Safety Science 48 (2010) 35–45

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/ssci

Associations between driver training, determinants of risky driving behaviour and crash involvement

Torbjørn Tronsmoen *

Department of Psychology, Norwegian University of Science and Technology, N-7491 Trondheim, Norway
Norwegian Public Roads Administration, Eastern Region, P.O. Box 1010 Skurva, N-2605 Lillehammer, Norway

ARTICLE INFO

Article history:
Received 11 September 2007
Received in revised form 3 April 2009
Accepted 7 May 2009

Keywords:
Driver training
Self-assessment of driving ability
Safety attitudes
Risk behaviour
Crash involvement

ABSTRACT

The core aim of the study is to examine associations between formal and informal practical driver training as well as driving experience on the one hand and young drivers' safety attitudes, self-assessment of driving ability and self-reported driver behaviour on the other hand. An additional aim is to examine the associations between attitudes, self-assessment and behaviour on the one hand and crash involvement on the other hand. The results are based on a self-completion questionnaire survey conducted among a representative sample of Norwegian drivers aged 18–20 years (n = 1419). The results showed that there were small yet significant associations between driver training, on the one hand and traffic safety attitudes and risky driving behaviour on the other hand. The amount of formal driver training was negatively associated with the respondents' evaluation of their driving skills; although the amount of lay instruction was positively associated with such self-evaluation. The results also showed that attitudes as well as self-assessment of driving ability were significantly associated with self-reported risk behaviour. This was especially true for attitudes related to rule violations. There was a strong association between crash involvement and exposure (measured as months holding a licence). Young novice drivers' crash involvement seems stronger associated with driving skills (manifested as self-assessment of driving ability) than safety attitudes and self-reported driver behaviour. The consequences of the results for driver training and accident prevention are discussed.

1. Introduction

Young drivers are overrepresented in crash and traffic fatality statistics. In member countries of the Organisation for Economic Co-operation and Development (OECD, 2006) between 18% and 30% of killed drivers are between 15 and 24 years old, although the same age group constitutes only between 9% and 13% of the population in their countries. However, there is a significant decrease in the number of accidents among young drivers during the first 6–8 months after passing their driving test (Sagberg, 2000; Mayhew et al., 2003). The strong decrease in crashes during a limited time demonstrated by the empirical findings indicates the risk reduction to be a result of driving experience, and experience to be a main factor in developing driving competence. This effect does not necessarily result from developing essential driving skills, it may also for example, be owing to a positive association between driving experience and safety attitudes. Grasping the primary elements of such a learning process seems important in efforts for enhancing the quality of driver training. Experience and time spent on individual tasks are an essential part of the skill acquisition process (Dreyfus and Dreyfus, 1986; Groeger, 2000). Consequently, it may benefit to provide young drivers as much driving experience as possible before licensing. Due to this, lay instruction is given an important role in the Norwegian driver training system.

Educational efforts are commonly considered successful if learning objectives are met and the students are passing the examinations or tests in the end of the course. Yet, driver education has a wider purpose, owing to the expectations to produce road safety effects. However, crash involvement is a difficult output variable measuring effects of driver training. One explanation for the difficulty to show such connections has been that accidents are rare incidents, which make it difficult to show near associations between educational measures and accidents (e.g. Engström et al., 2003). One possibility is to measure safety effects by using determinants of crash involvement as substitutes for safety. It is an important learning objective in the Norwegian driver training curriculum to influence safety attitudes, self-evaluation skills and safe behaviour in order to producing safe drivers (Norwegian Public Roads Administration, 2004). These variables are more suitable

* Address: Store Prestrudveg 55, NO-2315 Hamar, Norway. Tel.: +47 95894840; fax: +47 62553601.
E-mail addresses: torbjorn.tronsmoen@svt.ntnu.no, torbjorn.tronsmoen@vegvesen.no, torbjt@vegvesen.no

0925-7535/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.ssci.2009.05.001

for reliable measurement at individual level; provided that the context is neutral and the test is carried out anonymously. However, researchers have also emphasised that many determinants of accidents, such as attitudes, are at another level of specificity than accidents (Iversen, 2004; Stene, 2005; Ulleberg, 2002), which also makes it difficult to show near associations.

The relationship between practical driver training and safety attitudes, self-evaluation skills and behaviour are sparsely examined. Lay instruction is aimed at providing driving experience and to bring forth the safety effects of driving experience. An underlying assumption is that lay instruction will provide a safety effect similar to the effect obtained by driving alone. Driving experience may produce safety effects due to improved driving skills or the safety effect may be caused by improved safety attitudes. Driving experience may contribute to young drivers' understanding of how far various attitudes and behaviours related to safety are safety effective. If so, informal lay instruction may contribute to fulfil official learning objectives and thus may partly replace formal driver training. However, it is an underlying premise for using safety attitudes, self-evaluation skills and safe behaviour as outcome variables that they may result from driver training and that they are associated with crash involvement. Consequently, the present paper aims at *examining the associations between formal and informal practical driver training as well as driving experience on the one hand and safety attitudes, self-assessment of driving ability and self-reported driving behaviour on the other hand. The relationship between attitudes, self-assessment and driving behaviour on the one hand and accident involvement on the other hand is also examined.*

Development of driving competence is described in several theoretical models. In this paper Dreyfus and Dreyfus (1986) and the Goals for Driver Education – (GDE) model (Hatakka et al., 2002; Peräaho et al., 2003) are taken as examples. Dreyfus and Dreyfus see driving competence primarily as a skill, and developing competence mainly resulting from extensive practice in the domain. The GDE-model has a wider focus and identifies attitudes and self-assessment of driving ability as important, safety relevant targets for influence by driver training.

According to Dreyfus and Dreyfus' five-stage model, initially a 'novice' primarily depends on context-free rules to act (Dreyfus and Dreyfus, 1986; Wackerhausen, 1997). Acquisition of driver skills implies an enhanced understanding of the context in which the rules are applied. The 'advanced beginner' will interpret the rules in elucidation of the current traffic situation and will be able to place the rules into the context. When a driver reaches the stage of 'competence', he or she links decision-making to emotional involvement, because of the complexity and uncertainty in given situations. Resulting positive and negative emotional experiences will strengthen successful responses and inhibit unsuccessful ones, and the rules and principles formerly used as guidance for acting will gradually be replaced by situational discrimination, accompanied by associated response. When a driver has reached the stage of 'proficiency', reading of the current situation happens intuitively although the decision to act remains the result of specific considerations. At the stage of 'expertise', the expert will be able to perform immediately and intuitively in a domain, based on his or her response to a given situation. Such immediate and intuitively based responses will replace reasoned responses (Dreyfus and Dreyfus, 1986). In the advanced stages of the model, it will be expected that the rules will be less important in the driver's performance. Hence, dependence on the rules will be reduced. However, the skill model does not contain reference to motivational aspects of driving. Consequently, the skill model does not differ between accidents resulting from skill deficits and accidents resulting from failures in drivers' motivation and intentions to drive safely, because the latter is overlooked in the model.

Albeit motivational aspects such as safety attitudes are absent in the model of Dreyfus and Dreyfus, it is possible to derive some consequences of their approach about the role of safety attitudes. Owing to the role of rules in the skill model, it will be expected that safety attitudes may develop in a less than ideal direction, while getting more driving experience, provided measurement of safety attitudes is linked to attitudes towards rule violations. Consequently, the skill model does not indicate change in safety attitudes as a possible explanation of the strong risk reduction with increased amount of driving experience. Due to the skill-oriented perspective in this model, the explanation of the reduced risk should be enhanced driving skills, in the present study measured in terms of self-assessment of driving ability.

The Goals for Driver Education – (GDE) model is a framework for goals and contents of driver education. Opposite to the view of the skill model, the GDE-model provides a framework emphasising the necessity of motivational and intentional aspects of driving besides the importance of skill-based competence.

