Novice Drivers

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Novice drivers

Summary

Traffic crashes are the single greatest killer of 15 to 24 year olds in OECD countries, and, although data is not always available, the situation appears to be no better in other, non-OECD countries. This web text focuses on young and novice drivers in the age group of 18-24, addressing the magnitude and nature of the problem, and it discusses effective countermeasures.

Magnitude of the problem

In every crash and fatality statistic, 16-24 year old drivers are greatly over-represented, with risks a factor 2 to 3 times higher than those of more experienced drivers. They pose a greater risk to themselves, their passengers and to other road users than other drivers do. In young driver crashes, for each young driver killed, about 1.3 others also die (e.g. passengers and other road users). Young driver crashes differ from those of more experienced drivers, in that more young drivers crashes happen at night, are often single vehicle crashes (with no other vehicles involved), frequently as a result of 'loss of control' and high speeds. Even alcohol consumption in low quantities has a greater impact on youngsters than on experienced drivers.

Underlying factors contributing to this risk

Young drivers' high crash rates primarily result from immaturity, lack of experience, impairment, and lifestyles associated with their age and their gender. Young men in particular are often over-confident about their driving skills.

Immaturity

Biological research shows that at the age of 18 areas of the human brain which are responsible for the integration of information and impulse control, are still developing. Not only in physiological terms, but also in social terms youngsters are still maturing. An example is their getting away from their parents' influences and gaining more independence. As part of this process peers become increasingly important to them, particularly in lifestyle related choices.

Exposure

Young drivers drive more frequently during high risk hours and under high risk circumstances. Examples are night-time driving, speeding, carrying passengers and a less frequent use of safety belts and driving older cars with fewer safety features.

Lack of driving experience

Learning to drive demands a lot of practice before expert levels are reached. In comparison, vehicle handling skills are relatively easy to master in only a few hours, while skills such as anticipation of potentially hazardous traffic situations require years of practice. The driving task is partly determined by the demands of the road environment, such as road design, the presence and maneuvers of other road users, and traffic rules. However, the complexity of the driving task is very much under the driver's control also, because of his personal choices on driving speeds, following distances, and position. These choices may lead to either small or large safety margins, and are based on his personal estimates about his ability to handle these traffic situations. In making these choices, inexperienced drivers in particular need to aim at large safety margins in order to compensate for their lack of experience. In reality however, young inexperienced drivers tend to choose for safety margins which are too small.

To a large extent, this phenomenon is a consequence of the fact that this age group tends to overestimate its skills and to underestimate the complexity of the traffic situation. This is particularly the case for young males.

Impairment

In addition to their social and biological immaturity and their lack of driving experience, young novice drivers are often impaired while driving. This impairment results from alcohol and drug use, fatigue and distraction. Compared to expert drivers, alcohol deteriorates the young driver's task performance to a larger extent. Illicit drug use is on the increase in this age group, in principle resulting in increased crash risk. In particular, the combined use of different drugs and alcohol leads to extremely high crash risks. Youngsters are also strongly affected by loss of sleep, the task duration and the biological clock, that is when driving during sleeping hours. These three factors lead to increased fatigue, which can be recognized as a loss of energy, a reduced tendency to react and reluctance to continue with the task, ultimately resulting in falling asleep at the wheel. Distraction as a cause of driving errors is more prominent in novices than in experts. Furthermore, youngsters are frequently distracted, for instance by passengers or mobile phone use, which lessens the attention for the traffic situation.

Effective countermeasures

Specific measures must be taken to counteract and eliminate the bad effects that immaturity and inexperience may cause. First of all, measures that raise the overall safety level of the traffic system such as adequate enforcement (alcohol, speed and safety belt), safe roads and safe cars, will also increase safety levels of inexperienced and young drivers. Apart from these general measures, specific measures for novice drivers are also called for. Effective measures aim to increase the amount of driving experience before solo driving, and to protect against high risk situations in the first phases of solo driving. Pre-license experience can be increased by supervised driving (apprenticeship). Protection during the first stages of solo driving can be provided by measures such as low alcohol limits, and restrictions on night time driving and driving with peer passengers.
These measures will only be effective when compliance rates are high. Therefore compulsory measures are preferred, in combination with strict enforcement of these measures. To facilitate their acceptance, information campaigns are needed which increase problem awareness in society and in the group of youngsters and their parents in particular.

Possibilities for improvements

Possibilities for improvements can be found in driver instruction and in the application of technologies to control access to the traffic system and to monitor actual driving behavior. For the improvements in driver instruction the focus should shift from vehicle control and traffic participation to higher order skills such as hazard perception. A complex area in this respect is the training of how to recognize personal skill limitations and how to 'manage' safety margins in accordance with it. With respect to technology, the application of electronic car keys that hold information about the privileges of the driver, alcolocks and black boxes, may reduce the exposure of young drivers to high risk conditions. Other technologies like ESC (Electronic Stability Control) and Advanced Driver Assistant Systems may be beneficial to novice young drivers, but it is too early for firm conclusions because of the lack of empirical studies on the actual impact of these systems on this target group.

0. Introduction

This web text is based on the detailed OECD report *Young Drivers: the Road to Safety* published at the end of 2006 [27], which presents a broad international overview. The report was produced by a large group of experts in the field: policy makers and researchers. Furthermore, it was sent to an even larger group of experts in almost every corner of the world for consultation. This web text is not as detailed as the OECD report. Because the OECD report has an extensive reference list, this web text contains few references to individual studies and concentrates on studies commissioned by the European Commission. For recent data on this topic you can read the *Traffic Safety Basic Facts, 2005: Young people (aged 16-24)*. The tables in this web text are meant to illustrate the patterns that are discussed. The data was collected for the purpose of the OECD report, and will not be updated in the coming years.

1. Magnitude and nature of the problem

This section looks at the scope of young driver road safety risk. It, discusses the key characteristics of the problem, focusing on age, experience and gender related factors, as well as the conditions under which it is aggravated. Finally this section looks at the possible economic costs.

1.1 The magnitude

In most countries, novice drivers under the age of 25 account for the largest share of traffic crashes and fatalities. As a share of all driver fatalities within the EU, the proportion of fatalities for young drivers ranges from 18 % in Denmark to 32% in Germany. In contrast, the share of this age group in the total population ranges from 8% in Denmark to 13% in Ireland. Moreover, according to the IRTAD data, traffic crashes are the single greatest killer of those aged 15 to 24 in OECD countries, accounting for 35% of all deaths, or approximately 25,000 people annually in recent years, as is presented in Figure 1.

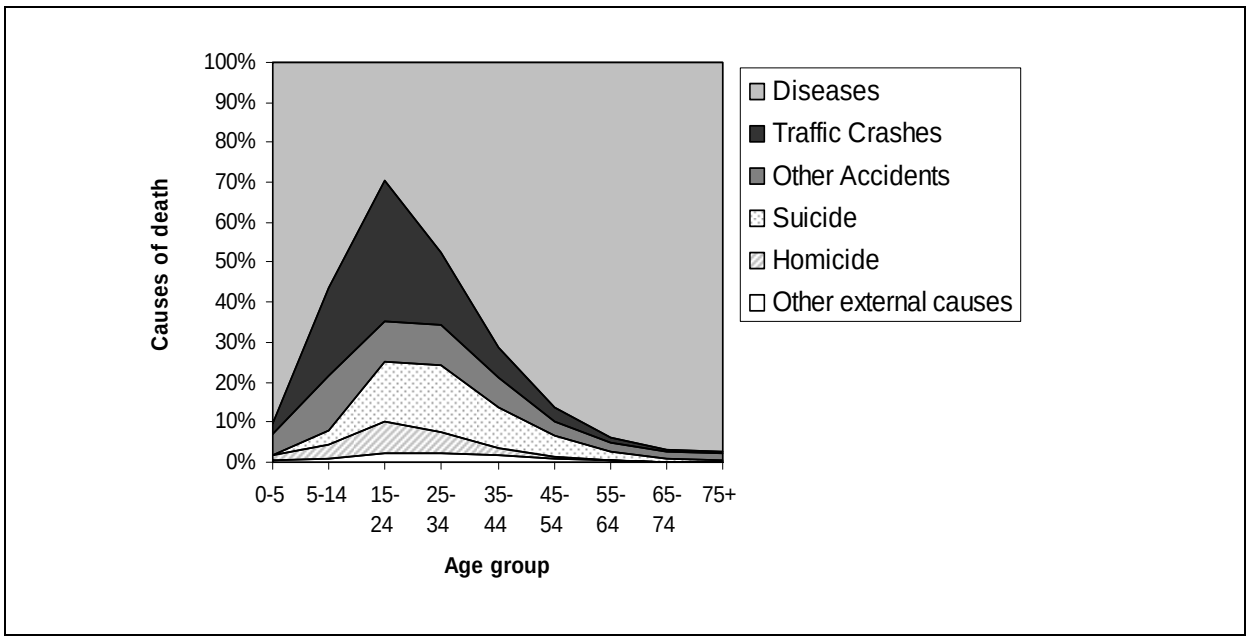

Figure 1: The proportional distribution of causes of death in OECD countries for different age groups.

Source: World Health Organization Mortality Database

1.2 Characteristics of these crashes

Young novice drivers are heavily over-represented in single vehicle crashes (crashes that do not involve other vehicles) and loss of control crashes. Although young novice drivers are over-represented in crashes at all times of day, weekend evenings and nights present higher risks per kilometre driven, especially for male drivers.
For males, speeding is an important accident cause. This, in combination with the fact that young drivers often carry more passengers in their cars, also results in more severe injuries and a higher number of people injured.

1.2.1 Speed and single accidents

Speed and speeding is undoubtedly one of the main causes of crashes involving young drivers, particularly men (almost 30% of all causation factors for crashes involving male drivers and 21% for female drivers, compared with only 15% for older driver's crashes). Speeding is much more likely to be a crash cause in a fatal crash when the driver is under 25 years old, the likelihood being highest for the youngest drivers. Speeding is much more prevalent for young male drivers than for young female drivers; 21 to 24 year old women have approximately the same level of involvement in speeding related fatal crashes as men aged 35 to 44. It is believed that poor speed adjustment is the reason why youngsters are over-represented in single accidents.

It should be recognized that, other than speeding, speeds which are too high for prevailing conditions are also a relevant phenomenon. In this situation, the driver does not violate the actual speed limit but crashes because of an inappropriate driving speed in a traffic situation which requires a much lower driving speed. In crash registrations this is seldom documented, but driver behavior observation studies show that inappropriate driving speeds are common in novice young drivers. Tackling this phenomenon is even more difficult than tackling the speed violations, as this behavior is the result of an inaccurate assessment of the complexity of the driving situation. Speed violations, in contrast, are the result of a 'simple' decision to drive faster than the observed legal limit.

1.2.2 Alcohol and drugs

Alcohol is a key factor in young driver crashes, particularly when combined with other factors, such as speed, night time driving and carrying passengers. While young novice drivers do not necessarily drink drive more than other drivers, the consequences are often more serious. As young people are over-represented in crash statistics, even the same proportion of alcohol-related crashes is likely to translate into a much higher absolute number of crashes and fatalities. Furthermore, lower quantities of alcohol seem to have a somewhat stronger effect on younger driver fatality risk as is shown in Figure 2. Use of illegal drugs is on the increase as a factor in young novice drivers crashes.

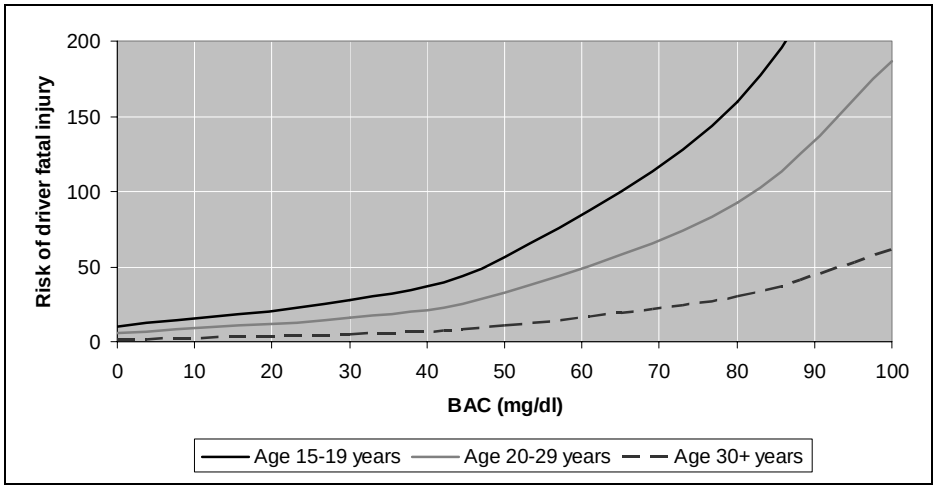

Figure 2: Risk by BAC (mg/d) and age Group, relative to risk of sober driver aged 30 or more, New Zealand (1995-2000) Source: adapted from Keall et al, 2004

1.2.3 Passengers

Young driver risk differs markedly from that of older drivers for the effect on crash risk of carrying passengers. For older drivers the crash risk decreases when they carry passengers; for 18-19 year-old drivers the risk doubles, while for 16-17 year-olds it increases by as much as 4 times, getting higher as the number of passengers increases.
As a result many youngsters are killed as passengers in a young driver crash. In the Netherlands for instance, 40% of the fatalities are passengers, and the remaining 60% are young drivers.

