

Summary:

Traffic education in Denmark: 'From cradle to wheel'

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Authors: Truls Vaa, Aslak Fybri, Michael W. J. Sørensen
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The report is specifically directed towards traffic education and training in Denmark where the commission has been to look into accidents and measures regarding children, adolescents and young adults up to the age of driver licensing. It has been important to identify measures which, on basis of satisfactory evaluation methods, establish a scientifically based knowledge base of effective measures regarding the age groups considered. For pre-school and school children in lower grades, it is most effective to teach in smaller groups, to make the educational context as realistic as possible, and to aim at making the pupils understand why they should behave in certain ways in given contexts. For older children, adolescents and younger adults, campaigns may be effective if they are well designed and composed in accordance with empirical evidence of what may provide positive outcomes of campaigns. Regarding young adults, formal driver education has led to more accidents compared to control groups without formal driver training. It is especially important to develop better measures for this group of young, novice drivers who have the highest accident risk of all drivers. Graduated Driver Licensing, including private driver training with lay supervisors, has shown to be effective in reducing the number of accidents.

The report consists of ten chapters. Chapter 1 deals with accidents among children and adolescents, chapter 2 is about evaluation, chapter 3 describes the development in children and adolescents. The chapters 4-6 deal with road safety measures concerning preschool children, school children 6-12 years of age, and adolescents 13-18 years of age, chapter 7 addresses young adults and driver education and training, chapter 8 deviant driver behaviour and behaviour change, chapter 9 research competence and ideas to enhance research environments in Denmark, and chapter 10 presents traffic education as a long-term strategy.

Accidents among children, adolescents and young adults

The chapter describes the development of accidents among children, adolescents and young adults across the period 2001-2008. The number of accidents is evenly increasing for children aged 0-12 years of age, but from age 13 the increase is stronger for each age level up to and including age level 18. The number of injured and killed reaches a peak at age 18 and then decreases at ages 19-20. The number of killed is low from 0-15 years of age, but substantially higher at age levels 16-20. The number of seriously injured shows a substantially increase at age 16, where the increase compared to age level 15 is close to 100 %.

Personal car is the predominant transport mode where children are injured up to age 10, but children are also injured as pedestrians at each age level. From age level 6, children are also injured as bicyclists. The predominant transport modes associated with age levels 12-14, 15-17 and 18-20 are bicycle, moped, and car, respectively.

There are few studies of accident risk among children below age level 13. This makes it difficult to compare accident levels with other countries as Denmark does not have

relevant data of exposure. Generally, preschool and public school children have fewer accidents than older children and adolescents. Three conclusions can be pointed out:

- Children have their highest risks as pedestrians and cyclists. In order to reduce the number of accidents, the road environment should be designed to make walking and cycling safer.
- Most accidents with children happens as passengers in cars. Efforts should be directed towards parents to ensure that they secure their children better.
- Regarding 15-17 year olds, the predominant challenge is to reduce accidents with mopeds. For young adults 18-20 years of age, the big challenge is accidents with cars, but moped accidents are frequent also in this age group.

Development in children and adolescents

To ensure that children can perform well as secure and independent road users, it is important that they achieve fundamental cognitive abilities. The cognitive development evolves as a continuous process from birth into adulthood in interaction with the environment. Hence, regarding children's ability to behave safely in road traffic, it is important that they learn to maintain awareness, tackle distractions, understand decision-making, and that they learn to act as parts of a social community.

Recent achievements in neuroscience have documented the slow maturity of the human brain. For men, the brain is not fully developed before the age of 25, for women somewhat earlier. This affects how risk perception shall be understood in children and young adults and should also have consequences for traffic education. One main hypothesis is that young people may have difficulties in perceiving dangers in traffic because of the slow maturation of the brain.

According to Reyna and Farley one should discern between two types of models – one is called *dual-process models* – where one holds that decision-making is rational and well-considered by weighing the benefits of available alternatives against the costs, while the other type - *fuzzy-trace models* – pinpoint that actions may not be well-considered, rather immediate reactions to what appear as an optionsw in a given context. Such models are necessary to understand issues which may appear as contraintuitive:

- a) Adolescents do not look upon themselves as “invulnerable”, despite that this seems to be a common perception.
- b) Even if the objective of many interventions is to increase the knowledge about factual risk issues, it is commonplace by adolescents to overestimate risk.
- c) Despite the fact that the ability to appraise risks increases with age, adults produce more “irrational” assertions about risk than adolescents do.

One consequence of this is that traditional interventions which emphasize concrete risks, may fail because adolescents already look upon themselves as vulnerable and because they often overestimate risk rather than underestimate it. There may also be differences in risk perception between different arenas where young people participate.