The model distinguishes between four levels of driving in a hierarchy. These four levels are from bottom to top: *vehicle manoeuvring*, *mastering traffic situations*, *goals and context of driving*, and *goals for life and skills for living* (for a more thorough presentation, see Hatakka et al., 2002; Peräaho et al., 2003). It could be considered an advantage of the GDE-model that it includes a fourth level linking it to social cognition models identifying behaviour as an interaction of personal factors, such as attitudes and self-assessment as well as the social and physical environment, see for example, Theory of Reasoned Action (TRA) and Theory of Planned Behaviour (TPB) (Fishbein and Ajzen, 1975; Ajzen, 1991). The GDE-model suggests that the factors on the highest of the four levels are the most important for safety (Peräaho et al., 2003). Moreover, the GDE-model emphasises that the highest levels determine actions and behaviour on the lowest levels in the hierarchical model. In the GDE framework, it is argued that the goals and motives of the driver are important variables to explain young drivers' behaviour and accidents (Hatakka et al., 2002).

Compared to the skill model, the GDE-model has a broader perspective, indicating that also changes in motivational and intentional factors such as safety attitudes may be a part of the explanation of the risk reduction during the first half a year of licensed driving. The wider perspective in the GDE-model opens for driving experience as a source for strengthening ideal safety attitudes. Driving experience may contribute to understanding of the importance of appropriate safety attitudes and behaviour to avoid accident involvement in traffic.

What we can see is that the different theoretical approaches in the skill model and the GDE-model, respectively, may lead to contradicting hypotheses about the relationship between driving experience and development of safety attitudes: *Based on the view in the skill model it seems likely that driving experience contributes to less ideal safety attitudes provided measurement of safety attitudes is linked to attitudes towards rule violations. In contrast, the wider perspective in the GDE-model opens for driving experience as a source for strengthening ideal safety attitudes.* However, both models consider developing driving skills as important for safety. In addition the GDE-model is stating that the driver's self-assessment of driving ability has to be in balance with actual driving skills as a base for appropriate regulation of the driving process.

1.1. Associations between driving experience and driver training on the one hand and self-assessment of driving ability, safety attitudes and risk behaviour on the other hand

Lajunen and Summala (1995) found that development of driving skills (measured as self-assessment of driving skills) was correlated with driving experience. Also other studies have found a

positive association between driving experience and self-assessment of driving ability (e.g. Goszczynska and Roslan, 1989; Katila et al., 2004; Groeger and Brady, 2004). Tronsmoen (2008) showed that self-assessment of driving ability grew while driving experience increased and crash involvement decreased. If crash involvement is interpreted as a measure of actual driving ability, the study indicated that young drivers have a fairly realistic view of their own driving ability. The argument for such an interpretation is that safety skills and the ability to avoid crash involvement are seen as an important part of the driving ability notion (Tronsmoen, 2008).

Lajunen and Summala (1995) also found that driving experience was associated with less safety and rule-oriented driving. Forsyth et al. (1995) found an increase in the number of speed violations during the first 3 years after gaining a licence. Furthermore, a study by Sagberg and Bjørnskau (2003) showed that how far respondents reported frequently violating traffic regulations increased with their driving experience. The study also showed that the risk level was significantly reduced during the first 9 months after licensing.

As shown, previous research have examined to which extent scores in self-assessment of driving ability, safety attitudes and risk behaviour is associated with amount of driving experience. However, little is known about how these variables are associated with the two forms of practical driver training. As mentioned previously, *this study aims at examine to which extent practical driver training is associated with safety attitudes, risk behaviour and self-assessment. Specifically, the present research examines the relative importance of formal and informal practical driver training in these factors.*

It is shown that safety attitudes may be influenced through well organised and adapted pedagogical measures, (e.g. Nyberg, 2007, p. 67; Senserrick and Swinburne, 2001; Nolen et al., 2002). Through official regulations and supervision it is possible to steer content and design in formal training, while informal driver training hardly may be quality assured to the same extent. Consequently, formal training may be carried out in accordance with the goals in the syllabus focusing more extensively on cognitive judgments and beliefs about hazards in traffic compared to informal training. Hence, formal driver training may be a more significant predictor of attitudes and behaviour compared to informal training. Gregersen et al. (2000) evaluated the implementation of a 16-year age limit for practicing with a lay instructor in Sweden. The results showed that despite significantly increased amounts of driving practice and improved safety due to the reform, the learners' knowledge and safety attitudes did not improve. The brief conclusion looking at the relationship between driver training and safety attitudes is that it seems possible to influence safety attitudes significantly through education based on insight programmes. However, the relationship between *practical driver training* and development of safety attitudes has been sparsely examined.

Groeger and Brady (2004) examined the association between driver training and self-assessment of driving ability. They found that learner drivers' self-assessment increased as their amount of training grew. Tronsmoen (2008) showed that professional instruction was negatively associated with self-assessment of skills, although lay instruction was positively correlated with self-assessment. This may indicate that professionals also in practical instruction contribute to fulfil the educational goal stating that novice drivers should develop a self-critical view of their own driving ability.

1.2. Factors associated with variance in risk behaviour and crash involvement

Risk behaviour is important in traffic safety (see for example, Elander et al., 1993; Parker et al., 1995). Consequently, examining the relations with possible determinants of driver behaviour may enhance knowledge relevant to improving traffic safety. Safety attitudes as well as self-assessment of driving ability may be important for driving behaviour. All these variables may in turn be important for crash involvement.

Performance as well as motivational and attitudinal factors may be important for safe driving (Rothengatter, 1997). Also according to Peräaho et al. (2003), it is important to distinguish between 'what the driver can do' (performance factors), and 'what the driver is willing to do' (motivational and attitudinal factors). Likewise, Parker et al. (1995) and Åberg and Rimmö (1998) distinguished between errors and violation in driver behaviour (Peräaho et al., 2003). Performance is linked to driving skills and the ability to avoid errors and accidents in urgent situations. On the other hand, violations relate primarily to how the driver decides to use his or her skills. In the present study these perspectives are attended to by focusing on the associations between safety attitudes and self-assessment of driving ability on the one hand, and safe driving and safety on the other hand. Self-assessment of driving ability and safety attitudes are assumed to be linked to crash involvement by their importance for risk behaviour.

The attitude-behaviour relationship is essential in both the TRA and TPB models (Fishbein and Ajzen, 1975; Ajzen, 1991). Attitudes and behaviour have been shown to correlate provided they are measured at corresponding levels of specificity (Ajzen and Fishbein, 1977, 2005; Ajzen, 1991; Kraus, 1995). Besides attitudes, social norms are considered an important predictor in TRA. In TPB, perceived behavioural control is included as a predictor in addition to the other two factors as determinants for intention, which in turn are strongly associated with future behaviour. The term 'perceived behavioural control' refers to people's perceptions of their ability to perform in a given manner. Consequently, based on the view in TPB it will be expected that also self-assessment of driving ability has a strong relationship with driving behaviour. Self-assessment of driving ability is linked to driving skills, which also may determine crash involvement directly, because lack of skills may determine more or less risky and unintentional errors.

Several studies have confirmed that there is a strong association between safety attitudes and risk behaviour in traffic (Lajunen and Summala, 1995; Parker et al., 1995). Iversen and Rundmo (2004) found that attitudes towards traffic safety were associated with involvement in risk behaviour, especially attitudes about rule violations and speeding, as well as other forms of reckless driving. They also found that younger respondents had a greater tendency to endorse attitudes less conducive to traffic safety than older respondents did. Ulleberg and Rundmo (2002) found that the attitude dimensions explained 50% of the variance in self-reported risk-taking behaviour. In addition, their study showed that self-reported risk behaviour was a significant predictor of accidents.

In addition to attitudes, the driver's assessment of his or her driving ability may have an impact on traffic behaviour and traffic safety (see for example, Brown and Groeger, 1988; Christensen and Glad, 1996; Glad, 1988; Gregersen, 1996; Keskinen et al., 1992). It seems reasonable that respondents who assess their driving abilities to be good also will perceive their driving control to be better, i.e. their driving ability will be associated with an enhanced level of perceived behavioural control, which in turn influences behaviour.