1.2.4 Time of day/ Day of week

A typical young driver accident happens in the early hours of the morning, and most frequently at weekends, as can be seen in Figure 3. Partly, this pattern is caused by the fact that youngsters do most of their driving in these hours. However, these hours are also more dangerous, because of the special driving context, such as tiredness, presence of peer passengers, and excitement.

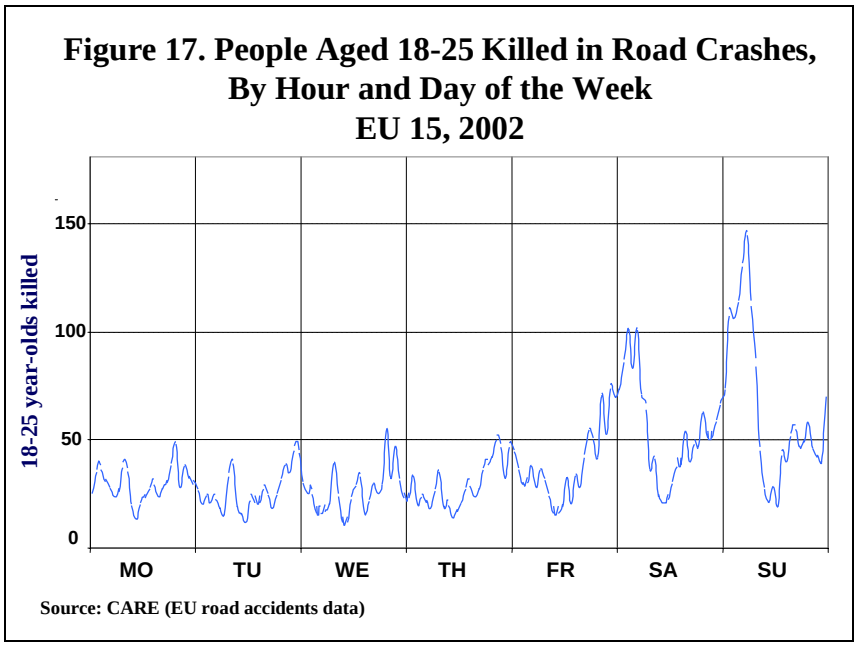

Figure 3: Persons aged 18-25 killed in road crashes by hour and day of the week in 15 EU countries

1.2.5 Typical young driver crashes

To answer the question on how 'typical' young driver crashes are, or whether these accident types just reflect country specific patterns, Lynam et al [21] compared the United Kingdom, Sweden and the Netherlands on the following accident types:

- Drink driving crashes: including all crashes in which the young driver had a blood/alcohol percentage that is over the 'national ' legal limit. In the Netherlands that is above 0.5, in the UK it is over 0.8, and in Sweden it is over 0.2
- Single crashes (an accident without any other traffic involved, or collisions with non-moving objects)
- Presence of (injured/killed) passenger
- Weekend night crashes (crashes in the period Friday 08.00 pm – Saturday 06.00 am and Saturday 08.00 pm – Sunday 06.00 am).

Differences between countries

Figure 4 shows the percentage of all fatal crashes within the particular age band that is characterized by the factors mentioned for both the young drivers (18-24 years of age) and the reference group (drivers between 30-59 years of age). The sum of the proportions within an age group can be higher than 100%, as one crash can be coded in more than one category. For instance, a crash, in which an intoxicated young driver carrying passengers collides into a tree during a weekend night, is present in all 4 categories.

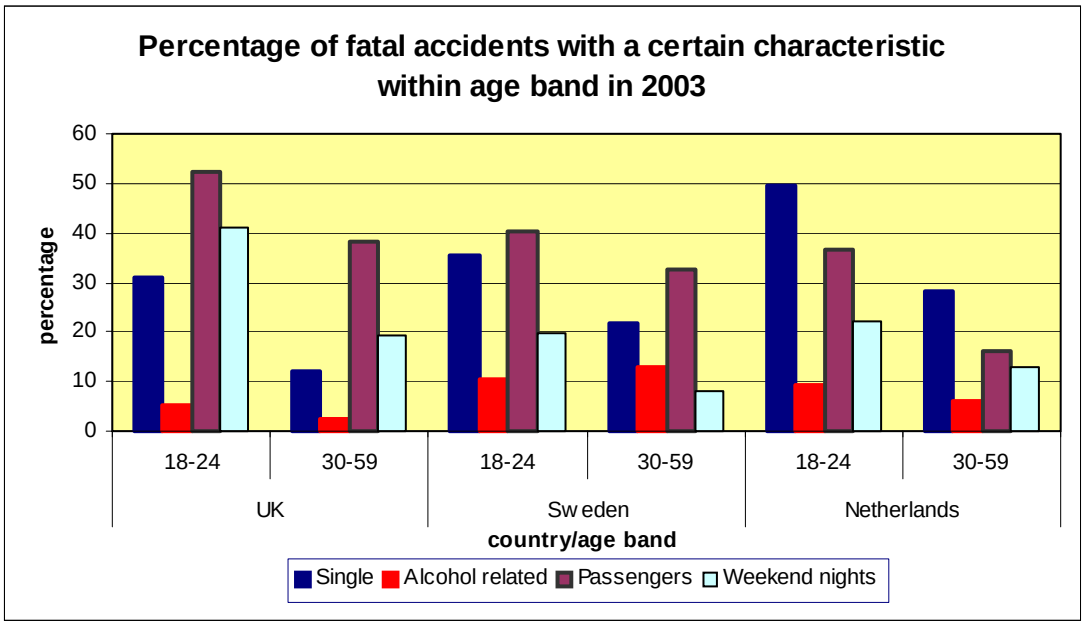

Figure 4: Percentage of fatal crashes that are single car crashes, alcohol related crashes, crashes in which passengers are injured or killed and weekend night crashes in the age bands 18-24 and 30-59

First of all, Figure 4 shows that the distribution of accident types is very similar for both novice drivers and expert drivers, indicating country specific problems. This asks for a broad approach, not only targeting young drivers. For instance, the percentage of single car crashes for both age bands is considerably higher in the Netherlands than in the other two countries. Particularly the Swedish drivers between 30 and 59 years of age have noticeably more alcohol related fatal crashes than the same group of drivers in the UK or the Netherlands. Compared to the UK, fatal crashes in which passengers are injured or killed are relatively rare in the Netherlands, and fatal crashes in weekend nights happen much more frequently in the UK than in Sweden or the Netherlands.

Beside these country specific patterns, the percentages in the 18-24 age bands are higher than in the 30-59 age bands in all 3 countries. The only exception is the percentage of alcohol related fatal crashes in Sweden. This percentage is slightly higher for the 30-59 age bands than for the 18-24 age bands.

Differences within countries

To compare older and younger drivers within each country, over-representation ratios were calculated (Figure 5). Values > 1 indicate an overrepresentation of young drivers in an accident type, while values < 1 indicate an under-representation.

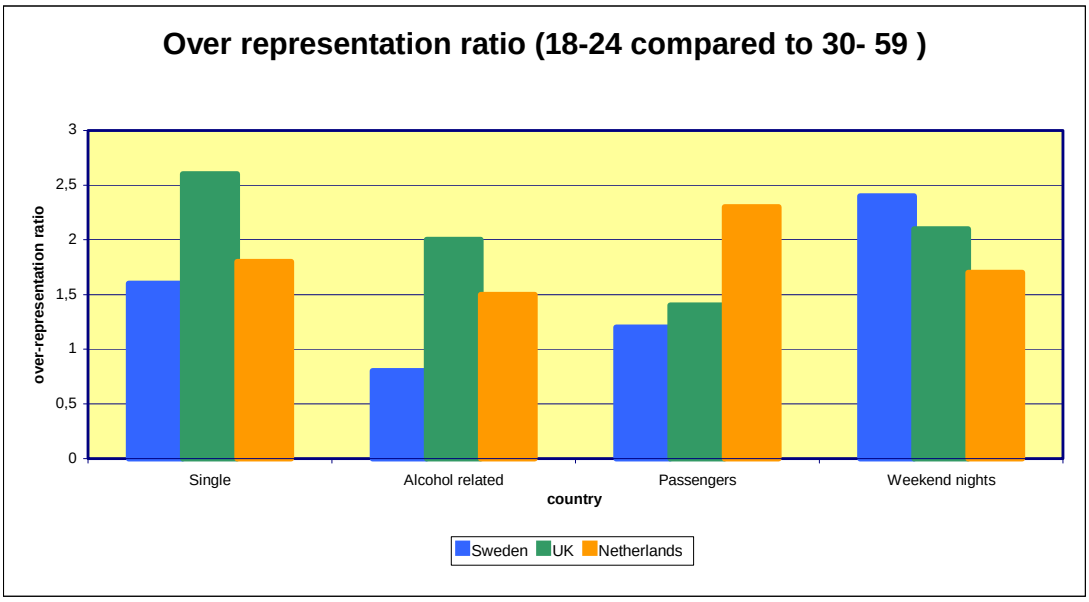

Figure 5: The ratio between the percentages of an accident type in the 18-24 age bands and the 30-59 age bands

Figure 5 shows young novice drivers to be relatively over-represented in single car crashes, fatal alcohol related crashes, fatal crashes in which passengers are injured or killed and fatal weekend night crashes compared with older more experienced drivers. Only in Sweden young novice drivers involved in fatal alcohol related crashes are under-represented (over-representation ratio slightly less than 1). The over-representation of fatal weekend night crashes for young novice drivers is quite similar between the 3 countries. The over-representation of fatal single car crashes in which young novice drivers are involved, is remarkably higher in the UK than in the other 2 countries. Compared to the 30-59 age bands, the 18-24 age bands in the Netherlands is more over-represented in fatal crashes with passengers, than is the case in the UK and in Sweden.

1.3 Risk

1.3.1 The concept of risk

Accident frequencies in themselves are not sufficient to draw conclusions about the over-representation of young drivers, as crash frequency is closely related to mileage, the number of licenses per age group, and the population size. Mileage has the strongest link to crashes: the more you drive, the higher the chance that you may get involved in a crash. This is why mileage of those groups needs to be taken into account to enable 'valid' comparisons across driver groups (like age groups or gender). Unfortunately, this type of data is rarely available, and therefore the other 'denominators' like license distribution and population size need to be used. Data on population size are widely available in relatively long time series as well. This is less the case for licensing rates.

1.3.2 Rates by age, experience and gender

Age

Young drivers have a higher fatality rate per head of the population as can be seen in Figure 6. The rate peaks in the age range 18-24, and then gradually declines. This is a feature to be found in most motorized countries.

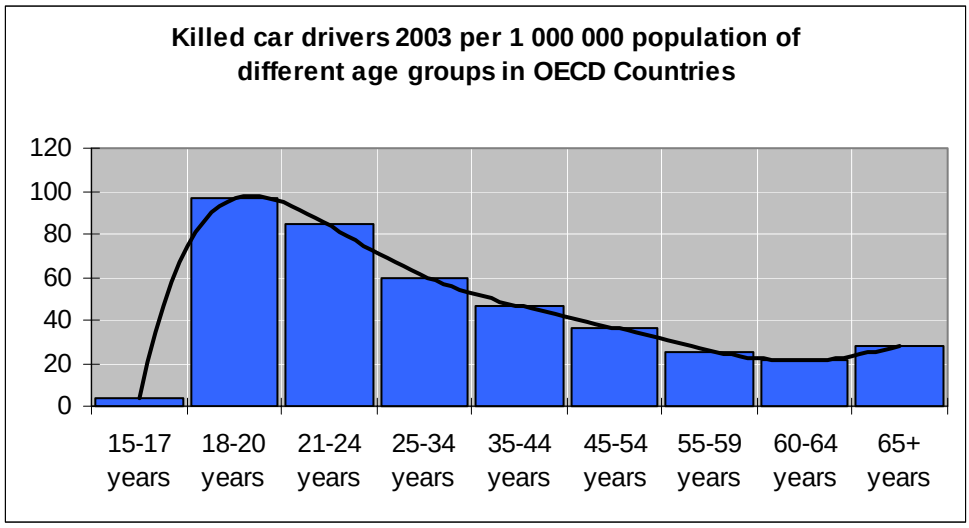

Figure 6: killed car drivers 2003 per 1.000.000 population of different age groups in OECD countries

Experience

A relevant question that needs answering is whether the fatality rate development is a result of a higher age or a result of increased experience.