Measures directed towards preschool children

A systematic evaluation of group-based information measures directed towards injury reduction among preschool children concluded that 5 of 9 measures had outcomes as intended. All nine measures applied some kind of classroom teachings, mostly interactive, often with exercises and role-play. However, the quality of evaluation quality was mixed, implying that some caution must be applied when conclusions are to be drawn, especially because none of the studies measured the frequency of injuries. In a recent American study (2010) three education methods were compared:

- 1) "Game condition" (a table-model displaying a traffic environment)
- 2) "Story condition" (a narrative with pictures of traffic signs)
- 3) "Song condition" (a song about situations in road traffic)

Only the children being exposed to the game condition had a significant improvement of behaviour in traffic. This is partly in line with a study done at TØI. In the TØI-study, which also used a table-model, only children living in urban environments, showed changes in traffic behaviour.

Based on these evaluations of classroom teachings, it is concluded that training must comprise more than mere simple instructions or rules about what children should do in traffic in order to achieve behavioural changes. It is regarded as crucial that education and teaching must provide some kind of *understanding* of the dangers in traffic and of what kind of behaviours that is needed in order to avoid dangers. On basis of these findings, and taking into account other aspects of traffic education of preschool children, the following criteria are regarded as important in order to achieve behavioural change:

- Realism of the learning context: Learning increases with increasing realism
- Explain *why*, not that *it is*: The pavement is safe because cars cannot use it.
- Provide interaction with the teaching aids: It will challenge their knowledge, and they will reach a deeper and a more coherent understanding.
- Repetitions over time: One exercise is not enough to provide learning.
- Make the learning goals concrete: "Press this button". "Stand on the curb".

Measures directed towards children 6 – 12 years of age

The majority of accidents involving children as pedestrians happens close to where they live, which means that such accidents are distributed across a large proportion of the road network. It will hence, be difficult to prevent accidents involving children with road design and road furniture measures only. Therefore it is important, and necessary, to apply measures that enable children to behave more safely through education and training.

There is a lot of empirical evidence which shows that education and training improve children's knowledge and attitudes in road traffic. There is, however, less evidence regarding the impact of education and training on children's behaviour. There is also insufficient evidence of measures that reduce the number of accidents, but several studies have shown that *community based programs*, where education has been one of the components, have achieved reductions in the number of accidents.

The most promising interventions regarding behaviour change have been those which are characterized by being systematic, coherent and carefully prepared. Also

the content plays a major role: A key to successful training is that the child, with a basis in concrete behavioural procedures, understands *why* something is dangerous and *why* certain behaviours are justified in a given context. The kind of education that should be chosen, is basically a matter of available resources, but it seems clear that the most common and least resource-demanding education, which is training of large classes, does not produce much outcome in terms of behavioural change. As with other types of education, it is more efficient to work in small groups (5-7 pupils). Further, the closer the training is to real traffic situations, the more likely it is that training will be successful. As education and training one-to-one in everyday road traffic contexts is the most efficient way of learning, it becomes clear the role of parents should not be underestimated.

Measures directed towards adolescents 13-18 years of age

Campaigns are often targeted towards adolescents and campaigns is the main theme of this chapter. It is often questioned whether campaigns have any effect on behaviour and/or accidents. Campaigns also often consist of different components and it can be difficult to ascertain which component(s) that make the outcome(s), if any. Important components are communication channels, the theme of campaign, duration, police enforcement or other accompanying measures.

In Norway, campaigns denoted "Speak out!", which have specifically been directed towards adolescents and young adults, have been used for many years. In short, the "Speak out!"-philosophy implies that young car passengers shall "speak out" whenever a driver is speeding, does not use seat belts, is drunk, or display other risky behaviours that may lead to accidents. These campaigns, which primarily have had speed and alcohol as main themes, have been run in several Norwegian counties since 1993. The original idea may have come from Denmark and two "Guardian Angel"-campaigns which were done around 1990. The outcome of the Norwegian campaigns has mainly been a reduction in the number of injured and killed *passengers* in the age-group of 16 – 24 year olds, but in more recent years there has been a reduction in the number of injured and killed *drivers* as well. The chapter also presents results from other, detached campaigns as "Crash magnets", "Not tough being dead", "Safely home for 5€", the Ringsted study, "Social norms approach", "The girls' road safety initiative" and "Step2get".

Regarding the more general outcomes of road safety campaigns, assessing a best estimate by meta-analyses has been done in the EU-project CAST. CAST collected and compiled a database of 115 independent results and an assessment by meta-analyses gave an overall, best estimate of 9 % reduction in the number of accidents. Components that contribute to reducing the number of accidents are choosing alcohol as the main theme, relatively short duration, roadside exposures to the theme (as with billboards), and use of personal communication as a channel of delivery. Police enforcement may have contributed as well, but the outcome is dependent of the enforcement methods which are chosen and that the level of enforcement is sufficiently high in terms of increasing the subjective level of apprehension.