However, if dimensions of self-assessment, safety attitudes and risk behaviour are to be used as substitutes for a risk measure as outcome variables for driver training, the underlying assumption is that these variables must be closely associated with crash involvement. Hence, *it is an additional aim to examine the relations between self-assessment of driving ability, safety attitudes and driving behaviour on the one hand and crash involvement on the other hand.*

1.3. The relationship between the variables in the study

The core aim of the study is to examine associations between formal and informal practical driver training as well as driving experience on the one hand and young drivers' safety attitudes, self-assessment of driving ability and self-reported driver behaviour on the other hand. An additional aim is to examine the associations between attitudes, self-assessment and behaviour on the one hand and crash involvement on the other hand. Fig. 1 shows the variables in the study. The direction of the influence is presumed to move from the left side and to the right side of the model as the arrows indicate. However, the present study is cross-sectional and do not allow for conclusions about causality. To some extent influences may be reciprocal. The present study examines associations between actual variables as indicated by the lines.

2. Method

2.1. Sample

The respondents of the present study were a sample of the Norwegian population's young drivers aged 18–20 years. 4000 persons were randomly drawn from the official driver licence registry AUTOSYS. They all held a driving licence for passenger cars. The minimum age for holding a driver's licence in Norway is 18 years. The drivers responded to a mailed questionnaire. The data were collected during autumn 2005 and spring 2006. 1419 respondents replied to the questionnaire. 167 were returned due to unknown addresses. The response rate was 37%. Analyses showed that the distribution of respondents were close to the distribution in the population. The respondents consisted of 49% men and 51% women, and according to Statistics Norway the actual distribution is 50.4 and 49.6. 13% of the respondents were from the four largest cities in the country. According to available licensing statistics from The Norwegian Public Roads Administration this reflects the actual distribution of 18 year olds licensed in 2005 (13.4% in the four largest cities). Note that in the licensed population the largest cities are underrepresented compared to the population as a whole, partly due to better access to public transport in urban areas.

The sample is also examined for possible selective recruitment to the two different types of practical driver training. In Norway, most of learner drivers undergo both formal and informal practical driver training. A minimum of professional driver training is mandatory, and learner drivers are free to obtain additional drivers' training with a lay instructor in an ordinary family car, provided the instructor has continually held a licence for a minimum of 5 years. The amount of lay instruction may of course vary from learner to learner by practical reasons.

Educational elements which are not possible to test adequately in the licensing test are addressed through mandatory lessons. These lessons include elements of theory and driving practice as well as practical evaluation lessons taken throughout the learning process. Thus, professional driving schools provide mandatory as well as optional programmes. Learners usually reduce their costs by supplementing the mandatory training with accompanied training to gain sufficient driving experience before taking their driving test. Most drivers in Norway therefore will have experienced both lay and professional instruction as learners. However, the mix between the two types of driver training may differ from person to person. In this context, selective recruitment may represent a source of bias. We actually do not know why some choose a high amount of lay instruction while others finish with more professional lessons. Choices may be influenced by external causes such as access to a car; an interested lay instructor as well as a suitable driving environment. Internal causes as for example, driving aptitude, interests and personality may have an influence. In other words, it is possible that those who choose lay instruction are different in other respects than with regard to randomly distributed external frame factors. The question is whether internal variables are linked to choices of driver training with a possibly link also to the outcome variables. In order to clarify this problem, two regression analyses were carried out with amount of lay instruction and professional driver training, respectively, as dependent variables. As independent variables were entered sex, degree of urbanisation in the living area in the period when driver training took place, age when lay instruction started, educational level, grades in comprehensive school in mathematics, languages, and gymnastics. These analyses showed no significant associations either for educational level or grades in comprehensive school. However, important for the amount of lay instruction and number of professional driver training lessons, respectively, were time for the first lay instruction lesson, (not surprising), gender and level of urbanisation. Learners living in rural areas attain more lay instruction compared to those who live in urban areas. Men gain more lay instruction than women. This indicates that there are some external frame factors which are of influence on the amount and distribution of training.

School performance seems to be of little influence on the number of professional lessons taken. The exception is school performance in gymnastics, which is weakly (though significantly) negatively associated with the number of professional lessons. More specifically, low grades in gym class seem to lead to a need for many professional driver training lessons.

2.2. Questionnaire

The measurement instrument applied to examine self-assessed driving ability consisted of 31 indicators. The indicators fell into four dimensions, further described in Tronsmoen (2008). The first

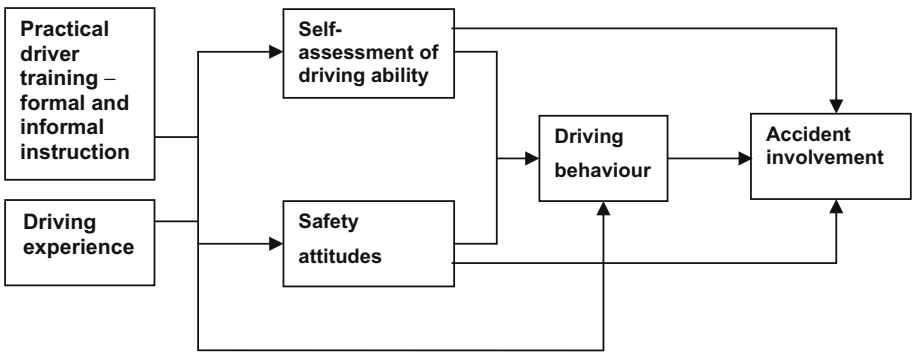

Fig. 1. The figure shows the variables in the study. The presumed direction of influence between variables is indicated by means of arrows. The present study examines associations between actual variables.

dimension related to self-assessment of *general driving ability*, which included skills such as driving fast, anticipating, driving in slippery conditions, and driving in the dark. The second dimension, *safety orientation*, referred to the driver's perception of his/her own ability to identify risk, danger and his/her perception of their ability to drive with satisfactory safety margins. The third dimension was *the body dimension*, which measured the feeling of unity with and control of the car. The fourth dimension was *specific task skills* and items under this dimension consisted of judgment of the ability for precise and effective parallel parking, reversing into a garage, as well as reversing using the rear-view mirrors. The subjects were instructed as follows: *'The next part of the questionnaire contains statements about how driving a car may be dealt with and perceived. How well do the statements fit how you deal with and perceive driving a car?'* A 5-point evaluation scale ranging from 'Fits me perfectly' to 'Does not fit me at all' was applied.

An 18-indicator Norwegian measurement instrument was used to measure attitudes towards traffic safety (Iversen and Rundmo, 2004; Iversen, 2004). A study examining the psychometric qualities of the instrument showed that the indicators fell into the following three dimensions: (1) *attitude towards rule violations and speeding*, including statements as 'Many traffic rules must be ignored to ensure traffic flow' and 'Speed limits are exceeded because they are too restrictive', (2) *attitude towards the careless driving of others*, including for example, 'I will ride with someone who speeds if that is the only way to get home at night', and (3) *attitude towards drinking and driving*, including e.g. 'I would never drive after drinking alcohol', (Iversen and Rundmo, 2004). Ratings of the statements were given on a 5-point scale ranging from 'Strongly agree' to 'Strongly disagree'.

In order to measure self-reported driving behaviour, Åberg and Rimmö's (1998) 32-items instrument was applied. The measurement instrument from Åberg and Rimmö were based on a study by Reason et al. (1990), however, extended with items constructed to fit a Scandinavian context. Åberg and Rimmö (1998) showed that the indicators fell into four dimensions: The first dimension *violations*, included items such as for example, 'Deliberately disregard speed limits' and 'Disregard speed limit to follow traffic'. The second dimension, *mistakes*, referred to dangerous errors and included for example, 'Misjudgement of the gap when overtaking'. The third dimension from Reason et al. (1990), harmless lapses, was split into *inattention* errors and *inexperience* errors (Åberg and Rimmö, 1998). *Inattention* included items such as 'Misread signs, find yourself lost' and 'Fail to notice green arrow'. *Inexperience* errors included for example, 'Have to check gear with hand' and 'Shift into wrong gear when driving'. Ratings were given on a 6-point scale ranging from 'Very often' to 'Never'.

