

The development and maintenance of driving skills of young mopedists

Since 1st June 1996 a theory certificate is obligatory for Dutch mopedists. To obtain this certificate mopedists have to pass a theoretical exam. The reason for introducing the obligatory theory certificate was to improve the preparation of young mopedists to participate in traffic.

Evaluation research (Van Schagen, 2000) of the effects of the theoretical exam for mopedists showed, however, that although the knowledge level of the mopedists improved, no effect was found of this measure on accident involvement.

In September-November 2000 a test was carried out in the North of Holland to examine if a practical driving course could improve the driving skills of young mopedists. Two groups of young novice mopedists were compared with each other. One group of 25 young drivers followed a 16-hour practical driving course and the other group (21 young drivers) did not. All drivers were in possession of a theory certificate. The two groups were tested on their driving skills in actual traffic conditions about one week before and one week after the practical driving course took place. The results showed that a 16-hour driving course results in a considerable improvement of the vehicle control and traffic behaviour.

Eleven months after this experiment, the two groups were asked for a follow-up measurement of their driving skills. The results were two-sided. Where the group of trainees showed an average driving performance that was at a constant performance level after eleven months, the group of non-trainees had improved their average driving performance to more or less the same level as the trainee-group.

Policymakers to decide upon the possible introduction of an obligated practical driving exam can use the results of this experiment. The results are used both in favour of and against the possible introduction. The practical course seems to accelerate the learning process but is not followed by a further improvement of driving skills. Guiding of the driving career of young mopedists, by means of a long-term educational programme with repeated short tests or feedback moments, can possibly contribute to the acquisition and maintenance of the young mopedists' driving skills.

Sjoerd Houwing
SWOV Institute for Road Safety Research
P.O. Box 170
2260 AD Leidschendam
The Netherlands
Tel: 31-70 31 73 33 3
Fax: 31-70 32 01 26 1

1 Introduction

In the Netherlands the minimum legal age for driving a moped is 16 years. About 70-80 Dutch mopedists are killed annually in traffic accidents. The age-group 16-17 years takes account for more than a quarter of these deaths. In an attempt to decrease moped accidents, the Dutch government introduced a theoretical exam for mopedists as a safety measure in June 1996. Although a practical exam is obligatory for car drivers and motorcyclists, it is not obligatory for mopedists. Evaluation research of the effects of the theoretical exam for mopedists showed, however, that although the knowledge level of the mopedists improved, no effect was found of this measure on accident involvement (Van Schagen, 2000). To improve the driving skills of mopedists it is being considered to introduce a practical moped driving exam.

Research on the effects of practical moped driving training could be used in the debate on introducing a practical moped driving exam. Though results from adjacent fields of studies are known and point at being in favour of introducing a practical moped driving exam, still no statistically significant figures can be given for positive effects of a practical course.

In the autumn of 2000, SWOV conducted an experiment in the North of Holland to examine what the effects of a practical driving course were on the driving skills of young mopedists. The results of this experiment are also reported by Goldenbeld et al. (in press). This article is partly based on the article of Goldenbeld et al. but will discuss the results of the tests in less detail and will therefore be more accessible for the general reader.

By conducting the experiment the following research questions could be answered:

1. Does training lead to a better skill of driving in traffic?
2. Does training lead to a better performance of skills in the vehicle control test?
3. Do differences in driving skill between trained and non-trained drivers diminish over time?
4. Does a traffic insight test give a stronger association with driving competence than the standard knowledge test of traffic rules?

Theoretical background

A theoretical background of the research questions is needed to give some insight in the expected results of our experiment. Theoretical knowledge on skills is described by Rasmussen (1983). He describes three levels of task performance:

- Skill based
- Rule based
- Knowledge based

On the skill-based level incoming information is connected directly to an automatic response that can be performed thoughtlessly (e.g. changing gear).

When there is no automatic response or alternative options are at hand, the behaviour shifts towards rule-based behaviour. At this level, the desired behaviour sequence is chosen, assimilated, and finally performed (e.g. turning right at a crossing on a daily route).