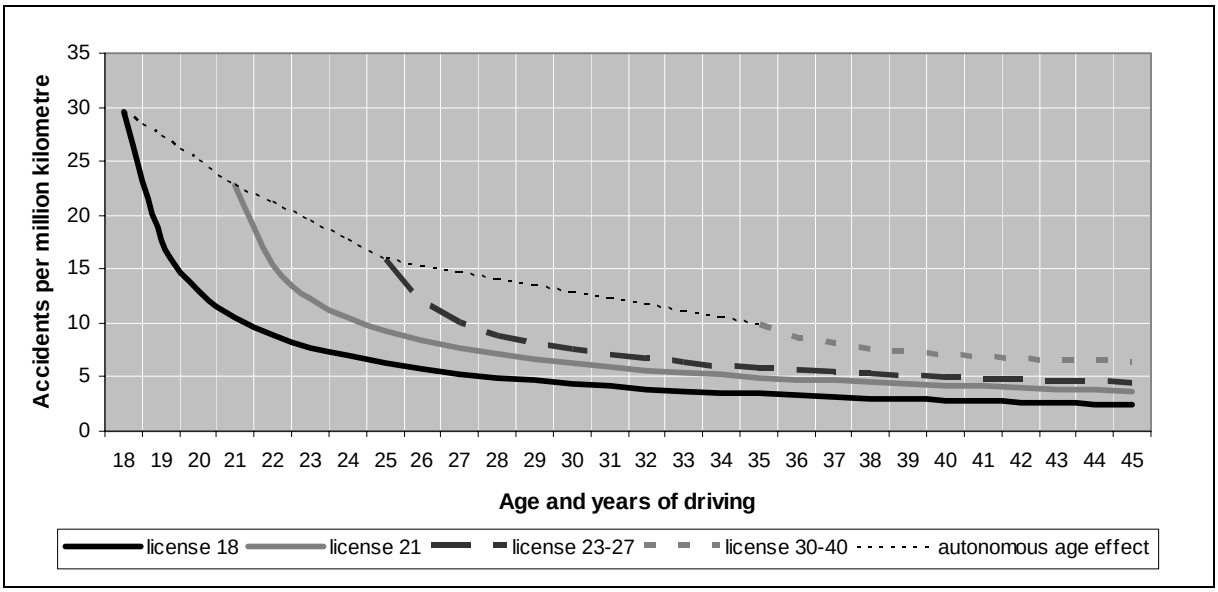

Figure 7: Age and driving experience: accident risk controlled for mileage for different age groups of novice drivers (Vlakveld 2004)

Figure 7 presents data from a national survey among car license holders in the Netherlands. The graph shows that the older the driver is when he gets his driving license, the lower is his initial risk. Consequently, it is safer to gain a license at a higher age. However, even then it takes many years before the increased risk levels out completely. Similar graphs have been obtained in other countries, and the conclusion is that both young age and lack of experience strongly influence accident risk. It is interesting to know the relative contribution of each factor to this risk. However, from a practical point of view this is less relevant, because in most motorized countries the novices are also young. Thus, both the age related and the

inexperience factors need to be dealt with in order to tackle the young driver risk.

Gender

In the age group 18-24, a male young driver's risk is considerably higher than that of the female young driver (Figure 8). National statistics differ in the precise shape of the curve and the absolute difference between the sexes, but the general pattern can be recognized in all countries.

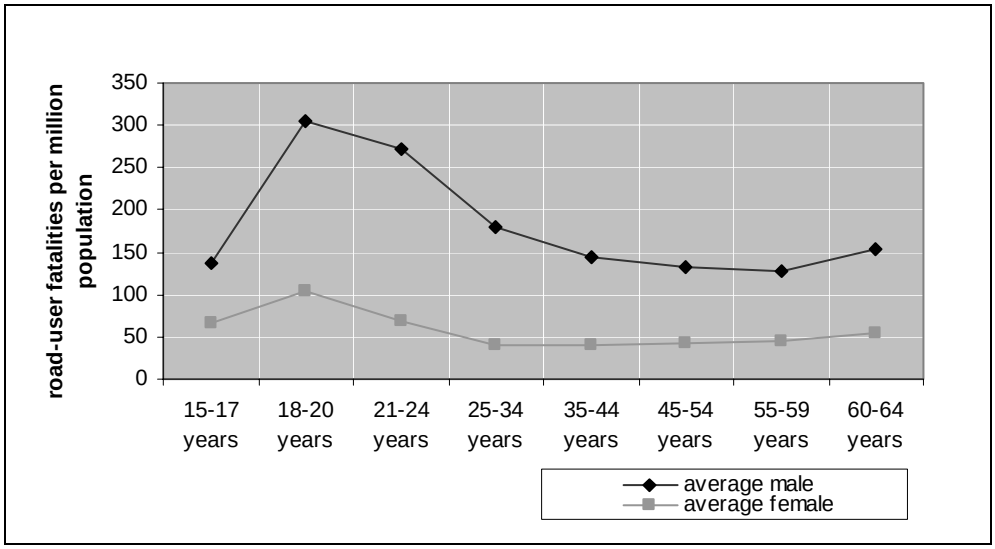

Figure 8: Road user fatalities per million population of different age groups. Source OECD, IRTAD

A possible explanatory factor may be differences in mileage. In other words: young males have more crashes because they simply drive more. The validity of this statement, however, cannot be verified on the basis of international statistics. More detailed national studies show that this pattern still holds good even after correction for the figures for mileage.

1.4 Trends

1.4.1 Development compared to other age groups

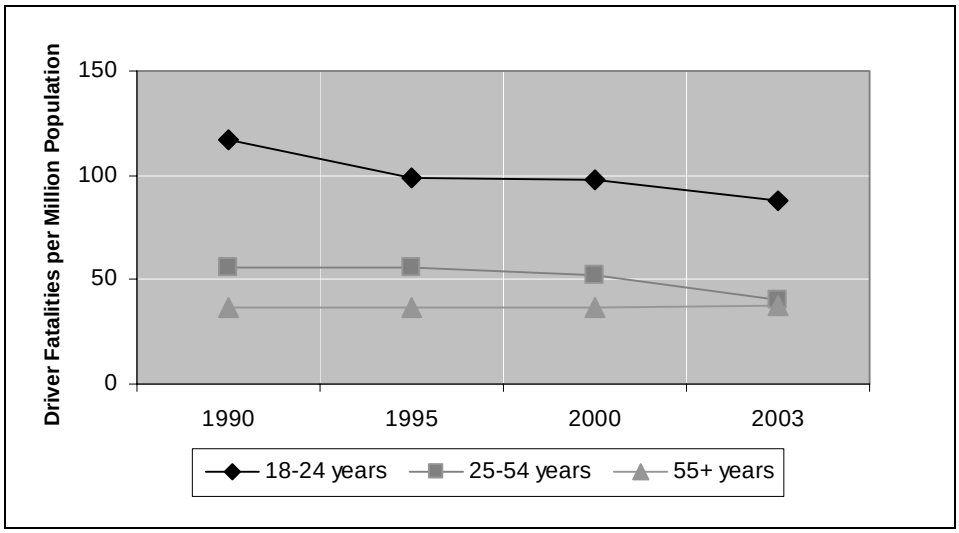

Figure 9: Driver fatalities per million population for different age groups in the period 1990-2003 in OECD-countries

In comparison with other age groups, the fatalities for young drivers have decreased by about the same extent as for the age group 25-54 (Figure 9).

1.4.2 Development per country between 1985-2003

Has road safety of young drivers improved over time? To answer this question Figure 10 compares the mortality rate of young drivers in several countries in two periods.

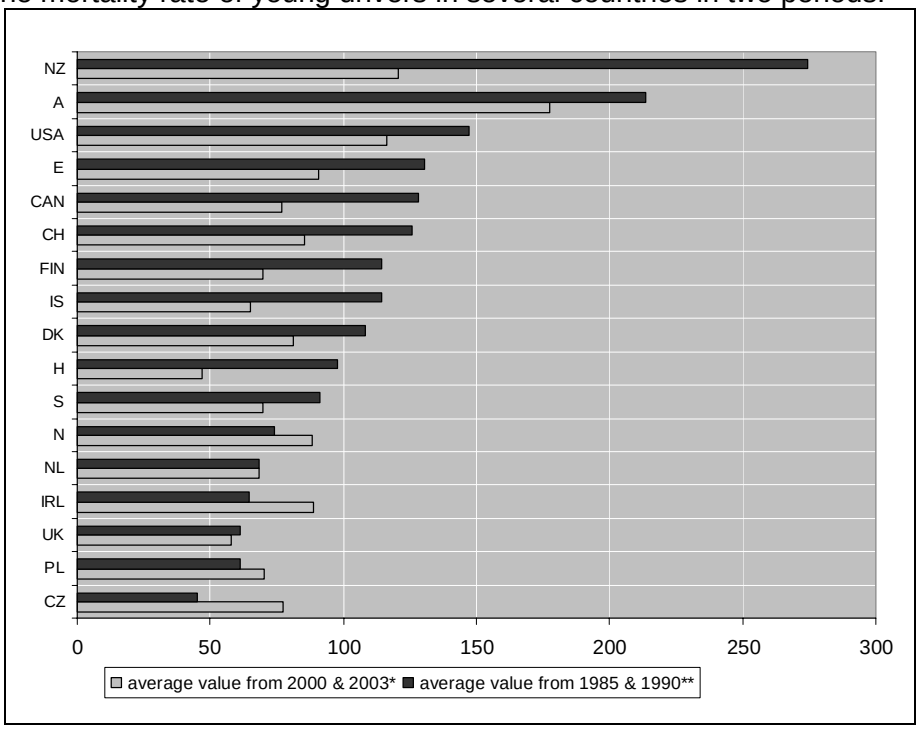

Figure 10: The development of driver fatalities per million population of age group 18-24 comparing two periods: 2000 & 2003 and 1985 & 1990 (source OECD, IRTAD)

Overall, a clear pattern shows that in most countries the fatality rate has gone down over time. Some countries are an exception to this general rule. It seems to be those countries that have experienced sharp increases in motorization in a relatively short period of time, like the Czech Republic, Poland and Ireland. But Norway, the Netherland and the UK all show very little or no change. However, a detailed comparative analysis of Sweden, The Netherlands and the United Kingdom [21] also shows the limitation of the analyses of fatalities per head of population presented here. When exposure is taken into account and fatalities are calculated per distance driven, these three countries also show an improvement over time.

1.4.3. Young driver risk and general safety levels

To what extent is young driver risk related to general safety levels in a country? And the other way around: Do unsafe countries have relatively unsafe young drivers?
If, all young drivers have problems irrespective of the safety level of a country, then specific measures targeted at young drivers are the only way forward. Similarly, if general safety level is dominant factor, then improving the general safety levels is the preferred action.

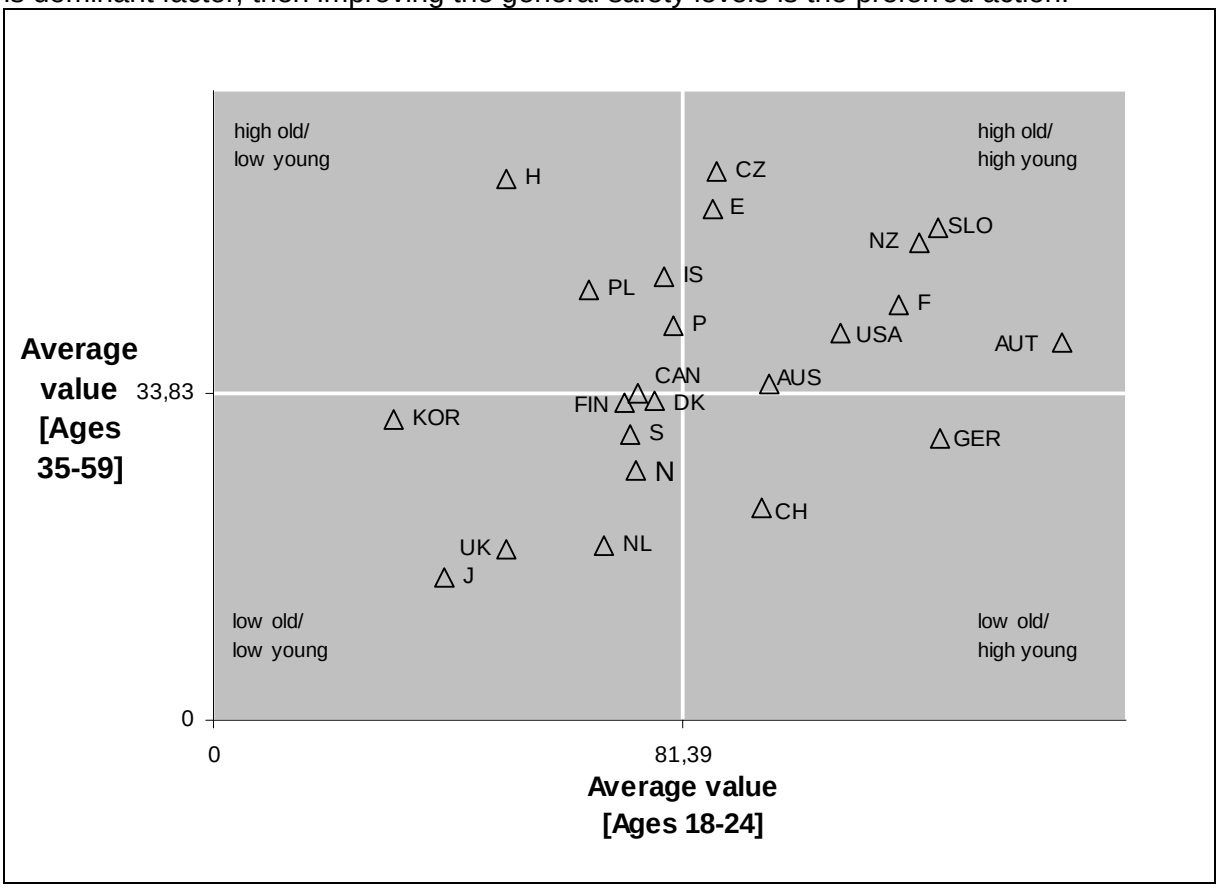

Figure 11: Fatalities per head of population per country in two age-groups compared to the OECD average

In Figure 11 the risk of experts and novice drivers are compared between countries. Each country has received two scores. One score on the novice driver risk and one for the expert driver risk. The white lines indicate the average value for the two groups in the OECD: the white horizontal line for the expert drivers; the white vertical line for the novice drivers.