In addition, the questionnaire contained demographic variables concerning sex, age and education. With regard to education the questionnaire covered educational level, and grades in secondary school in mathematics, languages as well as in gymnastics. The respondents were also asked to assess the amount of driver training with a lay instructor as well as the amount of driver training with a professional driving teacher.

Driving experience was measured by asking how many kilometres the subjects drove per month, and how long they had held a licence. Also, they were asked to report any crash involvement.

2.3. Statistical analysis

Principal Component Analysis (Varimax rotation) was used to examine the dimensional structure of self-assessment of driving ability, attitudes and self-reported driving behaviour. Cronbach (1951) alpha coefficient was applied to evaluate the homogeneity of the items within the different dimensions. Multiple regression analyses were applied to examine the influence of practical driver education as well as driving experience into variance in dimensions of self-reported behaviour, attitudes and self-assessment of driving ability. Pearson's r was calculated to show the associations between safety attitudes, risk behaviour, and self-assessment of driving ability on the one hand, and formal and informal driver training and driving experience on the other hand. The next step was to examine the importance of self-assessment and attitudes into dimensions of self-reported behaviour. This was done by applying multiple regression analyses with dimensions of self-reported behaviour as dependent variables and the other variables as independent. These analyses contained also variables controlling for interaction effects between driving experience and attitudes. The unique contribution of each of the predictor variables for the total variance explained was calculated and entered into figures in the result section. The unique contribution is calculated as follows:

$$R^2 \times 100\% = \sum_{i=1}^{n} \beta \times 100\%$$

The last question to elucidate was the relation to accident involvement. For this purpose, negative binomial regression analyses were conducted. In order to clarify possible effects of selective recruitment into the two kinds of driver training, two regression analyses were performed containing formal and informal driver training, respectively, as dependent variables. As independent variables were entered gender, degree of urbanisation (in the living area in the period when driver training took place), age when lay instruction started, educational level as well as grades in comprehensive school in mathematics, languages, and gymnastics.

3. Results

3.1. The amount of practical driver training

The entire sample, with exception of two of the respondents, received more professional practical driver training from driving schools than the mandatory dark driving and skid driving lessons. The mean value is 14.26 practical driving lessons attended at a driving school, while the median is 12 lessons. Standard Deviation is 9.47. 76% of the learners started their driving practice before they reached 17 years of age. Compared with Sagberg, 2000 who found that 54.5% started before 17, this indicates an increase of amount accompanied driving in Norway. More than 90% did not attend any professional practical driving lessons before starting accompanied driving with a lay instructor. Almost all the respondents had private instruction of different amount in addition to the mandatory driver education in professional driving schools. The mean value of lay instruction was 114.77 h, while the median was 75 h, indicating that the distribution is skewed. The spread was considerable high with a Standard Deviation 119.04. Table 1 shows the result of simple descriptive reports. The means and Standard Deviations are given for driver training and driving experience as well as for self-assessment of driving ability, safety attitudes and self-reported behaviour.

3.2. Self-assessment of driving ability

Tronsmoen (2008) showed that self-assessment of driving ability fell into four dimensions: (1) *self-assessment of general driving ability*, (2) *safety orientation*, (3) *the body dimension*, and (4) *specific task skills*. For further description of the dimensions, see Section 2.2. The internal consistency of the indices was found satisfactory (Table 2).

Table 1
Descriptive statistics – *Safety attitudes, Risk behaviour, Self-assessment, Driver training* and *Driving experience.*

Variables	Mean	SD	*N*
Safety attitudes			
Attitude towards rule violations and speeding	3.305	0.6983	1412
Attitude towards the careless driving of others	3.502	0.9368	1412
Attitude towards drinking and driving	4.749	0.6264	1411
Self-reported driving behaviour			
Violation behaviour	3.987	0.8300	1419
Mistakes	5.077	0.6279	1419
Inattention	5.189	0.5971	1418
Inexperience	4.914	0.6740	1419
Self-assessment of driving ability			
General driving ability	2.061	0.6419	1414
Safety orientation	2.591	0.5441	1414
The body dimension	2.319	0.6947	1409
Specific task skills	2.139	0.9407	1409
Driving lessons in driving school	14.26	9.47	1396
Driving lessons with lay instructor	141.98	144.96	1413
Driving experience after licensing (Km)	7709.81	9957.43	1381
Months with a licence	16.485	9.3378	1410

Attitudes: ratings were given on a 5-point scale ranging from (1) 'strongly agree' to (5) 'strongly disagree'. Low values correspond to non-ideal attitudes.
Self-assessment of driving ability: ratings were given on a 5-point scale ranging from (1) 'strongly fits me' to (5) 'does not fit me at all'. Low values correspond to low ratings of self-assessment.
Self-reported driving behaviour: ratings were given on a 6-point scale ranging from (1) 'very often' to (6) 'never'. Low values correspond to high ratings in all the dimensions of self-reported driving behaviour, i.e. low values correspond to non-ideal behaviour.

3.3. Attitudes towards traffic safety

A principal component analysis was carried out to examine the dimensional structure of attitudes towards traffic safety. The dimensions were: (1) *attitudes towards rule violations and speeding*, (2) *attitudes towards others' careless driving*, and (3) *attitudes towards drinking and driving*. The internal consistency was found satisfactory (Table 2).

3.4. Dimensional structure of self-reported driving behaviour

A principal component analysis showed that risk behaviour comprised four dimensions: (1) *violations*, i.e. the extent to which the respondents reported violating traffic regulations; (2) *mistakes*, i.e. misjudgement of traffic situations; (3) *inattention*; and (4) *inexperience* related to driving. The dimensional structure of risk behaviour in the present sample was identical to that of Åberg and Rimmö (1998). Based on the data from the present study the reliability of the indices was found satisfactory (Table 2).

3.5. Associations between driving experience and driver training on the one hand and self-assessment of driving ability, safety attitudes and risk behaviour on the other hand

The associations between formal and informal driver training as well as driving experience on the one hand, and attitudes, risk behaviour and self-assessment of driving ability on the other hand are shown in Table 3.

Table 3 shows that learners with the highest numbers of professional lessons were the most self-critical about their driving ability. Furthermore, the greater the number of professional lessons was reported to be, the more ideal the scores in safety attitudes were, and the less risky behaviour was with regard to reported rule violations and speeding. In contrast, the amount of lay instruction was positively associated with the level of self-assessment. There were also correlations between the number of lay instructor lessons on the one hand, and non-ideal attitudes and self-reported risk behaviour on the other hand, i.e. the higher numbers of lay instruction lessons that was reported, the less ideal the attitudes and the driving behaviour was reported. Driving experience showed relations with self-assessment, safety attitudes and risk behaviour similar to those of lay instruction. As seen in Table 3, the correlation coefficients were small to moderate, though the majority of them were significant.

Fig. 2 shows the results of 11 regression analyses. The aim of the analyses was to examine driving experience, professional driving lessons and amount of lay instruction as variables associated with variance in dimensions of self-assessment of driving ability, safety attitudes and self-reported behaviour. The results in Fig. 2 show small to moderate associations between training and experience on the one hand and self-reported *risk behaviour* as well as *attitudes* and *self-assessments* on the other hand. The highest level of explained variance occurred in *specific task skills,* a performance dimension of self-assessment related to vehicle manoeuvring. Also *general driving ability*, *attitudes towards rule violations* and *violation behaviour* showed moderate levels of explained variance. In general, compared to formal and informal driver training, driving experience was most important for variance in the outcome variables. There were no correlations between driving experience and the two forms of driver training on the one hand, and *attitudes towards drinking and driving* and *attitudes towards others' driving* on the other hand. There were neither found significant associations between driving experience and training on the one hand, and *inattention* and *mistakes* on the other hand.