When no rules are available or a person does not want to apply the rules, the behaviour turns into the knowledge-based level. In this case problems have to be thought about in order to interpret them and find a solution (e.g. finding the best route to a new destination). The skill-based level is the most important level to react in times of emergency: in terms of time, mental processes, and energy; the knowledge-based level provides the most and the skill-based level the least pressure (Rasmussen, 1983). Therefore it is important that young mopedists develop driving skills. It is difficult to measure whether the manoeuvres of young mopedist are based on skills or on knowledge. In this study we have measured skills by conducting a vehicle control test and a driving test in traffic. All the tested manoeuvres at five different traffic situations are interpreted as skills.

The importance of vehicle control skills is demonstrated in a study of Wierda (1990). Wierda investigated the extent to which mental capacity needed for vehicle control interfered with general attention capacity. He concluded that novice mopedists lacked elementary vehicle control skills, which made them virtually unable to divide their attention between vehicle control and a secondary detection task.

A study of Steffens et al. (1988) indicates that the skills learned will disappear over time. They found that mopedists drove faster after a year of driving experience and got into more dangerous situations than a year before. This was more so the case for self-taught drivers than for formally trained drivers. With increasing experience, formally trained and self-taught drivers tended to become more alike.

A diminishing of skills over time was also found in the study of Duncan et al. (1991). Experienced drivers performed relatively poorly in aspects of mirror checking, anticipation, and setting safety margins.

Based on these studies, we will expect that in our study also skills will diminish over time.

Many studies indicate a weak or even absent relation between the knowledge of traffic rules and actual traffic behaviour (e.g. Rothengatter, 1981; Van Schagen, Wierda and Brookhuis, 1987; Bächli-Biétry, 1990; Zeedijk et al., 2001; Steffens, Gawatz and Wilmes, 1988).

One of the reasons for this weak correlation may be the type of questioning. Traditional knowledge tests provide subjects with questions on the knowledge of traffic rules and whether they should be applied in a certain situation or not. The Dutch theoretic exam for mopedists exists of 50 questions on knowledge of the rules, traffic insight, responsible traffic behaviour, environment and technical aspects of the vehicle.

In reality, in traffic situations multiple behavioral rules are involved, which are inter-related. When sudden changes in the traffic situation occur, quick reactions are needed and multiple behavioral rules have to be applied within a short time. Based on other studies, the traditional knowledge test used in the Dutch theoretic exam is expected to be related to the actual traffic behaviour of a young mopedist.

In our study we conducted two knowledge tests: the first one is the standard knowledge test that is of the same type as the test for the theoretical mopedists' exam. The second one is a specially developed knowledge test (the traffic insight test) with questions on four behavioral components of two traffic situations.

2 Method

2.1 Design and method

The experimental design used in the experiment was a pre-test post-test design with one experimental and one control group and with a long-term (11 months) follow-up test in both groups.

Table 1 shows the set-up of the test:

Condition	Pre-test (September 2000)	Intervention	Post-test (November 2000)	Follow-up (October 2001)
1: no practical training (21 subjects)	- Vehicle control tests - Driving test in traffic - Questionnaire - Knowledge test - Traffic insight test	No driving course	- Vehicle control tests - Driving test in traffic - Questionnaire - Knowledge test - Traffic insight test	- Driving test in traffic - Questionnaire
2: practical training (25 subjects)	- Vehicle control tests - Driving test in traffic	16-hour driving course	- Vehicle control tests - Driving test in	- Driving test in traffic

subjects)	- Questionnaire - Knowledge test - Traffic insight test	in 4 weeks	traffic - Questionnaire - Knowledge test - Traffic insight test	- Questionnaire
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Table 1: Test set-up for the different measurements.

In this test the participants are divided into two groups. This is done by random selection of matched pairs. The pairs were matched by stratification on the following variables:

- Sex
- Age
- Education level
- Possession of theory certificate in number of months

The selection resulted in the following group samples:

Participant group	Variable	Pre-test September 2000	Post-test November 2000	Follow-up October 2001
Experimental group (training)	Male	14	14	10
	Female	11	11	11
	Total	25	25	21
	Mean age	16.5 years		17.4 years
Control group (no training)	Male	12	12	7
	Female	9	9	6
	Total	21	21	13
	Mean age	16.1 years		17.1 years

Table 2: Participants divided by group and sex (Goldenbeld et al., in press).

The experimental group had to take part in a practical moped driving course of 16 hours spread over four weekly sessions; the other group was used as a control group. In total 50 subjects were selected but four were not able to find free time to participate in the experiment. The other 46 novice mopedists took part in the first two tests. For several reasons (school, holiday, work) only 34 of them joined the follow-up test eleven months later.