The figure shows that, in general, countries with safe expert drivers have relatively safe young drivers as well (quadrant low old/ low young). The opposite is also true (quadrant high old/high young). This indicates that, the improvement of general safety levels (e.g. by enforcement, infrastructure, injury protection) is a valuable way toward improving the safety of young drivers.
But above all, this graph also indicates that in most countries, young drivers have elevated risk levels. This indicates that in addition to the general safety measures there is a strong need for specific young driver measures as well. Judging by the absolute differences between general safety levels within countries for young and older drivers, it may be worthwhile to begin with those measures that improve the situation for all drivers, and to focus on the individual risk groups such as young drivers after that.

1.4.4 The special case of young male drivers

Some recent findings indicate that the young male driver increasingly becoming a problem and does not respond to measures to the same extent as female young drivers do.

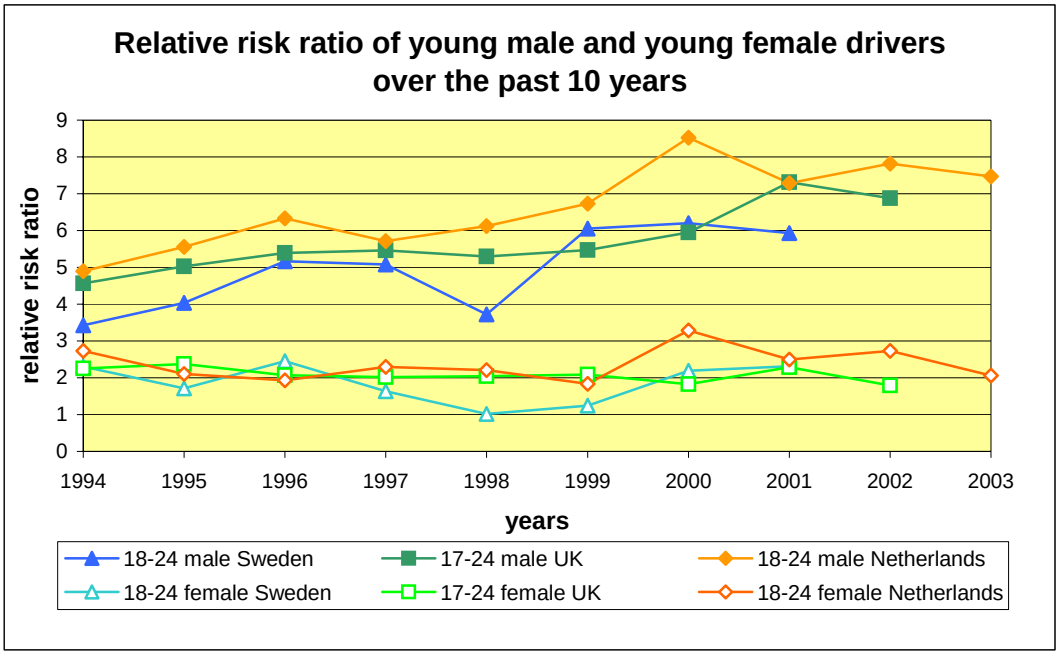

Figure 12: Relative risk ratios of young male and young female drivers over the past 10 years: The reference group is the group of older more experienced drivers of both sexes (30-59).

In a comparative study between the United Kingdom, Sweden and the Netherlands [21] the risk for young drivers of a serious accident per kilometre driven was calculated for each year in the period 1994-2003. This risk was then compared to the risk of expert drivers in those countries, resulting in a relative risk ratio. Values higher than 1 indicated a worse safety record for novice drivers. Figure 12 shows that female drivers have a worse record than expert female drivers, but that in all three countries the ratio is roughly constant over this time period. The relative risk ratio for young males was already higher than for females in the mid 1990s, and does not respond to overall improvements in safety levels. This pattern is consistent in all three countries. Therefore, we conclude that special attention needs to be paid to this trend.

2. Contributing factors to crash risk

Introduction

This section seeks to explain why young novice drivers are subject to a larger number of crashes and a higher crash fatality risk. As can also be recognized in the accident patterns, four factors play an important role:

Immaturity	Biological and social preconditions in youngsters are not sufficiently developed yet
Exposure	The exposure to risky conditions and driving situations is high
Lack of experience	The driving skills are not sufficiently developed
Impairment	Driving performance is impaired because of use of alcohol, legal of illegal drugs, fatigue or distraction

2.1 Immaturity

2.1.1 The body

Age undoubtedly affects the learning process. The older somebody is when he or she starts to drive after full licensing, the lower the accident risk will be at the start of his or her driving career.

Studies have demonstrated that, beyond the age of 18 the human brain is still developing, in particular the areas dealing with 'executive' functions like planning, impulse control, reasoning and the integration of information (i.e. thinking before acting). This could have an important influence on how to prevent young driver crashes, particularly as the combined abilities to take responsibility, to reflect on consequences, and to control impulses play an important role in driving safely.

The late maturing of parts of the brain is not the only biological aspect relevant to young drivers' road safety risk. There is also a positive correlation between sensation-seeking and testosterone levels, which provides a very basic explanation for why men are more likely to show risky behavior than women. Biological development is nevertheless significantly influenced by experience. Social and contextual factors may explain behavior patterns. As there is such a close relation between nature and learned aspects, educational programmes should always be aware of the limitations posed by the biological aspects.

2.1.2 Social development

An other factor which can be related to immaturity is that young, novice drivers are in the middle of a socialization process in which they are getting away from their parents' influence to become independent. The problem appears when during that process they are strongly influenced by peers, who may not be a good role model for safe driving.

2.2. Exposure

Young, novice drivers tend to drive in circumstances that would increase the risk for any driver, and of course especially for them. They drive under more risky conditions than older drivers, in terms of their driving styles (for instance driving at higher speeds), their larger proportion of night-time driving, their life styles (often drinking alcohol, carrying more passengers who influence their behavior) and their less frequent use of safety devices (such as safety belts). When these specific elements of risk exposure are combined with their

limited driving skills in a complex driving environment, it is not surprising that their risk is higher than that of other drivers.

It has also been suggested that young drivers often increase their exposure to risk by driving older vehicles, with fewer modern safety devices (e.g. no airbags, no headrest). However, it must not be ignored that the most popular cars among youngsters (the cheaper ones) also have less powerful engines. This may decrease their risk. Moreover, young people often drive their parents' cars, because they do not own their own car yet. Possibly this car has better safety features than the cars which most youngsters can afford. However, the possible negative contribution of car type to risk cannot be determined yet, because of the absence of studies in this field.

2.3 Lack of driving experience

2.3.1 A time-consuming process

Learning to drive demands a lot of practice before expert levels are reached. In comparison, vehicle handling skills are relatively easy to master in only a few hours, while skills such as anticipation of potentially hazardous traffic situations require years of practice. The driving task is partly determined by the demands of the road environment, such as road design, the presence and maneuvers of other road users, and traffic rules. However, the complexity of the driving task is also very much under the driver's control because of his personal choices on driving speeds, following distances, and position. These choices may lead to either small or large safety margins, and are based on his personal estimates of his ability to deal with these traffic situations. In making these choices, inexperienced drivers in particular need to aim at large safety margins in order to compensate for their lack of experience. In reality, however, young inexperienced drivers tend to choose safety margins that are too small. To a large extent, this phenomenon is a consequence of the fact that this age group, tends to overestimate its skills and to underestimate the complexity of the traffic situation. This is particularly the case for young males.

2.3.2 The need for extensive practice

Extensive practice is an essential prerequisite for developing expertise in a given task. To be successful, driving education should develop skills in the youngster that he/she will apply in real traffic. This implies that not only should the driver be able to apply what he has learnt, but he should also be motivated to do so. Therefore, driver training should ensure that the driver understands why he/she needs to execute tasks in a particular way, for instance to keep to the speed limit or not to drink and drive.

For experienced drivers, driving under normal circumstances is less demanding than for novice drivers. With practice, a task becomes more routine, requiring less mental capacity. Inexperienced drivers need all their attention on the road, and cannot cope with additional tasks adequately, such as turning on the radio, or talking to a passenger. This limitation becomes highly visible in demanding and unexpected situations.

Other difficulties that the lack of experience will impose on novice drivers are their reduced ability to use peripheral information and their ability to detect hazards. That is, to discover, recognize and react against potentially dangerous situations in traffic. Several studies have shown that experienced and expert drivers detect hazards better and faster than novice ones, with the difference being even greater for hazards further away from the driver.

2.4. Impairment

Young, novice drivers' capabilities while driving can also be reduced by alcohol, illicit drugs, fatigue, as well as by distraction.

2.4.1 Alcohol

Use of alcohol and drugs increases the crash rate of young and novice drivers. Drink driving is particular dangerous for the young for a number of reasons. First of all, the young person's tolerance of alcohol is lower, as the body is not used to its consumption. Secondly, the driving task is more demanding for young, novice drivers than for other drivers, and thus, as they need to pay more attention to their driving task, the disrupting effect of alcohol is greater than for expert drivers. Thirdly, alcohol reduces inhibition. As young people posses less developed self-control mechanisms, they suffer a stronger euphoric and emotional impact from alcohol. Finally, studies have shown that teenagers tend to underestimate their actual level of intoxication.
The negative impact of these specific factors is even larger, when combined with other exposure factors common to young driver crashes, such as the presence of passengers.

2.4.2 Drugs

Different drugs have different effects on driving performance, especially when combined with alcohol or with other drugs. Drugs can be either illicit drugs or prescribed medication. The use of these drugs by the driving population is strongly related to the legal restrictions on their use in a country. As these restrictions differ between countries, it results in different patterns of use while driving.
Within Europe, illicit drug consumption gradually increases in the age group 15 to 25 years old. The pattern of use differs between boys and girls. Whereas the use of legal drugs is more common among girls, alcohol, cannabis and ecstasy are more frequently used by boys. Compared to testing for alcohol, the drug screening of drivers creates a variety of problems. For instance, in some countries there is a political debate on the legalization of drugs, especially cannabis. Although the legalization of drugs in general is a different subject than that of the legalization of drug use in traffic, the debate will have an influence on the issues related to drug driving. Screening for the presence of drugs is not as clear cut as testing for alcohol. First of all, 'safe' intoxication levels for legal drugs still need to be determined [17]. In addition, the road-side screening methods are not sufficient for reliably assessing the momentary intoxication level in a driving. For this purpose, the European Union's ROSITA project is evaluating various toxicological measures, such as analyses of urine, saliva, sweat and hair.

Outcomes from epidemiological case-control studies indicate that use of illicit drugs in general is a source of risk for young, novice drivers. More in particular a combined use of drugs: these drivers have 25 times higher risk of a serious road crash injury. The combination of drugs and alcohol leads to a risk which even is 35 times higher [22] .

2.4.3 Fatigue

Fatigue is not only caused by the number of hours driving, but also by the time spent on other tasks before driving, by length and quality of sleep, or by stressful situations. Another factor that causes fatigue is the time of day the trip is undertaken. This is particularly important for young, novice drivers, as their relative crash rate at night is higher than that of adults.
Fatigue reduces the quality of many aspects of the driving task, such as adequate reactions to sudden changes, and tracking. Drivers try to compensate for the influence of fatigue, for

instance by either increasing the task demands (e.g. driving faster) or lowering them (e.g. increasing the safety margins by slowing down or using larger following distances,). But crashes and observations of driving performance show that these compensations are not sufficient to remove all excess risk.
As adolescents need more sleep than adults, which they do not usually observe, fatigue may affect youngsters even more than adults.

2.4.4 Distraction

The driving task requires the driver's attention to be focused on the traffic at all times. However, attention is easily and sometimes involuntary drawn to other events, objects or persons, inside or outside the vehicle, which are not related to the driving task (distraction). Attentional requirements of some driving tasks are higher for novice drivers, so distraction may affect them more than adults.
Special attention in this field must be paid to youngsters' extensive use of mobile phones and music devices and the distraction caused by the presence of excited passengers.