Table 2
Dimensions of self-assessment of driving ability, safety attitudes and risk behaviour – reliability.

Dimension	Number of items	Cronbach's α	Average inter-item correlation
Self-assessment			
General driving ability	8	.85	.58
Safety orientation	6	.70	.45
The body dimension	5	.79	.57
Specific task skills	3	.76	.60
Safety attitudes			
Attitude towards rule violations and speeding	8	.83	.55
Attitude towards the careless driving of others	2	.73	.57
Attitude towards drinking and driving	2	.77	.63
Risk behaviour			
Violations	8	.82	.54
Mistakes	8	.84	.56
Inattention	8	.76	.46
Inexperience	8	.80	.50

Table 3
Associations between dimensions of safety attitudes, risk behaviour, self-assessment of driving ability, and learning (Pearson's *r*).

	Driving lessons in driving school	Driving lessons with lay instructor	Driving experience after licensing
Driving lessons in driving school	1	−.253***	−.133***
Driving lessons with lay instructor	−.253***	1	.15***
Driving experience after licensing	−.133***	.15***	1
Attitude towards rule violations and speeding	.17***	−.14***	−.24***
Attitude towards the careless driving of others	.07**	−.01	−.06*
Attitude towards drinking and driving	.04	.04	−.04
Violation behaviour	.13***	−.12***	−.24***
Mistakes	.01	−.06*	−.09**
Inattention	−.08**	.01	−.04
Inexperience	−.13***	.07**	.16***
Self-assessment general driving ability	−.18***	.15***	.26***
Self-assessment safety orientation	−.11***	.06*	.07**
Self-assessment body dimension	−.12***	.14***	.21***
Self-assessment specific task skills	−.23***	.26***	.31***

* $p < .05$.
** $p < .01$.
*** $p < .001$.

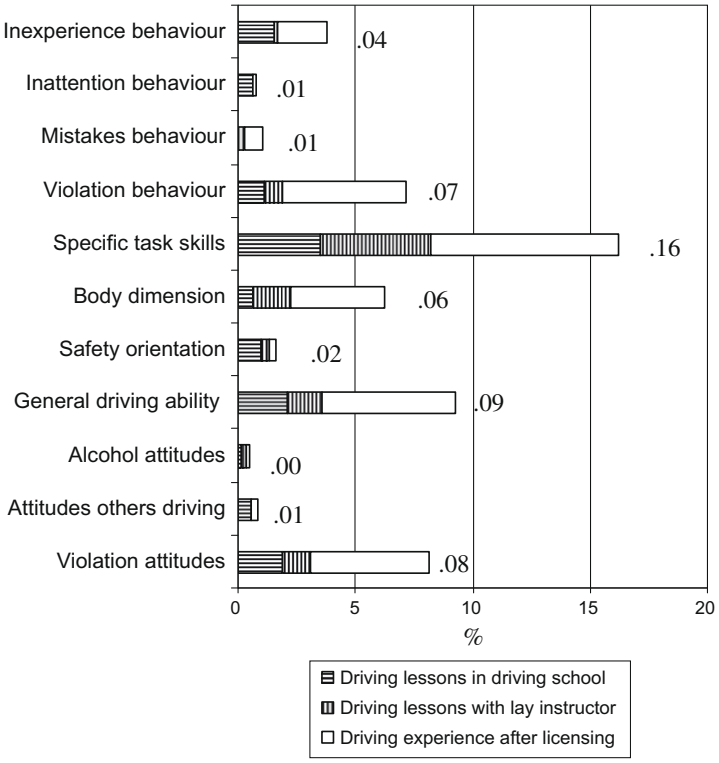

Fig. 2. Results from regression analyses – formal driver training, informal driver training and driving experience as predictors, and self-assessment, attitudes and self-reported behaviour as dependent variables – adjusted r^2 as explained variance in percent.

3.6. Dimensions in self-assessment of driving ability and safety attitudes associated with variance in risk behaviour

Fig. 3 shows the results of four multiple regression analyses. The aim of the analyses was to explain variance in the four dimensions of risk behaviour. The independent variables were dimensions of attitudes towards traffic safety and dimensions of self-assessment of driving ability. The most significant variable for explained variance in reported frequency of *rule violation behaviour* was *attitudes towards rule violation and speeding*. This variable was also most important for explained variance in the behaviour dimensions *mistakes* and *inattention*. Self-assessment of driving ability also contributed significantly to explained variance in behaviour. However, compared to safety attitudes, dimensions of self-assessment of driving ability were less important. The moderating effect of driving experience for the associations between attitudes and behaviour were also examined. No significant interaction effects were found.

3.7. Associations between dimensions of safety attitudes, risk behaviour, self-assessment of driving ability on the one hand and crash involvement on the other hand

Due to the distribution in crashes, negative binomial regression analyses were applied to examine the associations between dimensions of self-assessment, safety attitudes and self-reported risk behaviour on the one hand and crash involvement on the other hand. A precondition for analyses of accident models is that the variance in accidents is mainly systematic. The systematic variance in crash involvement was calculated to 77.6%. Consequently, it was

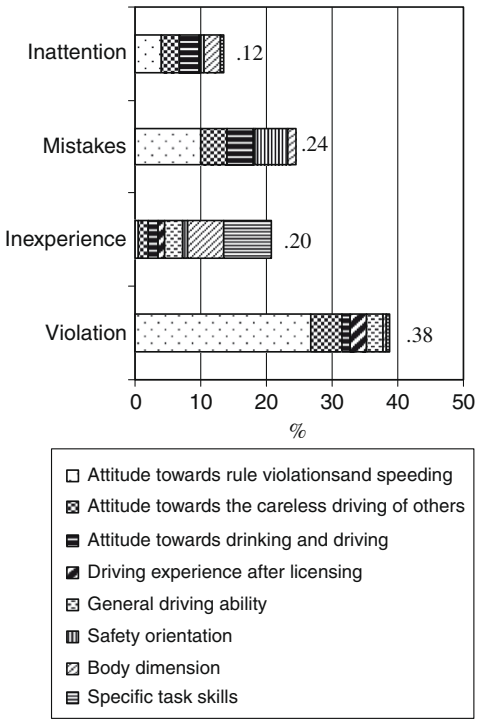

Fig. 3. Results from regression analyses – attitudes and self-assessment dimensions as predictors and self-reported driving behaviour dimensions as dependent variables – adjusted r^2 as explained variance in percent.

reason to perform multivariate analyses to examine the relations between accidents and self-assessment, safety attitudes and risk behaviour.

The overdispersion parameter shows the part of the systematic variance in accidents not explained by the model (see the 'Elvik index', described in Fridstrøm et al., 1995). The formula for calculating the overdispersion parameter is:

$$\text{Overdispersion parameter } (\theta) = \frac{\frac{s^2}{\overline{X}} - 1}{\overline{X}}$$

Accordingly, the overdispersion parameter in the raw data is

$$[(3,14033/0,7031) - 1/0,7031] = 5476.$$

The overdispersion parameter is not standardized and may show any value higher than zero. With a good accident model fitted to the data it is to expect that the value of the overdispersion parameter will be reduced (Fridstrøm et al., 1995). LIMDEP provides the overdispersion parameter for the different models in negative binomial regression analyses. This parameter makes it possible to estimate the explained variance due to the models of self-assessment of driving ability, safety attitudes and risk behaviour, respectively. A low value in the overdispersion parameter indicates a good fit of the model. The overdispersion parameters provided from the negative binomial analyses are shown in Table 4.