Driver education and training

Research on driver education and training has been going on for more than 50 years and is very comprehensive. The chapter discerns between the older, traditional driver training and the innovative rethinking represented by Graduated Driver Licensing (GDL). It sums up the research on driver age, knowledge, skills, formal driver training, supervised (private) driver training, GDL, and single components that may

be comprised by a given GDL-program. Based on this summary, the following conclusions can be stated:

Age of debut: Increasing the age of debut as a car driver with one year in the interval 16-21 years reduces the driver's accident risk of the first year of driving by 5-10 %. The effect is decreasing with increasing age. The risk decrease for each single age level is not statistically significant, but is probably nevertheless real because all estimates go in the same direction and because the tendency has been found in every study that is comprised by the calculation of accident risk.

Slippery-surface training increases the number of accidents for drivers who have gone through courses of driving on slippery surface. This finding is consistent for all groups of drivers having attended such courses. The increase in the number of accidents are lowest among personal car drivers (12 %) and highest among drivers of heavy vehicles (22 %) and both are statistically significant.

Driving-in-darkness training seems generally to increase the number of accidents among novice drivers by 11 %, which is statistically significant.

Problem drivers: Training problem drivers to drive defensively is commonly used in the USA and in other countries which have demerit point systems. Defensive driving courses for problem drivers reduce the number of accidents by 5-10%. This outcome is documented by experiments and should be regarded as a methodological well funded finding.

Basic/formal driver training: The best studies are designed as experiments where the drivers are randomly distributed to formal and non-formal driver training. When controlling for the number of kilometers driven, drivers with formal driver training have 11 % (+ 8%; +15%) more accidents pr km compared to drivers without formal driver training.

Outcome of number of driving lessons: Some of the studies that have evaluated the outcome of formal driver training also stated the number of training hours. These studies showed that the number of accidents pr km driven increased with the number of training hours. This finding is also based on experiments with random assignment to test- and control-group.

Supervised, private driver training: In 1993, Sweden lowered the age limit for driver training from 17,5 to 16 years. The reform allowed novice drivers to be supervised by a lay person when driving. The lay person has to be 25 years or older and having held a driving license for more than 5 years. After establishing the 16-year reform, formal driver training at an authorized driving school increased with 8 %, while supervised, private driver training increased with 100 %. As a consequence the risk of being involved in a personal injury accident was reduced from 0.98 to 0.81 pr million km driving, i.e. a reduction of 17 % ($p < 0.05$).

Effects of curfew laws: A curfew law making night-time driving illegal within specific limits of time, reduces the all-day number of accidents with 7 % ($p > 0.05$), while the effect within the time-limits of the curfew is a 36 % reduction in the number of personal injury accidents ($p < 0.05$).

Effects of graduate driver licensing (GDL): The best estimate of the effect of graduated driver licensing is a 19 % reduction in the number of all accidents (unspecified level of injury). For personal injury accidents the reduction is 6 %, fatal accidents 26 %, night-time accidents 31 %, and single accidents 21 % (all $p < 0.05$). For drink-driving

accidents the best estimate is a reduction in the number of accidents of 23 %, however not significant.

Effects of restrictions in the number of passengers: The number of passengers increases the accident risk for young drivers. One study found a significant reduction in the number of accidents for the first 6 months after the introduction of a GDL-program which included passenger restrictions.

Deviant driver behaviour and measures for behaviour change

The chapter discusses deviant driver behaviour, its causes, and potential countermeasures to mitigate deviant driver behaviour. Relative risks of being involved in personal injury accidents for some types of behaviour, driver states and conditions as drink driving, drug and medicine abuse, age, speeding, personality traits and psychiatric diagnoses as potential causes of accidents, are presented.

Personality traits can be defined as dimensions of individual differences regarding the tendency of displaying consistent patterns of thinking, emotions and behaviour. It is especially the trait of "sensation seeking" that has been associated with violations of traffic regulations, but also aggression, impulsivity, emotional instability and social deviance have been linked to violations of traffic law and regulations. Ulleberg identifies six sub-groups of drivers 18-22 years of age which differ significantly regarding the configuration of personality traits. Two of these groups stand out negatively by bypassing traffic law and regulations to a larger extent than the other sub-groups. They can behave relatively irresponsible and aggressively, they have low tolerance of frustrations, and they show low consideration and concern regarding others. Ulleberg labels these two groups *socially deviant* drivers and *aggressive* drivers. Both sub-groups have accident risks above average.

It has been claimed that drivers with an ADHD-diagnose (Attention Deficit Hyperactivity Disorder) have a relative risk of being involved in an accident which is 3-4 times higher than drivers without ADHD, but recent estimates from meta-analysis indicate that the relative risk may be as low as 1.24. Drivers who have ODD (Oppositional Defiant Disorder) and/or CD (Conduct Disorder) as comorbid states in addition to ADHD have, however, higher relative risks than ADHD-drivers without such comorbidity.