3. Countermeasures

Introduction

A variety of measures is available which specifically target the increased accident risk among novice drivers, including changes in their exposure to driving.
Due to its multi-faceted nature, there is no single solution to this problem. Therefore, a package of countermeasures is required in order to combat it. Furthermore, as OECD and ECMT countries widely differ in culture, history, motorization and overall traffic safety levels, the strategies employed will need to be different for each set of circumstances.
This section gives an overview of the countermeasures used in different countries that can have an important impact on reducing young novice driver risk. These countermeasures are associated with age of access, driver training and testing, enforcement and communication.

Before turning to these countermeasures, we will first discuss some introductory issues related to these countermeasures:

- Should countermeasures focus on young drivers only or should the measures be directed at all novice drivers?
- How to assess effectiveness? Are measures that are effective because they reduce the crash rate also 'acceptable' countermeasures?
- What is the contribution of general safety measures to young driver safety?
- What is the potential contribution of non-safety policy measures?

3.1 Novice versus young drivers

A central issue in the process of selecting countermeasures is the question of whether countermeasures should target only young drivers or all novice drivers? The answer to this question is primarily based on the following practical considerations. As all young drivers are initially novice drivers, in terms of countermeasures it is most effective to target the combined factors of age and inexperience-related phenomena. Moreover, in most industrialized countries, novice drivers tend to be fairly young. At the same time, many of the countermeasures that will be proposed are equally applicable to all novice drivers, whatever their age.

3.2 Exposure control versus safe traveling

Countermeasure effectiveness can be assessed for several different potential success criteria:

- Safe behavior like wearing a safety belt (an intermediate criterion)
- Crashes (an absolute crash criterion)
- Fatalities (an absolute fatality criterion)
- Crashes and fatalities per distance driven (a risk criterion).

The 'absolute number criterion' aims solely to increase safety and may entail measures that reduce travel, or even block access to the traffic system as drivers by increasing the age at which novice drivers can gain their license. In contrast, the 'risk criterion' states that safety should be expressed as a decrease in fatalities/crashes per distance driven.
These two different perspectives result in different assessments of the outcome of measures, as well as in preferred measures. They also show that individual measures are effective in two distinct ways:

- By reducing exposure to risky travel (by means of reducing mobility under risky conditions),
- By improving the general safety level of the traffic system, including novice driver performance, resulting in more safety per kilometre driven.

3.3 The contribution of general safety measures

It is important to recognize that young drivers benefit from general traffic safety measures such as adequate traffic regulations (like low BAC), good quality enforcement of rules and regulations, safe roads, injury protection systems etc. Table 1 gives a survey of general measures that are particularly effective for young drivers.

The strategic approach

Road safety issues	Classes of initiatives						
	Improved enforcement	Public education	Lower speeds	Safer roads	Occupant protection	Safer modes of travel	Planning a safer system
Drink driving	l	l		l	l	l	
Speeding	l	l		l	l	m	
Restraint non-use	l	l		m	l	m	
Driver fatigue		l		l	l		
Young drivers	l	l	l	l	l	m	l
Older drivers	m		l	l	l	m	l
Motorcycles	l	m	l	l	l	m	
Bicycles	m	m	l	l	l	m	l
Pedestrians	m	m	l	l	l	??	l
Heavy vehicles				l	l		
Drugs				l	l	l	

Table 1: Survey of generic measures beneficial to specific road safety issues, by type of effect (Unfilled circles = indirect effect/filled circles = direct effect). (Western Australia Road Safety Council and Government (2002)

3.4 Contribution of non-road safety policies

Non-road safety policies, such as the existence of an effective public transport system with reduced fares for young users can have an important impact in changing young novice drivers' patterns, mileage and risks. Other examples of how overall policies may affect young driver safety are geographical location of youngsters' meeting points like discos and socially safe transport. This kind of policy may encourage youngsters to drive or even drink and drive. Similarly, such non-road safety policies may also reduce exposure. In the Netherlands for example, the introduction of a free public transport pass for students has systematically and enduringly reduced mileage in the age group 18-24 yrs, and subsequently reduced their accident rate.

3.5 The need for early education

Although youngsters are new-comers as drivers, they are not new to the roads. They already have extensive experience in other traffic roles (e.g. moped, pedestrians). Moreover they have observed the way their parents drive and have been confronted with many driving violations of other road users. Studies in the field of developmental psychology have demonstrated that safety related attitudes are formed at a very young age. This implies that safety related education should not only be directed at youngsters preparing to take their driving test, but, perhaps even more importantly, be directed at children in primary and secondary school.

3.6 Age of access

The choice of a minimum age for solo driving is difficult, as it may be conditioned by different local, social, or cultural circumstances. A higher driving age may well save lives, by preventing young and inexperienced drivers from solo driving until they are older. It has been shown that first year fatalities rise as the age of first time solo driving decreases.
But these measures could, on the other hand, limit their access to work, and social and educational opportunities. Therefore, the need for mobility at a given age should be balanced against the cost of this mobility, in terms of human life and health, as well as economic impact. Such an analysis should be based on as complete and reliable data as possible.
Particularly in countries where people are allowed to drive from their mid-teens, any government seeking to reduce young driver related deaths should consider the option of rising the minimum legal age. Furthermore, learning periods following the minimum driving age and protective measures following licensing for solo driving can do much to reduce the age-related aspects of risk.
If a higher access age is chosen for car driving, this may motivate young people to choose even less safe modes of transport, such as motorcycles. Ideally, young people should not be allowed to ride a two-wheeled motor vehicle under the minimum age for solo car driving, but in some conditions this may restrict their mobility too severely. In terms of policy development, these potentially adverse effects of delayed licensing need to be carefully weighed against the expected safety gains.

3.7 Licensing regimes

The primary aim of licensing systems is to exclude individuals with insufficient driving ability and competence. Licensing systems are based on laws and regulations referring to the requirements for being licensed (e.g. age, driving aptitude), the quality of licenses (e.g. restrictions), the administrative procedures for licensing (e.g. licensing, withdrawal) and fitness to drive. Systems differ more or less regarding the items that are tested, the formal procedures and the institutions within the system.

Although in each country the licensing system is unique in terms of content and organization, in general two distinct categories of licensing systems can be distinguished: (a) traditional and probationary licensing systems and (b) graduated licensing systems (GDL).

3.7.1 Traditional

In this system, a driver is fully licensed after passing the driver test, and no special conditions apply to the novice driver (Figure 13). Today most countries using a 'single-phase licensing system' have also introduced a probationary license. Consequently, the novice driver does not become a fully licensed driver until he or she has completed a probationary period, which could include demerit points, and restrictions like zero BAC.

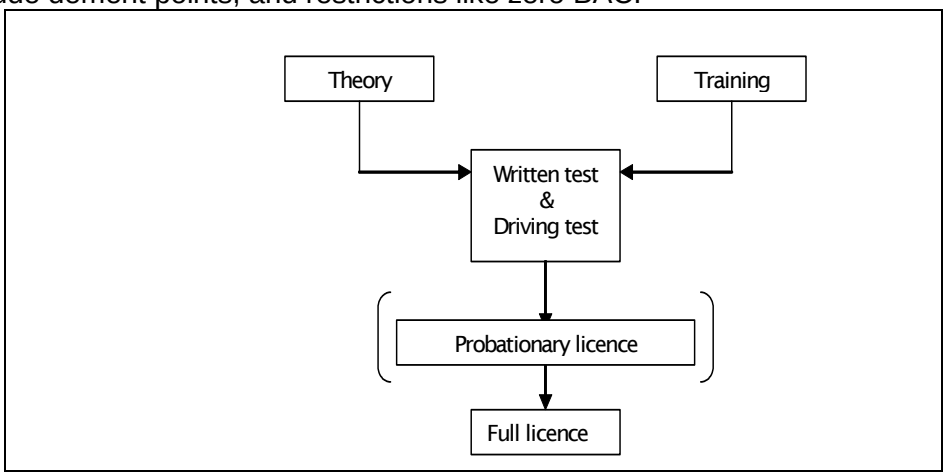

Figure 13: The structure of the single-phase licensing system. Adapted from Engström et al 2003 p. 100

A variation to this is the 'two-phased system' (Figure 14), in which candidates get a provisional license after having completed the first phase, allowing them to drive solo. Only after completing the second phase of theory and training, but without further testing, the full license is acquired.

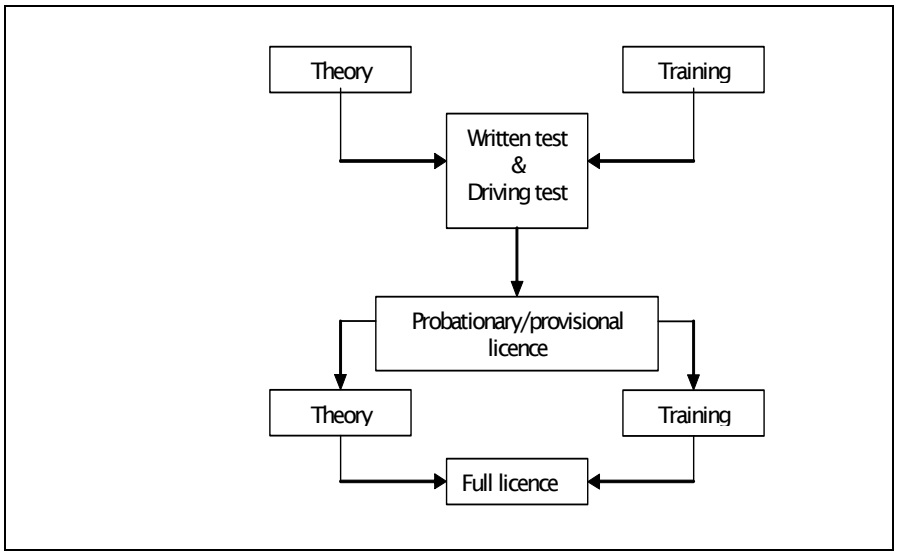

Figure 14: The structure of the two-phase licensing system. Adapted from Engström et al, 2003

3.7.2 Graduated licensing

The basic principle of graduated licensing (GDL) is to allow new drivers to acquire driving experience under low risk conditions. Initially the novice driver is only allowed to drive under low risk conditions like supervised driving and restrictions such as not carrying passengers. With growing experience, more driving privileges are phased in gradually. GDL systems are typically divided in three stages of progressively increasing difficulty during a longer learning process with protective learning conditions.

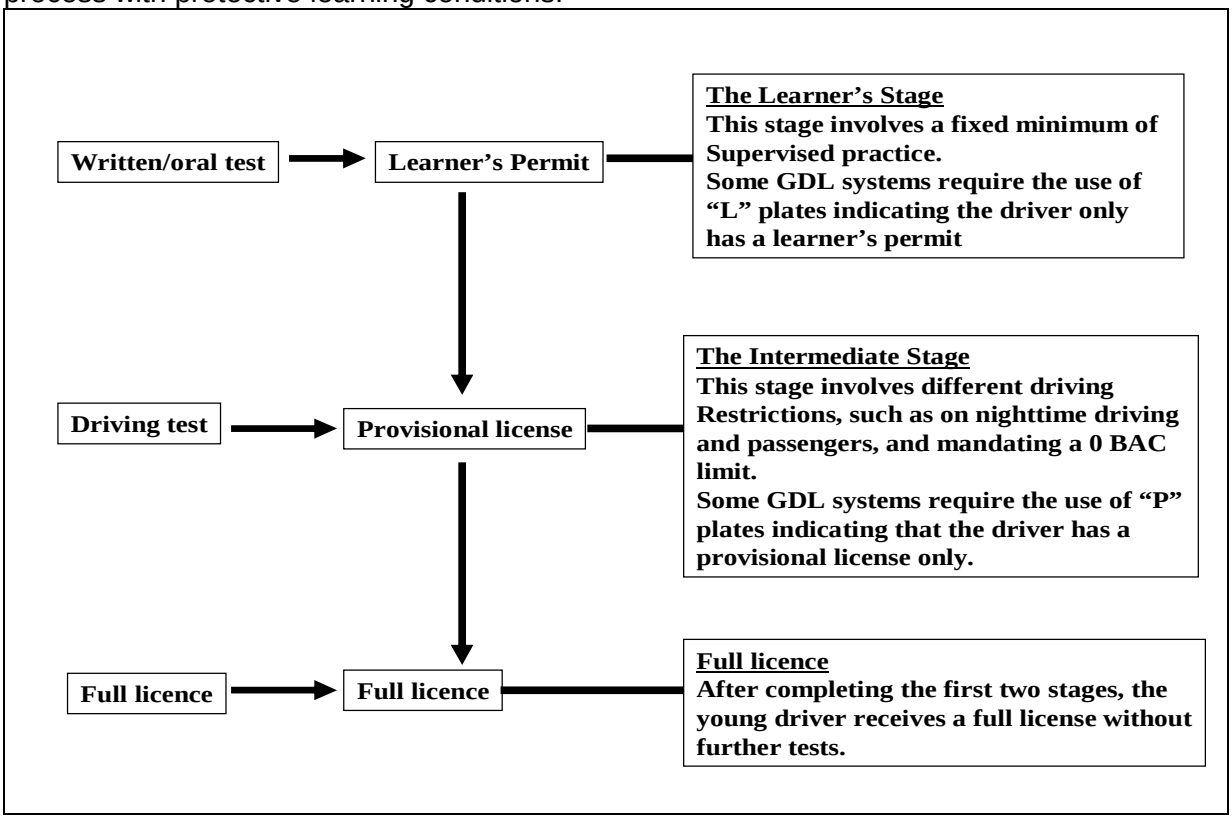

Figure 15: The structure of graduated licensing Engström et al 2003

Most evaluations of the graduated driving license conducted to date, have reported significant reductions in crashes and fatalities. However, they show great variation, some reporting effects as large between 10 to 60% [14][32][16][11]. It should be borne in mind though, that the graduated driving license is only implemented in the USA, Australia and New Zealand. The evaluation studies have shown positive improvements compared to their 'old' licensing systems. These systems however were less 'advanced' compared to the European licensing systems. This implies that the magnitude of the effect of graduated driving license in Europe may be smaller.