The negative binomial regression analysis of the self-assessment model showed the overdispersion parameter calculated to 0.8616. Variance after fitting the model to the data is calculated by inserting the value of the overdispersion parameter (θ) into the formula for the variance of a negative binomial distribution:

$$s^2 = \overline{X}(1 + \theta\overline{X})$$

$$\text{Variance} = 0.7031 \cdot (1 + 0.8616 \cdot 0.7031) = 1.129$$

The calculation showed the variance after fitting the self-assessment model to the data was 1.129.

The explained part of the systematic variance is calculated by dividing the difference between the systematic variance and the difference between variance after fitting the model and the mean of accidents in the sample, with the systematic variance:

$$\text{Explained variance} = 2.4372 - (1.129 - 0.7031)100\%/2.437 = 82.5\%$$

Table 4 shows the results from the different models with regard to the overdispersion parameter, explained systematic variance, and explained total variance in per cent in addition to coefficients and standard errors for the different dimensions in each model separately.

As can be seen in Table 4, the self-assessment model explains more variance (82.5%) than the safety attitudes model (80%) and

Table 4
Negative binomial regression analyses of self-assessment of driving ability, safety attitudes, risk behaviour and months with a licence – explained variance in crash involvement.

	Overdispersion parameter	*B*	Std. error	Explained part of systematic variance (%)	Explained total variance (%)
Self-assessment of driving ability and months with a licence	0.8616			82.5	64
General driving ability		−0.226*	0.0993		
Safety orientation		0.761***	0.1040		
The body dimension		−0.376***	0.0875		
Specific task skills		−0.013	0.0566		
Months with a licence		0.038***	0.0048		
Safety attitudes and months with a licence	0.9633			80.0	62.4
Attitude towards rule violations and speeding		0.297***	0.0658		
Attitude towards the careless driving of others		0.058	0.0473		
Attitude towards drinking and driving		0.188**	0.0639		
Months with a licence		0.036***	0.0046		
Risk behaviour and months with a licence	0.9581			80.7	62.5
Violation behaviour		−0.240***	0.0630		
Mistakes		−0.237*	0.0993		
Inattention		0.030	0.1005		
Inexperience		0.140	0.0858		
Months with a licence		0.034***	0.0047		

Dependent variable: crash involvement (numbers of accidents).
* $p < .05$.
** $p < .01$.
*** $p < .001$.

the risk behaviour model do (80.7%). However, for all the models this is a high percentage of explained variance, indicating that they to some extent must be correlated with each other. *Months with a licence* is an exposure measure and is the most important contributor to the variance in all the models. The table shows that in the self-assessment model *Safety orientation* and *The body dimension* are the most important contributors to the variance. In self-reported driving behaviour *Violation behaviour* is the most important contributor and within the safety attitudes model *Attitude towards rule violations and speeding* is the most important one.

In addition an analysis showing all the models together were entered into a new model in order to test the relative importance of the different dimensions of self-assessment, safety attitudes and risk behaviour, respectively, and controlled for months with a licence. The results from this analysis showed that *safety orientation* and *the body dimension* from the self-assessment model as well as *months with a licence* contributed significantly to the variance in crash involvement ($P < 0.001$). Also the dimension *Violations* from the risk behaviour model contributed significantly ($P < 0.01$). However, none of the variables in the safety attitudes model remained significant.

4. Discussion

4.1. Associations between driving experience and driver training on the one hand and self-assessment of driving ability, safety attitudes and risk behaviour on the other hand

The results of the present study showed that there were small, yet significant, associations between driver training on the one hand, and traffic safety attitudes and risky driving behaviour on the other hand. As expected, driver training seemed to be most related to the respondents' evaluation of their driving skills. Furthermore, the results showed that attitudes as well as self-assessment of driving ability were significantly associated with self-reported risk behaviour. This was especially true for attitudes related to rule violations. There was a strong association between crash involvement and exposure measured as months holding a licence. Formal training was significantly negatively associated with the respondents' judgment of their own driving ability. Formal training was also significantly positively associated with safety attitudes. Further, the opposite was true for informal training with a lay instructor and for driving experience.

4.1.1. Self-assessment of driving ability

A possible explanation for the negative self-evaluation amongst those who reported high amounts of formal training may be that the training focused on the problem of overconfidence, in accordance with the learning objectives present in the GDE-model (Peräaho et al., 2003) and the driver training curriculum (Norwegian Public Roads Administration, 2004). An objective is to enhance the learners' critical view of their own driving skills. Training focusing on the problem of overconfidence may lead learners to become more critical of their own skills as a driver. Thus, the results indicate that the training contributes to fulfilling this objective. Another explanation for the differences in self-evaluations may be that the weakest candidates need more formal training compared to candidates mastering the training situation and the educational process better, and that this fact will be reflected in their self-assessment. If so, the respondents' self-evaluations may reflect their driving aptitude. However, as described in Section 2.1 there were no significant associations into amount of lay instruction and professional driver training neither from educational level nor grades in comprehensive school. It is also possible that there may be external causes for which type of training the single respondent selects. Young drivers who have access to a car and a lay instructor may tend to choose informal training in order to reduce costs, while those with limited access to such a way of learning to drive would tend to seek formal training. This may also contribute to the need for a larger number of training lessons. In addition, there may be a geographical dimension; namely, in rural areas informal training may be easier to perform compared to urban areas, which also was indicated by the analyses referred to in Section 2.1. Thus, type of training may be partly a result of circumstances which are not related to the learner's driving aptitude.

A possible explanation for an increase in positive self-evaluations amongst those who receive informal driver training may be that they gain more driving experience throughout their learning period compared to those who to a greater extent have to rely on formal training. Another possibility could be that it is primarily formal training that causes more negative self-evaluations and that informal training does not have the same effect. These results support the hypothesis derived from the skill model (Dreyfus and Dreyfus, 1986). The level of self-assessed driving skills seems to be positively associated with the amount of driver training and driving experience.

4.1.2. Safety attitudes and risk behaviour

It is interesting to note that formal driver training is positively associated with safety attitudes. In this respect, the learning objectives within the GDE-model – in Norway implemented in the driver training curriculum – are fulfilled. The results of the present study have also shown that the more formal driver training the respondents reported to have received, the less frequently they reported violation behaviour. However, the results of the present study have shown that high amounts of lay instructor training and driving experience are positively associated with 'non-ideal' attitudes and risky driving behaviour. This was especially true in relation to the dimension *violations*. These findings support to a great extent the expectations deduced from the skill acquisition model (Dreyfus and Dreyfus, 1986) presented in the introduction section, and is in accordance with Lajunen and Summala (1995), who found that driving experience was correlated with less safety and rule-oriented driving. The findings are also consistent with Forsyth et al. (1995), who found an increase in the number of speed violations during the first 3 years after drivers were awarded their licence, and also consistent with findings by Sagberg and Bjørnskau (2003), showing that the extent to which respondents reported frequently violating traffic regulations increased with their driving experience.

However, the associations in the present study were significant though fairly weak, indicating that other aspects are more important predictors of attitudes and risk behaviour than practical driver training. It should be taken into consideration that practical driver training most likely focuses driver skills. It is not aimed at influencing general attitudes towards traffic safety. Consequently, the associations should not be very strong. However, it is interesting that the focus on safety attitudes seems to be retained throughout formal practical driver training, while lay instruction contributes to non-ideal attitudes just as driving experience does.

There can be little doubt that traffic rules are context-free rules. It is known that novice drivers' behaviour in traffic to a greater extent is rule based compared to that of other drivers. The more driving experience a young driver has obtained, the more will the rules be related to the context in which the driving takes place. This may influence how drivers evaluate the value of the traffic rules. They gain insight into the role of the context in relation to the rules. This can lead to that they do not follow the rules strictly because it is not functional or seems to be less important in some situations. Consequently, their attitudes towards rule violations and speeding will become more flexible and 'non-ideal', with consequences also for their behaviour.