American research, which have focused on so-called "problem drivers", have evaluated measures that potentially can improve the accident risk by changing driver behaviour. The most efficient measures are defensive driving courses, warning letters of license suspension, and license revocation, measures that seem to reduce the number of accidents by 14 – 21 %.

Ideas and strategies for improving research competence and -environments

The purpose of the chapter is threefold:

- Map existing research environments and competence on road safety for children and adolescents.
- Indicate areas where more research and competence are needed.
- Propose how research environments and competence on road safety for children and adolescents can be improved in Denmark.

These issues have been addressed through studies of 80 publications from the last 10 years in Danish professional journals, conferences and report series. In addition,

interviews have been done with 10 selected key personnel from DTU Transport, University of Copenhagen, Aalborg University, Danish Public Roads Administration, Århus University, Trafitec, Via trafik and Rambøll. The study shows that research on road safety issues concerning children, adolescents and young adults in Denmark is very limited. It is primarily engineers who work on themes concerning “children, young people and road safety”, and, only to a lesser extent, also psychologists and pedagogues. Many institutes and research centers, who to some extent are working with young people, are seldom considering road safety topics, even if this would be highly relevant. A large amount of the publications considers school policies and ways to school. In most cases the theme has been concrete analyses, delivered by consultative engineers, of ways to schools in one or more municipalities. Only nine publications specifically address road safety issues concerning children and young people.

The amount of free research, where researchers themselves can decide the themes and problem statements, is low and the research environments are dependent on increased economic resources in order to achieve a strengthening of research on road safety issues specifically concerning children and young people. In short, the recommendations are:

- Establish larger projects specifically directed towards enhancement of competence of researchers
- Employ more researchers in order to create a critical mass of researchers and research environments
- Establish interdisciplinary research centers providing an increased and improved cooperation.
- Launch more PhD-projects within this area.

An establishment of a research center could, for example, be an interdisciplinary center for road safety research on children, adolescents and young adults consisting of psychologists, sociologists and engineers from DTU, KU, RUC, AU, AAU and other relevant parties. This would be important for establishing a critical mass of researchers who could create a continuous and long-term focus and commitment regarding road safety on issues for children, adolescents and young adults.

Traffic education as a long-term strategy

Publications from the following countries and supranational bodies have been collected and considered: Australia (Western Australia), Canada, Denmark, England, Japan, the Netherlands, New Zealand, Norway, Sweden, EU (three publications), ETSC and OECD. EU has the most comprehensive description of traffic education measures.

Vision Zero, which was stated as long-term strategy in Sweden around 1995, has also been adopted as a vision in Norway. Vision Zero appears with similar concepts in countries, institutions and Australian states: “*Achieving a Society with No Traffic Accidents* (Japan) and “*Towards Zero: Ambitious Road Safety Targets and the Safe System Approach*” (OECD and Western Australia).

Sweden, Norway, the Netherlands and Western Australia, specifically pinpoint that the use of road safety measures, as a part of a long-term strategy for improving road safety, must be based on *scientific evidence*. This means that road safety measures that are applied in the road system, must have effects that are well documented, and, if

they are new, they must be evaluated and found to have positive outcomes before they are applied on a permanent basis.

Graduated Driver Licensing (GDL) can be regarded as a long-term strategy in itself, however limited, but important, not least because there is a considerable amount of research going on on this topic around the world today. The final and most optimal composition of a GDL-program has not yet been established, but the outcomes of several components of a GDL have been promising. One important component in GDL is supervised, private driver training, i.e. where a lay person above 25 years of age and having held a driving license for 5 years or more, often a parent, is supervising the novice driver when driving. In Sweden, an amount of 120 driving hours was found to reduce the number of accidents significantly. This amount of 120 hours of supervised, private driver training appears also in strategies stated in New Zealand, Australia (Victoria) and the OECD.

Another long-term strategy is linked to the GDE-matrix (GDE = Goals and contents of Driver Education). The purpose of the GDE-matrix was to elaborate guidelines and goals for the future development of driver education and training. In addition to the traditional, hierarchical structure, tripartition of driver behaviour in strategic (conscious), tactical and operational (automated) level, the GDE-matrix introduces a fourth level which allocates skills and goals for life in general. The content of the education on this level is oriented towards knowledge and control of how goals and personal inclinations affect driver behaviour, especially how life-style, group norms, motives, self-control, and personal values. In the Netherlands, the ability to realistically appraise one-self and one's own competence, in a process called *state awareness*, is specifically focused. This process is considered to enable the appraisals and mastering of the behavioural limits in road traffic in a better way.