3.8 Content of training: Best practice

The fundamental goal of the education, training and licensing process should be to create drivers who are safe, and not just technically competent, by the time they are permitted to drive unsupervised and unaccompanied. Essential to this is a training process that engages novice drivers personally and emotionally, increasing their awareness of their own limitations and of the dangers inherent to driving. It is important to focus on the fundamental beliefs about driving, including assessment of the trainees own skills and motives for driving, as well as the basic skills needed for driving.

In order to provide an overview of what the licensing process should cover, the GDE Matrix was initially developed in the context of the EU's GADGET project [33], and later frequently updated ([8]. This GDE can be seen as 'best practice', as it was developed on the basis of the knowledge of risk conditions and learning processes.

GDE matrix

(Goals for Driver Education)

(Hatakka, Keskinen, Glad, Gregersen, Hernetkoski, 2002)

	Knowledge and skill	Risk increasing aspects	Self assessment
Goals for life and skills for living	**L**ifestyle, age, group, culture, social position etc, vs driving behaviour	**S**ensation seeking **R**isk acceptance **G**roup norms **P**eer pressure	**I**ntrospective competence **O**wn preconditions **I**mpulse control
Goals and context of driving	**M**odal choice **C**hoice of time **R**ole of motives **R**oute planning	**A**lcohol, fatigue **L**ow friction **R**ush hours **Y**oung passengers	**O**wn motives influencing choices **S**elf-critical thinking
Driving in traffic	**T**raffic rules **C**o-operation **H**azard perception **A**utomatization	**D**isobeying rules **C**lose-following **L**ow friction **V**ulnerable r.u.	**C**alibration of driving skills **O**wn driving style
Vehicle control	**C**ar functioning **P**rotection systems **V**ehicle control **P**hysical laws	**N**o seatbelts **B**reakdown of vehicle systems **W**orn-out tyres	**C**alibration of car-control skills

Table 2: GDE Matrix

It provides a hierarchical schema of the driver's task and addresses on four different levels:

Level 4: Goals for life and skills for living
This level refers to personal motives and tendencies that may influence attitudes, decision-making and behavior in driving and, consequently, crash involvement. Examples of such tendencies are a person's desire to experience thrills, or to impress others. The basic message is 'the way you drive as a reflection of who you are, or who you want to be'.

Level 3: Goals and context of driving
This level focuses on the goals behind driving and the context in which driving is performed. Examples include the type of car you want to drive, the trips you make, and the choice to drive with alcohol or not. Clearly, level four elements might affect decisions at the third level. In turn, choices made on the third level have an influence on situations that will occur in real traffic, the level of risk (level 2) and how well the driver will be able to handle specific traffic situations (level 1) .

Level 2: Driving in traffic situations
This level is about mastering driving in specific traffic situations. The ability to adjust his or her driving to constant changes in traffic, as well as the ability to identify potential hazards and to act correctly in order to avoid them, are both included in this level.

Level 1: Vehicle control
This level focuses on the vehicle control skills. It includes the ability to control the vehicle, even in difficult situations, as well as the functioning, use and benefits of injury prevention systems such as seat belts.

These four levels are considered hierarchical, because the higher levels directly affect the lower ones. On the basis of expert opinion and literature reviews, the EU BASIC project concluded, that by focusing on the higher levels in the model in driver training, more inherently safe drivers could be produced [12]. The current training systems primarily focus on levels 1 and 2.

These four levels make up the GDE Matrix in Table 2, which defines appropriate goals for driver education, when combined with three key training areas:
- Knowledge and skills. This area describes the basic skills and knowledge a driver needs for normal traffic situations.
- Risk increasing factors. The driver needs to be aware of risk increasing factors, such as the effect of fatigue, worn-out tires, alcohol, and peer pressure.
- Self-assessment. This domain deals with how accurately a driver assesses his own competencies. This is particularly relevant as this self-assessment will be the basis on which a person selects his driving speed and following distances (safety margins). Young drivers tend to overestimate their driving skills.

In 2006 Norway has based its training and testing system on the GDE. An evaluation study is expected in a few years.

3.9 Training Method

Two pre-license training methods can be distinguished:
- Formal pre-license training
- Informal pre-license training

3.9.1 Effects of formal training

Formal pre-license training is a training in which a candidate driver practices under the supervision of a qualified driving instructor, usually while simultaneously receiving instruction on how to drive and as a part of a structured training process.
Different reviews [4][8][7] have reached the conclusion that formal pre-license driver training is not always effective as a safety measure, as it does not reduce novice drivers' crash rates. At the same time, it must be noted that formal training adds to the cost burden of the learner. Recent surveys on the content of formal pre-licensed training have shown that current training systems primarily focus on the 'lower order' car driving skills, such as vehicle control and the execution of manoeuvres like overtaking and crossing intersections, while there is a lack of training at a more strategic level, like route finding, and self-assessment of driving skills. It has been hypothesized that including the 'higher levels' in driver training will improve its effectiveness.

3.9.2 Effects of informal training (accompanied driving)

Informal pre-license training is a training in which the candidate practices with an experienced driver in the passenger seat. This option is available in the UK and in Sweden. Informal driver training is voluntary in many licensing systems, although it is often encouraged by official regulations in order to increase the learner's driving experience prior to solo driving.
In formal training schemes, young drivers often only have about 25 to 40 hours of driving experience when they are licensed for solo driving. Research [10][30] indicates that risks would be greatly reduced if all learner drivers were to acquire much higher levels of pre-license driving experience. However, on its own this measure may not be sufficient as was demonstrated in France, where a similar scheme aimed at increasing pre-license driving experience failed to be effective [28].

3.9.3 Quality of trainer/supervisor

Having well-educated instructors who possess the necessary knowledge and teaching skills covering all the necessary aspects that should be covered in driving training, is vital for a well-functioning system. The EU project MERIT has made an inventory of the standards in the EU countries, and has set guidelines for further improvements. The quality of instructors may lead to success or failure of potentially effective training programmes [5].
In addition, to get good results with an informal pre-licensing system, it is essential that those accompanying the learner (e.g. parents) must be prepared to provide appropriate direction and influence. Some countries have published guidelines for that purpose. Evaluations of the effects of these guidelines have not been made.

3.9.4 Advanced vehicle skills are counterproductive at this stage

Courses concentrating on advanced vehicle control skills like skidding should not be included in driver training for novices, as they may cause a reverse effect of the one pursued. It has been shown that, as a result of these courses, young drivers may be more confident about their abilities to handle a car in very dangerous conditions, which they previously would have avoided [1]. Moreover, it may lead to an illusion of control based on overestimation of the improved skill levels, which in fact are not fully acquired. For instance skid control is a skill that should be extensively practiced, and regularly applied. Use it or loose it. A one day course does not achieve this.

3.10 The Driver Test

In addition to the importance of good training, well-qualified instructors, and the availability of teaching resources, a well functioning licensing system needs a high quality testing system. First of all, the design and content of the test should enable a check on whether the stated training objectives have been reached. Secondly, a well designed test provides direction and content for the training process. If certain objectives are not covered in the test, and are not tested in other ways, most likely these topics will not be dealt with in the training process any longer. Therefore test and training need to reinforce each other. Discrepancies lead to a malfunction of the whole system.

3.10.1 Content

In many countries, the driving test consists of a theory and a practical test. Tests are used to decide whether the learner has achieved the defined training objectives, so they need to be of high quality. Some countries have a separate hazard perception test.

Theory test
In a theory test the candidate needs to demonstrate that he/she has a good and thorough understanding of the traffic systems and the rules that apply. Although it can be assumed that this understanding will probably improve the quality of a driver's decisions, the relative contribution of this test to overall safety has not yet been studied, and hence no conclusions can be drawn about its effectiveness.

Practical test
When comparing the practical tests in different countries, two different ways of establishing the content of the test can be distinguished: In some countries, such as Norway and Great Britain, standardized test routes are used in order to guarantee that the test includes certain elements. In other countries, like Sweden, the examiner decides on the test route for the practical test, but ensures that all relevant traffic situations are present in the route.
The European Union project TEST [35] showed that the test procedure differed significantly between countries and that not all elements required by the European Driving License directive are tested. As yet no assessments of the quality and effects of different tests are available.

Hazard perception testing
Young novice drivers are poor in detecting and assessing hazards. Therefore, several countries have introduced hazard perception tests as a compulsory element of driver testing, to test the ability to foresee and react to hazards.
This kind of test is still under development and several other countries now consider implementing this type of test. It is currently too early to conclude whether hazard recognition tests will have positive effects, and further work is needed in this field.

3.10.2 Quality of tests

Reliability
Any driving test needs to be reliable. Reliability refers to the degree to which test scores are free from errors of measurement. If the test is reliable, then the same candidate, when tested twice, should have approximately the same score both times. The European project TEST [35] concluded that a low reliability is undesirable because it is likely to be seen as unfair, and thus to randomly penalize some candidates and pass others. Moreover, an unreliable test is inefficient and costly, since it will result in unnecessary failures and subsequent retests, and is likely to be held in general disrepute.

Validity
Validity is also an important characteristic in any driving test. It refers to the extent to which the test measures competence and propensity to be a safe driver. In other words, how effectively does the test discriminate between those drivers that will be safe and those who will be unsafe in future? As yet, studies on this subject are not available. A test can be judged to have a good content validity if it (a) covers all aspects of driving known or judged to be relevant to its objective (e.g. safety) and (b) induces adequate training and practice in all of these aspects even if they do not feature in the test itself.

Legitimacy
Aside from these more methodological issues, an additional point can be made about the importance of the legitimacy of the licensing process in the eyes of the public. Changes to the system should be convincingly related to safety and mobility in order to prevent public concerns about changes only being aimed at generating financial benefits for the licensing

authority. In line with this, it is of vital importance to assure that the licensing process is free of any possible corruption.

3.11 Specific post license measures for novice drivers

Accident figures show that it is of the utmost importance to convince youngsters to drive safely, not to intentionally violate traffic rules, and to reduce exposure. Instruments to achieve this are:

- Advanced training: to improve driver quality
- Protective measures: to reduced exposure to high risk conditions

Nevertheless, it must not be ignored that drivers' safety-related attitudes are formed well before the age at which one legally begins driving. Therefore, measures should also focus on children at a much younger age than 16-18.

3.11.1 Advanced training

The amount of experience gained during formal pre-license driver training is limited. Also, the types of situation encountered during training are likely to be rather limited compared to the conditions regularly faced by drivers, such as driving in heavy traffic, late at night, and driving for long periods.
For these reasons, some countries have post license training as a compulsory part of a two-phase licensing system. Some other countries offer it as a voluntary option.
Advanced post-license training has been shown to influence behavior and attitude, but evaluation studies aimed to study effects on accident risk have not been carried out yet [26].

3.11.2 Protective measures

The necessity to reduce risk when it is likely to be the highest (immediately following gaining a license) can be achieved by way of protective measures. These measures create conditions which reduce the degree of risk that a solo driver would otherwise be exposed to. Protective measures limit the complexity of the driving task, and protect the novice driver from dangers resulting from poor self-regulation and self-control, in the period in which higher order skills are still 'under construction'.
Licensing systems throughout the world are implementing different combinations of these measures. The measures applied most frequently are:

- Zero alcohol limits
- Restrictions on night time driving
- The presence of peers as passengers

Zero alcohol limits
Alcohol consumption, even in small amounts, increases driver fatality risk. This effect is particularly strong in young novice drivers.
Hingson et al. (1994) showed that for young drivers, starting from a Blood Alcohol Level (BAC) of 0.8 g/l, only lowering from 0.8 g/l to 0 or 0.2 g/l was effective, and that lowering BAC levels to 0.4 or 0.6 g/l did not produce significant reductions in alcohol-related fatalities. In both graduated driving license and probationary systems, a maximum BAC level of 0 to 0.2 g/l, linked to severe repercussions or high demerit point loss as a result of contraventions, could contribute much towards lowering young driver risk.

Many countries have already, or are about to introduce lower BAC levels for novice drivers, and there is an ongoing debate on whether the best level would be 0.2 g/l or 0 alcohol. The primary philosophy behind the 0 alcohol limit is the consistency with the message which

emphasizes that any amount of alcohol will increase crash risk. The choice for 0.2 g/l alcohol limit is based on the relative low risk below the 0.2 g/l limit, the possibility of false positive results in tests and the withdrawal of enforcement capacity form the high risk categories (above 0.2 g/l) leading to a potential increase in alcohol related crashes. These arguments would in principle suggest 0.2 g/l as the more effective measure.