4.2. Dimensions in self-assessment of driving ability and safety attitudes associated with variance in risk behaviour

The four dimensions within self-reported driver behaviour are only partly explained through self-assessment of driving ability and safety attitudes. The best explained dimension is violation, R^2 = .38. It is safety attitudes which explain the main part of this variance (see Fig. 3). This is in line with earlier findings showing a strong association between attitudes and behaviour (Ajzen and Fishbein, 1977, 2005; Ajzen, 1991; Kraus, 1995; Ulleberg and Rundmo, 2002). Self-assessment of driving ability seems less important for explained variance in violation driving behaviour.

However, the body dimension and the specific task skills dimension together explain more than a half the explained variance in the behaviour dimension entitled 'inexperience'. The significant associations may indicate that the dimension inexperience is a valid dimension given that perceiving the car as a part of the body and skills to perform advanced manoeuvres; depends on driving experience. However, the associations are not strong, indicating that interpretations should be done with caution.

4.3. The association with crash involvement

As mentioned in the introduction a presupposition for using safety attitudes, self-assessment of driving ability and risk behaviour as safety relevant outcome variables for driver training as substitutes for accidents, is that they are closely related to crash involvement.

It is interesting to note that self-assessment as well as safety attitudes and self-reported driving behaviour separately explained more than 80% of the variance in crash involvement when it was controlled for how long time the respondents had held the licence. However, in the last negative binomial regression analysis in which all the models were entered as predictors, self-assessment of driving ability with particularly the *safety orientation* and *the body dimension* seemed to be the most important dimensions in addition to time holding the licence. The self-assessment instrument relates more to driving skills, while the others relates to safety attitudes and more or less directly related self-reported behaviour, indicating that skills may be more important element in young drivers' crash involvement than attitudes and self-reported driving behaviour. However, in the present study, serious accidents as well as less serious accidents and car crashes with only material damage were included. More than one-third of the subjects reported involvement in one or more crash. There is reason to believe that many of these are minor accidents and car crashes with small material damage. It could be that minor accidents primarily were caused by lack of driving skills while the more serious accidents happened due to rule violations in the form of speeding and drunk driving, in accordance with the results from in-depth analyses of young drivers' accidents (Clarke et al., 2002; Moe, 1999). However, the data in the present study do not allow for conclusions to be drawn in this respect.

Another possible explanation for finding the self-assessment model to be the model strongest associated with crash involvement may also be that this instrument to some degree invites the respondents to relate their response to the driving context, which may lead to a more corresponding level of specificity with crash involvement, see for example Ajzen and Fishbein (1977) who assume that attitudes and behaviour are highly correlated when measured at corresponding levels of specificity. The safety orientation aspect of self-assessed driving ability seems to be important for safety, and is positively associated with driving experience. The situation may very well be that driving experience helps young drivers to develop accurate judgments of dangers and risk elements in traffic independent of traffic rules, and that these abilities are more important for safety rather than safety attitudes measured as law-abidingness.

4.4. Consequences for driver training

The present study has shown that high amounts of lay instructor training and driving experience are associated with 'non-ideal' attitudes and risky driving behaviour. Although lay instruction (Gregersen et al., 2000; Sagberg, 2000) as well as driving experience (Sagberg, 2000; Mayhew et al., 2003), has been shown to contribute to reduced risk, the negative correlation with safety attitudes and behaviour indicate possible safety benefits if these safety relevant variables could be improved by other educational measures.

In this respect it is interesting to note that the results showed professional driver training associated with enhanced safety attitudes and less frequent self-reported risk behaviour. The conclusion is that professional and informal practical driver training may supplement each other, and that both formal and informal training are beneficial, albeit in different ways. The present study identifies some of the differences with regard to important safety relevant variables, stated as important objectives in the driver training curriculum.

It seems that the safety utility of informal driver training as well as driving experience hardly can be attributed to changes in safety attitudes and behaviour. However, the level of self-assessment of driving ability grows along with the increase in lay instruction and driving experience. The fact that self-assessment of driving ability increased with driving experience, and parallel to a reduction in accident involvement, indicate that safety relevant skills are reflected in the conception of self-assessment of driving ability. Hence, the strong risk reduction may at least partly be attributed to developing driving skills. Also Lajunen and Summala (1995) found driving skills correlated with driving experience based on a study in which driving skills were measured in terms of self-assessment of driving skills. A tentative conclusion is that the present study support previous research regarding informal driver training as a valuable source for developing safety skills.

According to Clarke et al. (2002) and Laapotti et al. (2001), safety attitudes are important as an explanation at least for the most serious of young drivers' accidents. The present study shows safety attitudes to be the most important determinant of variance in risk behaviour. Hence, the results indicate that there is a need for goal-directed driver education to influence attitudes. Lay instruction is not goal directed in this respect. Lay instruction and driving experience are a way to improve driving skills rather than a way to strengthening safety attitudes. Goal-directed formal driver training may influence safety attitudes (towards rule violations) more effectively. This may be the explanation of the positive association between amount of formal driver training and the strength in safety attitudes. However, it is important to influence safety attitudes in a way that makes them less vulnerable to a possible negative attitudinal effect of driving experience. In accordance with the skill model (Dreyfus and Dreyfus, 1986; Wackerhausen, 1997), it may be crucial how the importance of the traffic rules is taught. If they are taught with reference to individual risk they will soon lose their actual guiding value for acting in traffic. This is because the young driver learns that minor exceeding of, for example, speed limits will not be dangerous in itself; rather, it will depend on the situation. Risk associated with small and relatively common violations of the traffic rules is hardly apparent at an individual level. What young learners are taught as risky has to be visible as an outcome at the individual level, i.e. risks causing serious accidents, such as serious speeding offences, driving when impaired and possibly also combined with not wearing seatbelts.

Following the regulations in traffic is important to improve the overall safety margins which will result in reduced accident costs to society, due to reduced numbers of killed and injured. However, due to the features of the accident variable, including the high degree of randomness, it will be impossible to address the gain to specific individuals in advance. Driver education with the goal of influencing attitudes, and making learner drivers less vulnerable to the negative influences of driving experience, should emphasise the ethical aspect of the rules. It is necessary to make it clear that the objective behind learning the rules is not to test whether or not they are needed for individual safety purposes. Rather, traffic rules are mainly needed in order to ensure general safety margins in traffic, beneficial for the society and for individual road users who we never can identify in forehand as accident victims resulting from too low safety margins. Thus, every driver is responsible for the safety of others as well as for themselves.

The conclusion is that formal and informal driver educations seem to complement each other. Formal as well as informal driver training are important, due to the fact that they are differently associated with output variables important for traffic safety.

Acknowledgements

Thanks are due to the anonymous referees for very helpful and instructive comments on an earlier version of this article. Thanks to my supervisor Dr. Torbjørn Rundmo. Thanks are also due to Peter Christensen for providing the supplementary statistical analyses in LIMDEP. I am grateful to the Norwegian Public Roads Administration for funding the study.

References

Åberg, L., Rimmö, P.-A., 1998. Dimensions of aberrant driver behaviour. Ergonomics 41, 39–56.

Ajzen, I., Fishbein, M., 1977. Attitude–behavior relations: a theoretical analysis and review of empirical research. Psychological Bulletin 84, 888–918.

Ajzen, I., Fishbein, M., 2005. The influence of attitudes on behaviour. In: Albarracin, D., Johnson, B.T., Zanna, M.P. (Eds.), The Handbook of Attitudes. Erlbaum, Mahwah, NJ, pp. 173–221.

Ajzen, I., 1991. The theory of planned behaviour. Organizational Behavior and Human Decision Processes 50, 179–211.

Brown, I.D., Groeger, J.A., 1988. Risk perception and decision taking during the transition between novice and experienced driver status. Ergonomics 31 (4), 585–597.

Clarke, D.D., Ward, P., Truman, W. 2002. In-Depth Accident Causation Study of Young Drivers. TRL Report TRL 542. Transport Research Laboratory, Crowthorne, UK.

Christensen, P., Glad, A. 1996. Obligatorisk glattkjøringskurs for førere av tunge biler: virkningen på ulykkesrisikoen [Mandatory course of driving on slippery roads for drivers of heavy vehicles. The effect on accidents]. TØI Report 334. Transportøkonomisk institutt, Oslo.