The participants were recruited using different types of media. To ensure optimal motivation to show their competence, the subjects were paid €90 for their participation.

For supervising and scoring the driving tests, qualified examiners were used. Their main task in the experiment was to administer the different tests.

Before the experiment started, a small pre-test was conducted to find out if there was a bias between the ratings of the examiners and if they had any problems with scoring the subjects. This pre-test was also useful for the examiners to get familiar with the three routes that were used in the experiment. No serious bias between the examiners was found in the pre-test.

In the experiment, the examiners were also blind to the condition of the subjects, to ensure that the results would be unprejudiced.

2.2 Measurements and tests

In order to find answers to the research questions the examiners had to run a number of tests on the subjects. The first two measurements both contained five tests:

1. Vehicle control tests
2. Driving test in traffic
3. Questionnaire
4. Knowledge test
5. Traffic insight test

These test are described below:

1. Vehicle control tests

The subjects were tested on their vehicle control skills by performing three exercises on a closed training ground owned by a big driving school in a suburb of Leeuwarden. The following exercises were tested: driving in a small circle, braking at 25 km/h, and driving at walking speed. The examiner instructed the participants and judged them on 5-point rating scale going from very bad to very good.

The examiners were also told to give an exam rating. This is a two-point scale with the possible options "passed" and "failed". This rating system is also used in the official Dutch

exam for motorcyclists. A driver will pass when no mistakes have been made on eight different types of situations. In all the other cases the driver will fail to pass the exam.

2. Driving test in traffic

In the experiment three different routes were used to test the driving skills in traffic. These three routes were selected by an examiner and contain different kinds of manoeuvres and traffic situations. The duration of the drive was 30 minutes and a headset was used to steer the subject along the route. The subject was judged on five different traffic situations: driving on straight and curved sections, turning left or right, intersections, overtaking others, and changing lanes. As in the vehicle control test, a 5-point rating scale was used to judge the driving scales.

3. Questionnaire

A questionnaire was designed to get more background information of the participants. Main subjects of the questionnaire were: evaluation of estimating internal and external risks, self-estimated skills, moped driving experience, involvement in traffic accidents, and getting traffic fines.

4. Knowledge test

The standard knowledge test for this experiment consisted of 25 questions about traffic situations presented on a television screen using cd-rom software. Each question had to be answered by "yes" or "no" within a period of 7 seconds. The test is also used as training for the Dutch theoretical moped exam, which is modelled in the same way.

5. Traffic insight test

The traffic insight test was conducted by the examiner and consisted of a structured interview. During the interview, two pictures of a traffic situation were shown to the subject and twelve questions were asked on this situation on four aspects: right-of-way, speed, distance, and position on the road. The questions per situation were divided into: knowledge of the rules, knowledge of the consequences of the rule for own behaviour, and knowledge of the consequences of the rule when the situation changes. The scoring was based on a three-point scale: correct/partly correct/wrong.

2.3 Training

After performing a series of tests, the practical training group had to do a 16-hour training course. The training course was provided by a number of driving instructors. The course consisted of four units:

- Vehicle handling (4 hours);
- Driving in traffic (8 hours);
- Insight training, (3 hours);
- Exam training (1 hour).

The average group consisted of four subjects. The groups were not allowed to be too large in order to let the instructor be able to give every subject the attention needed. Since moped driving training is not obligatory in Holland, the instructors had no previous experience in teaching 16-17 years old to drive a moped.

The course unit vehicle handling was practised on the area of the driving school where the tests were conducted; the other training units were done in real city traffic. The instructors were not acquainted with the possible routes of the post-test so that biases in learning effects by familiarity of the route would be avoided.

2.4 Procedure of the experiment

The experiment was conducted at a driving school in a suburb of Leeuwarden in the North of Holland. After dividing the subjects into matched pairs and randomly putting them into one of the two conditions, appointments were made with the participants to do the tests.

Each test session took about 90 minutes. At first the subjects were tested on the vehicle control skills, and next they participated in a practical driving test in real city traffic. The test driver was followed by the examiner who also rode on a moped and gave direct instructions by an intercom system built into the helmet. After the first two tests, the subjects went back inside the building to continue with the knowledge test and traffic insight test. The session was completed with a questionnaire.