Night time restrictions
Young drivers have a particularly high crash risk during night hours. Thus, restrictions on night time driving are often included in graduated driving license systems, of which they are considered to be one of the most beneficial elements in lowering crash involvement and severe crashes during solo driving.
However, the benefits of this countermeasure need to be weighed against the social equity issues of mobility and access.

Presence of peers as passengers
Driving with other young people in the vehicle increases young drivers' crash risks. Thus, limits on driving with similarly aged passengers are widely used in the intermediate stage of graduated driving license.
Again, social equity and access to the benefits associated with mobility is an issue. With this in mind, in almost all systems where this restriction is used it does not apply to family members.

3.12 Enforcement

3.12.1 Police strategies

Compliance is vital in order for protective measures to have an effect. This requires effective enforcement. However, targeting on young people can lead to serious suggestions of discrimination and in many countries it may not be possible from a legal point of view. This implies that initiatives aimed at all drivers are particularly relevant for young drivers, who are most likely to commit many violations and to have a high crash risk.
New developments in the field of information technology systems may, in future, assist in focusing enforcement on certain high-risk groups.
Special attention should be paid to unlicensed driving. The more regulated and demanding the licensing process becomes, the more tempted novices will be to drop out of the licensing process and to drive without a license.

3.12.2 Targeted violations

Speed
Speed enforcement, both by the police and by automatic systems, is essential for ensuring young driver safety, but has limited effects. In this sense, while it may be a good tool for focusing on specific problems, such as illegal races, it is not a solution against the mass phenomenon of inappropriate speed choices made by young, novice drivers. This can only be achieved by the use of electronic devices, like black boxes, that make continuous monitoring of driver behavior possible.
Also, a stringent demerit points system or restrictions regarding alcohol, night driving, and carrying passengers could mitigate the effects of speed.

Drink driving
Clearly, enforcement plays a key role in preventing drink driving. Random and targeted breath testing (RBT), meaning that drivers are selected purely on the basis of chance, during periods when and at locations where high alcohol use is expected, is an effective policing technique. RBT increases the potential offenders' perception of the possibility of being caught, which affects their drinking and/or driving behavior.
Police enforcement in this field can be targeted on specific problem areas where higher proportions of impaired individuals can be expected among the driving population, such as close to discotheques, music halls or leisure-time areas. In this sense, it should be noted that patterns of youth drinking may differ from those of older people.
Although social tolerance on drink driving has decreased over time, the effectiveness of RBT requires intense enforcement activity on the road and accompanying media coverage.

Drug driving
One basic problem in dealing with drug-related road safety risk is that, in roadside testing, drugs are less easily detected than alcohol, as the technology both for detecting them, as well as for determining their level of presence, is not yet as precise as it is for alcohol. This may induce some people to opt for drugs rather than alcohol.
Clearly, enforcement of drug driving would be enhanced by improved roadside testing technology, as well as by appropriate legislation. More detail on the issues of risk and roadside testing is available form the EU's ROSITA (www.rosita.org) and IMMORTAL projects, and the literature review by Lenne et al [20].

3.12.3 Point systems

One disincentive for risky driving is the threat of losing one's license or having to pay more to renew it. This is often enforced through demerit points assigned to drivers caught breaking rules. Demerit point systems for young and/or novice drivers have in common that the frequent violation of traffic rules committed by novice drivers is punished more severely than that committed by more experienced drivers.
Evaluation studies show mixed results on the effects of demerit point systems, in particular regarding their lasting effect. Experiences with 'general' demerit systems for all drivers have demonstrated that, after an initial positive effect, the impact decreases over time to zero in conditions where police enforcement is low. This indicates that demerit point systems are only effective if the chance of the police detecting a violation is high.
In addition, the fact that license revocation as a part of point system may lead to an increase in unlicensed driving also needs to be counteracted in order for demerit point systems not to lose credibility.

3.12.4 Publicity campaigns

Publicity campaigns pursue the aim of persuading young people to drive safely. Their overall effect was estimated by the European project GADGET (1999) to reduce the number of crashes by 8.5% during the campaign period. During the period following the campaigns, the overall effect nearly doubled, to 14.8%. These results must be attributed to all components of the campaign, including other actions like police enforcement, rewards, legislation, educational programmes, etc, and not only to the media campaign itself. These programmes can be directed at youngsters and/or their parents or caretakers. However, most programmes target youngsters; not many programmes focus on the role of parents [6][24].

3.12.5 Parents

Parents need to play an active role in moderating high risk among young, novice solo drivers. Many programmes and instructional materials have been developed to help parents teach

adolescents to drive, but few educational materials are available to encourage and teach parents how to deal with young driver risks.
Parental management (monitoring and restriction) is undoubtedly an important influence on teen driving and safety when imposed, but unfortunately, parents do not perceive teen driving as highly risky and establish few restrictions on teens once they have gained their license. Therefore, the first step should be to increase problem awareness.

3.12.6 Youngsters

Persuasive information campaigns should be employed in combination with other countermeasures, such as enforcement and education, as a means of positively changing attitudes towards safe driving.
It is especially necessary for these campaigns to make a thorough analyze of target groups and the appropriate message for them, and specifically target young males.
It is also necessary to ensure ongoing evaluation and improvement of these campaigns.

3.13 ITS

Technology based interventions are still under development and can be very useful. In some cases, the use of new technologies may require difficult decisions related to individual freedom, as well as to the legal implications of reducing the driver control over aspects of the vehicle functioning. On the other hand, though, they could be very convenient as a means of restricting very young drivers, as it would enable parents to impose that technology, especially when using the 'family car'. It is also important that new drivers learn how to use these technologies, as well as to develop skills for situations in which the technologies do not function or are not available.
As these measures are very new, some are in the test phase, others only exist on the drawing boards, few studies have been made of the safety benefits and disadvantages of these measures. Promising ITS applications for young drivers are:

- Smart cards
- Alcolocks
- Seatbelt systems
- Driving data storage unit
- Electronic stability control (ESC)
- Advanced driver assistance systems (ADAS)

Smart cards
Smart cards hold information about the driver and, used in conjunction with the ignition key, prevent the car from starting if the driver is not authorized to drive it. They could also be used as a tool to select which drivers are allowed to drive under specific conditions (for instance, they could prevent novice drivers from driving at certain hours of the day).

Alcolocks
Alcohol is one of the important risk factors for young drivers. A system which could prevent youngsters from using a car while under the influence could improve safety. An alcolock is a device that checks the concentration of alcohol in the driver's breath before and during driving. If the alcohol level is higher than a pre-set level, the system will render the car impossible to start and drive. So in theory, such an application for young drivers may save lives. As yet, evaluation studies have only been applied to programmes using alcolocks for repeat alcohol offenders. No programmes are known that have targeted on young drivers.

Seatbelt systems
Given the role of non-seatbelt use in fatal and serious casualties among young, novice drivers, systems that warn the driver to put on a seatbelt, or prevent the engine from starting until the seatbelt is fastened, also play an important role in reducing risk.

Driving data storage unit
Also named black-boxes, they can be used to register information about the driver's performance, the vehicle, and traffic situations, in order to provide feedback to the driver or others, such as employers, parents, traffic authorities or insurance companies. Black-boxes, especially in combination with incentives (for instance, insurance based ones) and punishment, may have great potential.

Electronic stability control (ESC)
This system uses sensors to detect a vehicle's deviations from the driver's intended path, and then applies breaking or power reduction to individual wheels to bring the vehicle back under control. It also assists in slowing down the vehicle in loss-of-control situations [27]. The OECD assumes that ESC can be effective in reducing single-vehicle, loss-of-control crashes that result in serious injuries or fatalities by more than 30%. As this type of accident is so prominent in young drivers, such a system might be of value to them, under the condition that it does not lead to 'more' risk taking, rather than reducing it. Such counter effective patterns have been observed related to the introduction of similar systems, encouraging drivers to use smaller safety margins (behavior adaptation). ESC might have similar effects on young, in particular male drivers. Therefore, careful piloting and subsequent monitoring should be part of any implementation program.

Advanced driver assistance systems (ADAS)
This is a broad category of systems aimed at supporting the driver in his driving task, such as speed choice and following distances. The effects of many of these systems are still being studied (see also text Older drivers). The available information shows that none of these studies have differentiated between user groups, and as a result we do not know what these systems will contribute to young driver safety. This is a serious omission, as young drivers are a high risk group, likely to test the limits of any ADAS system.

4. Implementation process

Implementing measures in the field of road safety and in particular with respect to young drivers, is a complex process. For detailed information on the organization of these processes we refer to the web text on Road Safety Management Here we highlight some aspects that are closely related to the young driver issues: prioritizing measures, costs and benefits, and public support.

4.1 Prioritizing measures

The many-sided nature of the young novice driver problem requires a broad spectrum of measures to prevent these crashes. Still, within this broad spectrum it is necessary and possible to prioritize these measures on the basis of availability and effectiveness. That is, focus on those measures which are known to be effective in a broad range of situations and across countries. This, in contrast to measures that have been shown to be effective in small scale pilots only, or are believed to be effective on the basis of expert knowledge.

- Implement general safety measures such as adequate laws on safety belts, speed and alcohol. Improve, roads in particular road sides. Enforce the traffic rules effectively.
- Introduce supervised practice before licensing, and add protective measures during the first stages of solo driving.

- Improve driver testing and driver training using the GDE matrix.

4.2 The role of cost-benefit analyses

To overcome resistance to change, which will also be caused by questions of cost, objective data and facts are needed that show economic savings generated by these measures to be higher than their costs.
Table 3 shows the socio-economic costs of young driver fatalities in OECD countries. The costs include medical costs, production loss, settlement costs and loss of quality of life (also referred to as 'human costs' or 'human losses'). For most European countries a standard European value is used (corrected for differences in purchasing power), as proposed by the ECMT. In addition, country specific values have been used for non-European countries. The calculations indicate that the total costs of young driver fatalities in the countries mentioned are about 20 billion euros (price level 2004). A large part of these costs, about 14 billion euros, are human losses. The other costs (medical costs, gross production loss and settlement costs) are about 6 billion euros. Note that victims of young driver crashes killed along with the young drivers are not incorporated into the calculations in Table 3, nor are the costs of injuries. Thus, obviously, the full costs of young drivers' crashes will be much higher [27].

	Number of young driver fatalities	Cost per fatality including human losses (million euros, 2004)	Total costs including human losses (million euros, 2004)	Total costs excluding human losses (million euros, 2004)
Australia (1)	195	1.16	227	179
Canada (1)	262	1.37	360	-
NZ (1)	51	1.66	85	0
USA (1)	3 999	3 58	14 333	3 715
Iceland (2)	3	2.19	6	2
Austria (3)	110	1.78	196	72
Belgium (3)	154	1.83	281	104
Denmark (3)	35	1.86	65	24
Finland (3)	43	1.70	73	27
France (3)	645	1.80	1 159	429
Germany (3)	750	1.82	1 362	504
Greece (3)	105	1.65	173	64
UK (3)	330	1.85	611	226
Ireland (3)	31	1.93	60	22
Netherlands (3)	74	1.96	145	54
Norway (3)	25	2.04	51	19
Portugal (3)	80	1.72	137	51
Spain (3)	322	1.83	591	219
Sweden (3)	40	1.77	71	26
Switzerland (3)	49	1.85	90	33
Total			20 065	5 903

Source: SWOV,
(1) Source of calculations: Sælensminde (2003)
(2) Source of calculations: Calculations by SWOV
(3) Source of calculations: ECMT (1998)

Table 3: the costs associated with traffic fatalities per country

These calculations can be used to carry out cost-benefit analyses, in which the costs of measures are compared to the savings that will result from the measures. As yet, in the field of young novice drivers no such cost-benefit analyses have been carried out.

4.3 Public acceptance

Road safety improvements greatly benefit society, by reducing injuries, loss of lives and other general economic costs, associated with police, medical care, and emergency services. But at an individual level these benefits are not always recognized, as countermeasures can also interfere with a person's freedom. This is particularly true for young drivers: as their driving license is their passport to adulthood, the gateway to independence and an opportunity to enlarge the social circle. Most of the measures proposed here and particularly the most effective ones complicate their access to a driving license and reduce the young drivers' mobility in the first stages of solo driving. In addition, these countermeasures may also be perceived as unfair as they do not only affect bad drivers, but every young novice driver irrespective of his previous driving record. These types of general measures often meet with more resistance than those targeted on 'problem' drivers only. Finally, the predictable bad reception of these types of measures by citizens make politicians reluctant to introduce them.

Even though all these difficulties exist, it should not be forgotten that other important measures on road safety, such as the use of seatbelts or helmets, or the limits on alcohol were also badly received by the public at first. Nowadays, they have become standard practice in most countries, and in particular the alcohol policies are supported by the majority of the population [31]. This means that initial resistance should not discourage the implementation of these measures, as acceptance will grow over time.