Cronbach, L.J., 1951. Coefficient alpha and the internal structure of tests. Psychometrica 16, 297–334.

Dreyfus, H., Dreyfus, S., 1986. Mind Over Machine. Free Press, New York.

Elander, J., West, R., French, D., 1993. Behavioural correlates of individual differences in road traffic crash risk: an examination of methods and findings. Psychological Bulletin 113 (2), 279–294.

Engström, I., Gregersen, N.P., Hernetkoski, K., Keskinen, E., Nyberg, A. 2003. Young Novice Drivers, Driver Education and Training. Literature Review. VTI Report No. 491A. Swedish National Road and Transport Research Institute (VTI), Linköping.

Fishbein, M., Ajzen, I., 1975. Beliefs, Attitudes, Intention and Behavior: An Introduction to Theory and Research. Addison-Wesley, Reading, MA.

Forsyth, E., Maycock, G., Sexton, B. 1995. Cohort study of learner and novice drivers: Part 3, accidents, offences and driving experience in the first three years of driving, TRL Report No. 111. Transport Research Laboratory, Crowthorne.

Fridstrøm, L., Ifver, J., Ingebrigtsen, S., Kulmala, R., Thomsen, L.K., 1995. Measuring the contribution of randomness, exposure, weather, and daylight to the variation in road accident counts. Accident Analysis and Prevention 27, 1–20.

Glad, A., 1988. Fase 2 i Føreropplæringen. Effekt på Ulykkesrisikoen. TØI-rapport 0015/1988. Transportøkonomisk institutt, Oslo.

Goszczynska, M., Roslan, A., 1989. Self-evaluation of drivers' skill: a cross-cultural comparison. Accident Analysis and Prevention 21 (3), 217–224.

Gregersen, N.P., 1996. Young drivers' overestimation of their own skill – an experiment on the relation between training strategy and skill. Accident Analysis and Prevention 28 (2), 243–250.

Gregersen, N.P., Berg, H.Y., Engström, I., Nolén, S., Nyberg, A., Rimmö, P.A., 2000. Sixteen years age limit for learner drivers in Sweden – an evaluation of safety effects. Accident Analysis and Prevention 32, 25–35.

Groeger, J.A., 2000. Understanding Driving: Applying Cognitive Psychology to a Complex Everyday Task. Psychology Press, Hove, UK.

Groeger, J.A., Brady, S.J. 2004. Differential Effects of Formal and Informal Driver Training, Road Safety Research Report No. 42. Department for Transport, University of Surrey.

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.

Iversen, H. 2004. Risk Behaviour in Traffic. A Study Investigating Relationships between Attitudes, Personality, Stress and Behaviour. Doctoral Theses at NTNU Norwegian University of Science and Technology 2004:143. Trondheim.

Iversen, H., Rundmo, T., 2004. Attitudes towards traffic safety, driving behaviour and accident involvement among the Norwegian public. Ergonomics 47, 555–572.

Katila, A., Keskinen, E., Hatakka, M., Laapotti, S., 2004. Does increased confidence among novice drivers imply a decrease in safety? The effects of skid training on slippery road accidents. Accident Analysis and Prevention 36, 543–550.

Keskinen, E., Hatakka, M., Katila, A. Laapotti, S. 1992. Was the Renewal of Driver Training Successful? The Final Report of the Follow-up Group. Psychological Reports No. 94. Turku: University of Turku (in Finnish, with English abstract).

Kraus, S.J., 1995. Attitudes and the prediction of behaviour: A meta-analysis of the empirical literature. Personality and Social Psychology Bulletin 21, 58–75.

Lajunen, T., Summala, H., 1995. Driving experience, personality, and skill and safety-motive dimensions in drivers' self-assessments. Personality and Individual Differences 19 (3), 307–318.

Laapotti, S., Keskinen, E., Hatakka, M., Katila, A., 2001. Novice drivers' accidents and violations – a failure on higher or lower hierarchical levels of driving behaviour. Accident Analysis and Prevention 33, 759–769.

Mayhew, D.R., Simpson, H.M., Pak, A., 2003. Changes in collision rates among novice drivers during the first months of driving. Accident Analysis and Prevention 35 (5), 683–691.

Moe, D. 1999. Dybdeanalyse av møte- og utforkjøringsulykker på rette strekninger i 80- og 90 soner med død eller alvorlig skade, SINTEF-rapport STF A99559. Trondheim, Norway.

Nolen, S., Engström, I., Folkesson, K., Jonsson, A., Meyer, B., Nygard, B. 2002. PILOT – Vidareutbildning av unga bilförare. Slutrapport [PILOT – Further education of young drivers. Final report]. VTI-Rapport 457. Swedish National Road and Transport Research Institute, Linköping.

Norwegian Public Roads Administration, 2004. Læreplan for klassene B og BE (Syllabus for acquisition of a licence for passenger cars) Directorate of Public Roads, Oslo, Norway (in Norwegian).

Nyberg, A. 2007. The Potential of Driver Education to Reduce Traffic Crashes Involving Young Drivers. Linköping University Medical Dissertation No. 985. Linköping University, Linköping.

OECD, 2006. Young Drivers. The Road to Safety. Joint Transport Research Centre, ECMT and OECD, OECD Publishing, Paris.

Parker, D., Reason, J., Manstead, A., Stradling, S., 1995. Driving errors, driving violations and accident involvement. Ergonomics 38, 1036–1048.

Peräaho, M., Keskinen, E., Hatakka, M. 2003. Driver Competence in a Hierarchical Perspective; Implications for Driver Education, Traffic Research, University of Turku.

Reason, J., Manstead, A., Stradling, S., Baxter, J., Campbell, K., 1990. Errors and violations on the roads: a real distinction? Ergonomics 33, 1315–1332.

Rothengatter, T., 1997. Editorial preface. Applied psychology 46 (3), 221–222.

Sagberg, F., 2000. Novice drivers' crash risk before and after the age limit for driver training in Norway was lowered from 17 to 16 years. TØI- report 498/2000.: The Institute of Transport Economics, Oslo (In Norwegian with summary in English).

Sagberg, F., Bjørnskau, T., 2003. Uerfaren bak rattet. Hva forklarer nye føreres ulykkesreduksjon de første månedene med førerkort? (Inexperienced at the wheel. Errors, driving behaviour, and hazard perception among novice drivers) TØI-rapport 656/2003, The Institute of Transport Economics, Oslo.

Senserrick, T.M., Swinburne, G.C. 2001. Evaluation of an Insight Driver-training Program for Young Drivers. MUARC Report No. 186. Monash University Accident Research Centre, Victoria.

Stene, T., 2005. Er opplæring et godt sikkerhetstiltak? Forebygging av risiko og ulykker gjennom opplæring av trafikantene. Doctoral Thesis at NTNU Norwegian University of Science and Technology 2005:149. Trondheim, NTNU.

Tronsmoen, T., 2008. Associations between self-assessment of driving ability and accident risk among young drivers. Transportation Research Part F: Traffic Psychology and Behaviour 11 (5), 334–346.

Ulleberg, P., 2002. Influencing Subgroups of Young Drivers and Their Passengers – Motivational Influences of Personality Traits on Risk-taking Attitudes and Driving Behaviour. Doctoral Thesis at NTNU Norwegian University of Science and Technology. Trondheim, NTNU.

Ulleberg, P., Rundmo, T., 2002. Risk-taking attitudes among young drivers: the psychometric qualities and dimensionality of an instrument to measure young drivers' risk-taking attitudes. Scandinavian Journal of Psychology 43, 227–237.

Wackerhausen, S. 1997. Apprenticeship, experts and intuition. An Interview with Hubert and Stuart Dreyfus, Department of philosophy, University of California Berkeley. Nordisk Pedagogik, vol. 17(3), pp. 204–207.