car passengers

More safety measures are available for children as car passengers as this is the most common mode of travel in higher income neighbourhoods and for people living 5 or more kilometres away from schools and other facilities. The use of rear-facing child safety seats is recommended as the safest type of restraint for the youngest children, though not adjacent to an airbag system. Between the ages of 4 and 8 years children should move to booster seats and preferably sit in the back seats of the car; this last regulation also applies to children up to the age of 12-14 years. The importance of sitting in the back seat is a pending one as it is crucial that parents and adults understand that children are likely to be killed if placed in a seat in front of an airbag. As children often dislike being secured with belts in cars which places a greater obligation on adults to comply with the law and act role models for belt wearing. Training children (and parents) in the correct use of seat belts is an essential part of their awareness- raising of road safety (BMVIT, 2009).

6.6 Summary of key facts

- Intervention programs should take income level, location and children's roles as road users into account.
- Measures are more likely to be effective if they take account of human factors
- Education: parents, peers and teachers have significant influence on the younger generations.

- Infrastructure: Traffic calming, speed reducing, visibility enhancing measures are most effective.
- Vehicles: Driver Assist systems and child safety seats are effective, though airbags can endanger children.
- Law: Strict laws, regulations and enforcement are needed.

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Notes

1. Country abbreviations

Belgium	BE	Italy	IT	Romania	RO
Bulgaria	BG	Cyprus	CY	Slovenia	SI
Czech Republic	CZ	Latvia	LV	Slovakia	SK
Denmark	DK	Lithuania	LT	Finland	FI
Germany	DE	Luxembourg	LU	Sweden	SE
Estonia	EE	Hungary	HU	United Kingdom	UK
Ireland	IE	Malta	MT		
Greece	EL	Netherlands	NL	Iceland	IS
Spain	ES	Austria	AT	Liechtenstein	LI
France	FR	Poland	PL	Norway	NO
Croatia	HR	Portugal	PT	Switzerland	CH

2. This 2018 edition of Traffic Safety Synthesis on Children in Road Safety updates the previous version produced within the EU co-funded research project DaCoTA (2012). This Synthesis on Children in Road Safety was originally written in 2012 by K. Ausserer, E. Füssl, S. Rosso, A. Risser and then updated in 2015 by K. Ausserer and E. Füssl, FACTUM.

3. All Traffic Safety Syntheses of the European Road Safety Observatory have been peer reviewed by the Scientific Editorial Board composed by: George Yannis, NTUA (chair), Robert Bauer, KFV, Christophe Nicodème, ERF, Klaus Machata, KFV, Eleonora Papadimitriou, NTUA, Pete Thomas, Un.Loughborough.

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5. Please refer to this Report as follows:
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