Despite the fact that measures will meet with initial resistance, a lot can be done to ease the implementation process. In gaining acceptance the following aspects are important to consider:

- The cooperation of relevant actors. Many earn their living in the driver training, the testing industry, and car insurance companies. Care should be taken to involve them in the process.
- Parents: They care about their children, but are badly informed about the actual risk. Inform and involve them.
- Young drivers-to-be. They have to accept the changes. Their problem awareness is low. Inform them.

A good example of how to generate the public debate in this field is the initiative of some Australian states [36][37].

4.4 A strategic approach to implementing countermeasures

Countermeasures need to be implemented in a strategic manner that shows results both immediately and over the longer term. In doing so, particular attention should be paid to the key elements that underlie and increase risk. Furthermore, there are important differences between the various countermeasures in terms of their impact, their costs, and the timelines within which they can be implemented, which will condition the options for action. In particular, those that require new legislation will take considerable time to implement.

The following is a suggested step by step implementation of countermeasures:

- Increase public awareness of the problem. This could involve undertaking information campaigns, based on well-researched information, sensitizing the public to the nature of the risk and encouraging changes in attitudes and behavior. Also, political leaders could highlight the problem in speeches and other interventions. This countermeasure may be undertaken immediately. In itself, it is not expected to yield high reductions in risk, but it is a prerequisite for achieving greater public understanding of the problem and encouraging acceptance of other countermeasures. Furthermore, the combination of other countermeasures, particularly enforcement, with communication can bring about changes in attitudes towards safety risk over the longer term. There are obvious costs involved, although these are likely to be uncontroversial, given the importance of the message and the fact that the public is accustomed to seeing information campaigns from public authorities.
- Consider the road safety effects, especially for young drivers, of public policy decisions that are not directly related to road safety. These include, among others, such issues as the availability and cost of public transport, the costs of operating a vehicle, the availability of parking at schools and other areas frequented by young people, and the locations of bars and discos. The immediate impact may not be expected to be particularly large, although over time it could have important cumulative effects. This is an area where action could begin immediately, although more time would be required to formalize such practice. Resistance is to be particularly expected in instances where decisions limit the options of individuals and businesses.
- Implement overall road safety improvements that address young driver risk. This includes ensuring the existence of appropriate legislation and rigorous enforcement of road safety law, focusing on areas where young driver risk is especially high: speeding, alcohol, drugs and seat belt use. It is an area where immediate action can be taken, based on existing laws and regulations, and short-term gains are to be expected. There will be important costs, in the form of resources used for enforcement, as well as in the implementation of high standards of safety in vehicles and infrastructure. Effective communication will thus be required to gain public support. However, public resistance may be expected, particularly to enforcement.
- Introduce high levels of pre-licensing accompanied practice. This is potentially one of the most effective countermeasures. However, it may require new legislation, meaning that it cannot be implemented in the short term. Costs are relatively low, both to administrations and the public, and primarily consist of demands on the time of young, novice drivers and those who accompany them. While young people themselves may be expected to voice opposition, consultation with the community, including co-operation with relevant community groups, may well reveal a widespread demand for action to reduce young driver risks. In countries where licensing begins at 18 years-old, resistance will be less if the accompanied practice is allowed to begin before that age.
- Implement protective restrictions during initial solo driving. This countermeasure holds considerable potential. It should include BAC levels of no more than 0.2 g/l. and limited driving at night and/or with passengers should also be considered. Again, legislation is probably required, although the minimal BAC restrictions could possibly be implemented under existing drink-driving laws. The effective enforcement discussed under the second point is a key pre-requisite to such measures. There will also be additional administrative costs associated with changes to the licensing system. Considerable resistance to these measures can be expected from the young drivers themselves, although an effective communication strategy may reveal substantial support for such measures among society in general.
- Provide effective disincentives to inappropriate driving behavior. Enforcement of road safety law and special licensing measures will only be effective if they are backed up with concrete repercussions for non-compliance. Novice drivers should be subject to

probationary periods during which inappropriate behavior could result in loss of driving privileges or obligatory retraining. This could be reinforced by way of special demerit point scales. Such countermeasures may require new legislation, but would not add important additional costs to those associated with enforcement, as discussed above. While they may be subject to considerable resistance from young drivers, they are not expected to be unpopular with society as a whole. Additional disincentives to unsafe driving by young drivers could be provided through vehicle insurance. Road safety administrations and insurance companies could examine means of co-operating in this area.

- Improve driver training and testing, including a stronger focus on self-awareness and understanding the circumstances that lead to safer driving. Such changes will require considerable prior analysis, and probably legislative action, meaning that they will require time for implementation. While this measure is important, it is not likely to have the same impact as countermeasures that effectively limit exposure to risk and increase experience prior to solo driving, such as those noted in Points 3 and 4. Initially, there will be new costs associated with changes to the licensing system, and resistance may be expected from the driver instruction industry in particular.
- Understand the benefits of technological solutions for monitoring and enforcement, and for assisting the novice driver with the driving task, and selectively implement these where they prove to be effective. This is a longer term initiative, particularly as it will involve research and development. While the potential is high, the actual gains to be achieved from new technologies are unknown. These solutions will initially generate new costs for implementing technology in vehicles, which could cause resistance from drivers and vehicle manufacturers. Concerns regarding the legal side effects of new technologies will also need to be addressed, particularly if they are perceived to relinquish the driver of full responsibility for operating the vehicle.

5. References

1. Advanced (2002) The EU ADVANCED Project: Description and Analysis of Post-licence Driver and Rider Training. Final report, 2002, CIECA, the Netherlands
2. Bartl, G. (ed.) (2000) DAN-Report. Results of EU-Project: Description and Analysis of Post Licensing Measures for Novice Drivers, Kuratorium für Verkehrssicherheit (KfV; Austrian Road Safety Board), Vienna
3. Baughan, C. J., and Simpson, H. (1999) Consistency of driving performance at the time of the L-test, and implications for driver testing. In : G. B. Grayson (ed) behavioural Research in Road Safety IX Transport Research Laboratory , Crowthorne
4. Christie, R. (2001) The Effectiveness of Driver Training as a Road Safety Measure: A review of the literature. Report no: 01/03, Report prepared for the Royal Automobile Club of Victoria (RACV) Ltd., Noble Park, Victoria
5. Craen, S. de Vissers, J.A.M.M. Houtenbos, M. and Twisk, D.A.M. (2005) Young drivers experience: the results of a second phase training on higher order skills : evaluation study in the framework of the European project NovEV. Leidschendam, SWOV Institute for Road Safety Research, R-2005-8
6. Delaney, A., Lough, B., Whelan, M., and Cameron, M. (2004) A review of mass media campaigns in road safety, Monash University Accident Research Centre, Melbourne
7. Elvik, R. and Vaa, T. (2004), The Handbook of Road Safety Measures, Elsevier, Amsterdam
8. Engström, I., Gregersen, N.P., Hernetkoski, K., Keskinen, E. and Nyberg, A. (2003) Young Novice Driver Education and Training, Literature review, VTI-rapport 491A., Swedish National Road and Transport Research Institute, Linköping
9. EU MERIT Project (2005) Minimum Requirements for Driving Instructor Training, Final report. EC Contract (DG TREN) SER-B27020B-E3-2003
10. Gregersen, N.P. (2000b) 'Sixteen years age limit for learner drivers in Sweden - an evaluation of safety effects', Accident Analysis and Prevention, No. 32, pp. 25-35.
11. Hartling, L. Wiebe, N., Russell K., Opetruk J., Spinola C. and Klassen T.P. (2004) Graduated driving licensing for reducing motor vehicle crashes among young drivers. In: The Cochrane library. Issue 2, 2004. Chichester, UK: John Wiley and Sons, Ltd
12. Hatakka, M., Keskinen, E., Baughan, C., Goldenbeld, C., Gregersen, N. P., Groot, H., Siegrist, S., Willmes-Lenz, G., Winkelbauer, M. (2003) BASIC – driver training: new models. Final report, 31st August 2003. University of Turku, Finland
13. Hatakka, M., Keskinen, E., Gregersen, N. P., Glad, A., Hernetkoski, K. (2002) From control of the vehicle to personal self-control; broadening the perspectives to driver education. Transportation Research Part F, 5 (3), 201-215
14. Hedlund, J. H. (2005) Countermeasures that work: a Highway safety countermeasure guide for state Highway safety officers. Prepared for the National Highway Safety Administration. U.S. department of Transport, by the governors highway safety association
15. Hedlund, J. and Compton, R. (2005) Graduated driver licensing research in 2004 and 2005, Journal of Safety Research, No. 36, pp 4-14
16. Hedlund, J. Shults, R.A. and Compton, R. (2003) 'What we know, what we don't know, and what we need to know about graduated driver licensing', Journal of Safety Research, Vol. 34, no. 1, pp. 107-115.
17. IMMORTAL Impaired Motorists, Methods of Roadside Testing and Assessment for Licensing www.immortal.or.at

18. Keall, M.D., Povey, L.J. and Frith, W.J. (2001) 'The relative effectiveness of a hidden versus a visible speed camera programme', Accident Analysis and Prevention, Vo. 33, No. 2, pp. 277-284
19. Ker, K., Roberts, I., Collier, T., Beyer, F., Bunn, F., Frost, C. (2005) Post-licence driver education for the prevention of road traffic crashes: a systematic review of randomised controlled trials. Accident Analysis and Prevention, 37, 305-313
20. Lenne, M. Triggs, T. Regan, M. (2004) Cannebis and road safety, a review of recent epidemiological driver impairment and drug screening literature. Monash University Accident Research Centre
21. Lynam, D. Nilsson, G. Morsink, P. Sexton, B. Twisk, D.A.M. Goldenbeld, C. & Wegman, F.C.M. (2005) SUNflower +6 : further comparative study of the development of road safety in Sweden, United Kingdom, and the Netherlands. Leidschendam, SWOV Institute for Road Safety Research / Crowthorne, Berkshire, Transport Research Laboratory TRL / Linköping, Swedish National Road and Transport Research Institute VTI
22. Mathijssen, R; Houwing, S (2005) The prevalence and relative risk of drink and drug driving in the Netherlands: a case control study in the Tilburg police district Research in the framework of the European research programme IMMORTAL R-2005-9
23. Meewes, V. & Weissbrodt, G. (1992) Führerschein auf Probe : Auswirkungen auf die Verkehrssicherheit. Bergisch Gladbach, Bundesanstalt für Strassenwesen BASt, Unfall- und Sicherheitsforschung Strassenverkehr ; Heft 87
24. Mulvihill, C. Senserrick, T, Haworth, N. (2005) Development of a model resource for parents as supervisory drivers Report No, 243 Monash University Accident Research Centre
25. Norwegian Public Roads Administration (2005) Driver training in Norway. Foundation for the revisions of the regulations and curricula 2005, Norwegian Public Roads Administration
26. NovEV (2002) The EU NovEV PROJEKT: Evaluation of post-licence training schemes for novice drivers. Final report, 2004, CIECA, the Netherlands
27. OECD/ECMT (2006) 'Young drivers: The road to safety – ISBN 92-821-1334-5
28. Page, Y., Ouimet, M.C., and Cuny, S. (2004) An evaluation of the effectiveness of the supervised driver-training system in France. Annual Proceedings/Association for the Advancement of Automotive Medicine, 48:131-145
29. Road Safety Council, Government of Western Australia. (2002) 'Arriving Safely, Road Safety Strategy for Western Australia 2003-2007'. Developed for the WA Road Safety Council by Narelle Haworth and Peter Vulcan, Monash University Accident Research Centre
30. Sagberg, F. (2002), 'Driver education from the age of 16: potential of an extended learning period and increased driving experience to reduce the crash of novice drivers. Experiences in Norway', in: BASt (ed.), Zweite internationale Konferenz 'Junge Fahrer und Fahrerinnen. Berichte der Bundesanstalt für Straßenwesen. Mensch und Sicherheit. Heft M 143, Bremerhaven: Wirtschaftsverlag
31. SARTRE 3 report (2004) European drivers and road risk, Report on principal results. INRETS, Paris
32. Senserrick, Teresa and Whelan Michelle (2003), Graduated driver licensing: effectiveness of systems and individual components, Report No. 209, Monash University Accident Research Centre, Melbourne
33. Siegrist, S. (Ed.) (1999), Driver training, testing and licensing – towards theory-based management of young drivers' injury risk in road traffic. Results of EU-Project GADGET, work package 3. Bfu-Report 40. Schweizerische Beratungsstelle Fuer Unfallverhuetung, Berne

34. Simpson, H., Chinn, L., Stone, J., Elliot, M. and Knowles, J. (2002), Monitoring and evaluation of safety measures for new drivers, TRL525, Transport Research Laboratory, Crowthorne
35. TEST (2005) Towards European Standards for Testing; final report. CIECA, Brussels
36. VICRoads (State of Victoria, Australia) (2005) Young Driver Safety and Graduated Licensing Discussion Paper. Have your say!, August 2005
37. Western Australia (2005) Helping Keep Our Kids Safe on Western Australia's Roads, Novice Driver Review Public Discussion Paper, State Government of Western Australia.