More than half a year after the post-test, letters were sent to ask the participants to join the follow-up measurement. Only half of the participants reacted to the letter so that many participants had to be contacted again by telephone or e-mail.

Unfortunately, it was not possible at the end to get everybody in the follow-up measurement because some of the subjects did not live in the vicinity of the project anymore, others were busy with their school, and some of them were on holiday and could not be reached in time for the last part of the experiment.

The follow-up test consisted of a questionnaire and a driving test in traffic. Since all the participants already knew what they could expect, all the test sessions went very quickly (45 minutes) and without any problems worth mentioning.

3 Results

The results of the experiment are presented in this section by answering the research questions.

1. Does training lead to a better skill of driving in traffic?

Using a repeated measures test, a significant effect of training was found on driving skill. Subjects who participated in the training programme improved in driving skill between pre-test and post-test. The average score at the 5-point rating scale was pre-test 2.3, and post-test 3.1. Subjects who did not follow the course showed no improvement test (av. pre-test = 2.3; av. post-test = 2.2). These effects are shown in Table 3. In line with the first research question, the conclusion is that training improves driving skills.

2. Does training lead to a better performance of skills in the vehicle control test?

A repeated measures test was also used to test the effect of training on vehicle control skills. Subjects who participated in the training programme improved their skills on each of the three tests between the pre-test and the post-test; Subjects who did not follow the course showed no improvement. These effects are shown in Table 3.

Skill	Control group (n = 21)				Experimental group (n = 25)			
	Pre-test		Post-test		Pre-test		Post-test	
	Av.	S. D.	Av.	S. D.	Av.	S. D.	Av.	S. D.
Circle driving	2.4	1.0	2.1	0.7	2.0	0.7	3.0	1.0
Brake trial	2.8	0.8	2.5	0.9	2.3	0.8	3.5	1.0
Driving 5km/h	3.1	0.8	2.8	0.6	3.0	0.8	3.5	0.9
Driving in traffic skill	2.3	0.5	2.2	0.4	2.3	0.6	3.1	1.0

Table 3: Average skills of vehicle control and driving in traffic at pre-test and post-test for control (no training) and experimental group (training) (Goldenbeld et al., in press).

Despite the large improvement in driving skills, a training of 16 hours is still not sufficient for the required driving level to pass an exam, since almost 60% of the subjects would fail to pass the exam.

Based on these results, it is concluded that training leads to a better performance in the vehicle skills test. However, a 16-hour training programme will not be sufficient to improve the skills on a required level to pass an exam.

3. Do differences in driving skill between trained and non-trained drivers diminish over time?

To examine the effect on the average driving skills score per group (course and no-course), a T-test was conducted. As expected, the skill level of the participants of the two groups converged after 11 months. Whereas the training group stayed at more-or-less the same level, the skills of the non-training group improved through driving experience. This effect is shown in Figure 1. No differences in driving experience were found for both groups for the route and the city where the routes were set out.

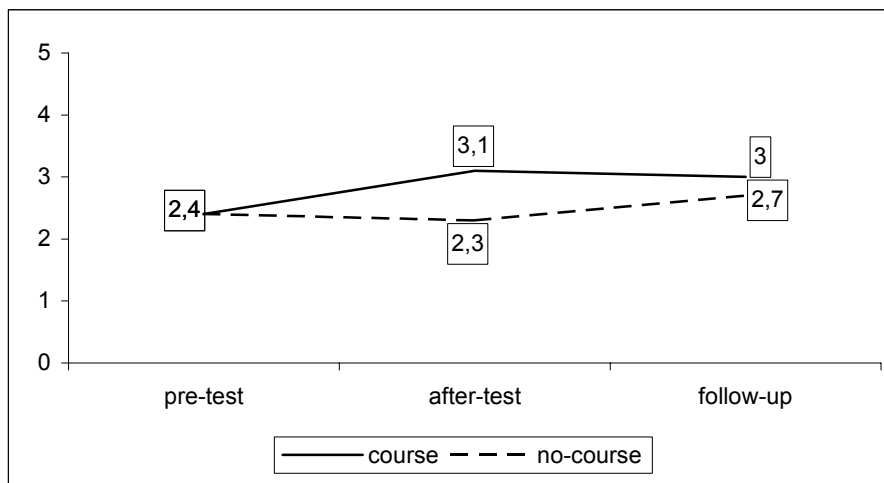


Figure 1: The average driving skill per condition.

Figure 1 shows that driving skills learned in a course seem to fade away within a year (the average skill score decreases from 3,1 to 3,0). However, this effect turned out to be not statistically significant.

The percentage of drivers that succeeded in passing the exam diminished therefore to almost 20%. However, the difference was not statistically significant. The non-course group remained, as in the first measurement, below the 10%. These results are shown in Table 4.

Condition	Pre-test		Post-test		Follow-up	
	% passed	n passed	% passed	n passed	% passed	n passed
Course (n = 21)	5%	1	43%	9	19%	4
No course (n = 14)	7%	1	0%	0	7%	1
Total (n = 35)	6%	2	26%	9	14%	5

Table 4: Absolute numbers and percentage mopedists who passed the practical exam.

Figure 2 shows the percentage of participants who passed their practical exam per group. The arrows indicate a statistically significant difference between two points. No statistical differences are found between other points.

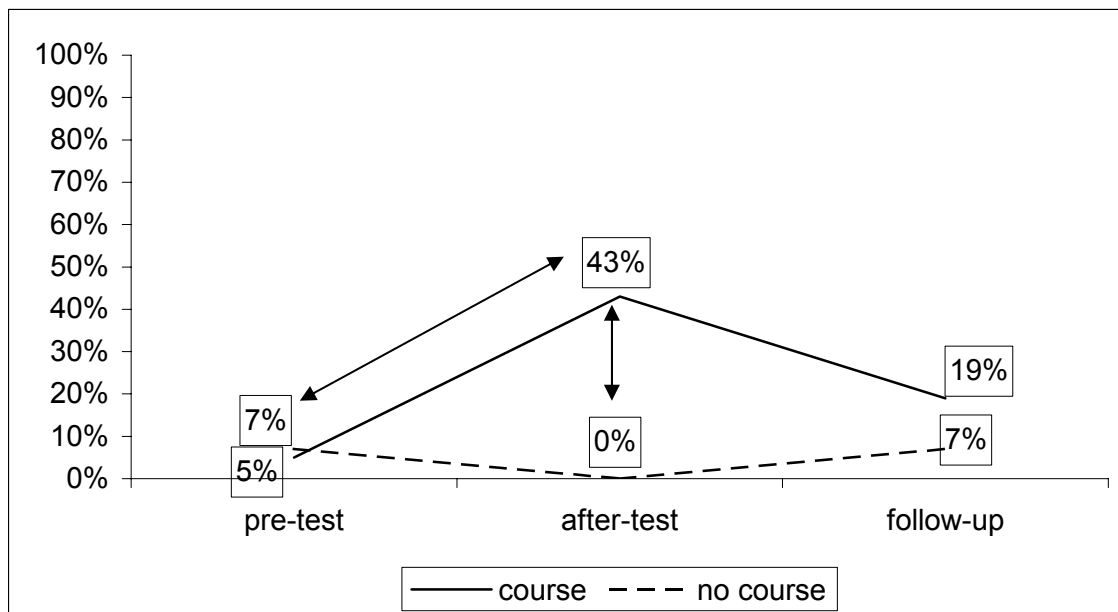


Figure 2: Percentage participants who passed the practical exam per group.

When Figure 2 is compared to Figure 1, it is noticeable that the positive effect of driving experience on vehicle control skills in the follow-up measurement for the non-training group is not present in the percentage of drivers who passed their practical exam. The percentage of drivers that followed a training and passed their exam in the follow-up test was also much lower than would be expected, based upon their scores in the average driving skills. Therefore it may be concluded that on some points the skills were improved by experience, and that other skills faded away through time. The improvement of skills by experience however seems not to be good enough to pass a practical exam.

Based on the findings, the answer to the third research question is that differences between trained and non-trained mopedists do diminish over time

4. Does a traffic insight test give a stronger association with driving competence than the standard knowledge test of traffic rules?

Using a Pearson's correlation test, no significant correlation was found between the standard knowledge tests and driving achievement, vehicle control skills, and the traffic insight test. However, significant correlation was found between mopedists who performed better at the traffic insight test and at the driving test in traffic ($r = 0.51$; $p < 0.000$).

It can therefore be concluded that the traffic insight test gives a stronger association with driving competence than the standard knowledge test of traffic rules.

4. Discussion

This experiment was conducted to study some effects of a practical moped driving training. Training young mopedists will lead to better skills in driving in traffic. The subjects developed better driving abilities. A practical moped driving training results in a considerable acceleration and optimization of the learning process. However, young mopedists will develop their own driving style after the training or exam. Some skills deteriorate and others improve. This results in an average driving skills level that will be more-or-less the same in the long term. The pass rate on the driving test shows a fall in the long term that is greater than would be expected when compared to the development of skills in the long term. In the future, guiding the driving career of young mopedists by means of a long-term educational programme with repeated short tests or feedback moments may possibly contribute to the acquisition and maintenance of the young mopedists' driving skills.

A significant positive effect is found for training the driving skills in the vehicle control test. This is tested only on a short-term base.

No significant correlation was found between the standard knowledge test and driving achievement. However, significant correlation was found between mopedists who performed better at the traffic insight test and the driving test in traffic.

These results can be used both for and against the introduction of an obligatory practical moped exam in the Netherlands. After a year of experience in traffic, the driving skills of the experimental group are no longer better than those of the control group. Opponents of the introduction of a moped driving exam stress that it is a lot of effort and a waste of money to invest in a measure that will only show a positive effect for a year.

However, moped driving careers last mostly only 2 to 4 years. Then mopedists tend to switch over to car driving. The improvement of a year can then be considered as a considerable contribution to safer driving behaviour of young mopedists.

A problem that would probably arise at the introduction of an obligatory practical moped driving exam are the costs. These include not only the cost for extra trained examiners and for the training of driving teachers, but also the costs payed by the young mopedists who want to follow a course in order to pass their exam. If a government will not subsidize the courses, young mopedists will be more likely to choose for driving without a moped driving certificate so that the total effect of the introduction will be smaller than expected.

A possible solution would be an integration of moped and car driving education, where people who followed a moped driving training and passed the exam should be allowed to skip certain parts of car driver training and examination.

This experiment on the effects of practical moped training was conducted on a small scale. To investigate the effects of moped driving training in terms of accident reduction, research on a larger scale is needed.

Literature

Bächli-Biétry, J. (1990). Erfolgskontrolle von theoretischem Verkehrssinunterricht im Verlauf der Fahrausbildung. (Evaluation of theory instruction in driver education). Bfu Report 15. Schweizerische Beratungstelle für Unfallverhütung bfu, Bern. [In German]

Duncan J., Williams, P. and Brown, I. (1991). Components of driving skill: experience does not mean expertise. *Ergonomics*, 24, 919-937.

Goldenbeld, Ch., Twisk, D.A.M. and Craen S., de. (In press). Short and long term effects of mopedist training: a field experiment. *Transportation Research Part F. Traffic Psychology*.

Rasmussen, J. (1983). Skills, rules and knowledge; Signals, signs and symbols, and other distinctions in human performance models. In: *IEEE Transactions on systems, Man and Cybernetics*, Volume SMC-13, Nr 3, p257-266.

Rothengatter, J. A. (1981). Traffic safety education for young children. An empirical approach. Swets & Zeitlinger, Lisse.

Schagen, I. van (2000). De verkeersonveiligheid in Nederland tot en met 1999. (The road safety in the Netherlands until 1999). Report D-2000-15. SWOV Institute for Road Safety Research, Leidschendam. [In Dutch]

Schagen, I. van, Wierda, M. and Brookhuis, K.A. (1987). Kennis en attituden van fietsers en bromfietsers. (Knowledge and attitudes of cyclists and moped rider). Report VK 87-16. Traffic Research Centre, Groningen. [in Dutch]

Steffens, U., Gawatz R. and Wilmes, G. (1988). Wirksamkeit von Mofakursen. Heft 67. Bundesanstalt für Strassenwesen Bast, Bergisch Gladbach. [In German]

Wierda, M. (1990). Riding a moped: acquisition of basic skills and mental effort. In: *Proceedings of Road Safety and Traffic Environment in Europe, 26-28 september 1990, Gothenburg*. VTI report 364A, pp.1-9. Swedish Road and Transport Research Institute VTI, Linköping.

Zeedijk, M.S. Wallace, L., Carcary, B., Jones K. and Larter K. (2001). Children and road safety: Increasing knowledge does not improve behaviour. *British Journal of Educational Psychology*, 71, 573-594.