# TRAFISAFE – Parental feedback for novice drivers
## Austrian Report

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## Austrian report

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Finnish Transport Safety Agency
Liikenteen turvallisuusvirasto Trafi
Trafiksäkerhetsverket Trafi
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# ALKUSANAT

Tutkimuksen kohteena olivat nuorten mieskuljettajien korkeat onnettomuusluvut. Halusimme nähdä, voidaanko onnettomuuksia vähentää lisäämällä vanhempien antamaa palautetta. Toinen selvitettävä kysymys oli, hyväksyvätkö vanhemmat palautteenantovälineeksi nykyaikaisen tekniikan.

Tähän yhteistutkimuksena toteutettuun hankkeeseen osallistuivat itävaltalainen Test & Training International Planning and Service GmbH sekä Liikenteen turvallisuusvirasto Trafi. Tutkimuksen tekivät itävaltalaiset tri Michael Gatscha ja Claudia Grand. Hanketta ohjasivat Jussi Kiuru ja tri Sami Mynttinen sekä tri Michael Gatscha. Välineet kehitti tri Andrew Durrant Nottinghamissa sijaitsevasta Race Technology -yrityksestä, joka vastasi myös tiedonkeruusta.

Haluan lämpimästi kiittää ohjausryhmän puolesta kaikkia osanottajia mielenkiintoisista vuosista hankkeen parissa. Opimme sen aikana paljon. Lopulta näimme myös valoa lupaavien tulosten muodossa.

Helsingissä syyskuussa 2016

Sami Mynttinen

Johtava asiantuntija, Suomen liikenteen turvallisuusvirasto Trafi

# FÖRORD

Den här studien fokuserade på olyckstoppen för unga och oerfarna manliga förare. Vi ville ta reda på om antalet olyckor kunde minskas genom att utöka föräldraresponsen. En annan fråga var om föräldrarna är villiga att acceptera modern teknologi för att ta emot responsen.

Avtalsparter i forskningsprojektet var det österrikiska företaget Test & Training International Planning and Service GmbH och Trafiksäkerhetsverket. Forskningen genomfördes av doktor Michael Gatscha och Claudia Grand från Österrike. Projektet leddes av Jussi Kiuru, doktor Sami Mynttinen och doktor Michael Gatscha. Verktygen som användes i studien utvecklades av doktor Andrew Durrant vid Race Technology, Nottingham, som också ansvarade för datainsamlingen.

På ledningsgruppens vägnar vill jag framföra ett varmt tack till alla deltagare för de intressanta projektåren. Vi har lärt oss mycket genom vårt arbete. I slutändan såg vi också en ljusning i form av lovande resultat.

Helsingfors, september 2016

Sami Mynttinen

Chief Adviser, Trafiksäkerhetsverket Trafi

# FOREWORD

Young male novice drivers' accident peak was a target in this study. We wanted to see, if it could be reduced by the increased parental feedback. Another question was, if the parents are willing to accept modern technology in getting the feedback.

The contracting parties in this consortium research project were the Austrian Test & Training International Planning and Service GmbH and the Finnish Transport Safety Agency. The research was made by Austrians Dr. Michael Gatscha and Mrs. Claudia Grand. Steering of the project was made by Finnish Mr. Jussi Kiuru and Dr. Sami Mynttinen as well as Dr. Gatscha. The instruments were developed by Dr. Andrew Durrant from the Race Technology, Nottingham, who was also in charge for the data collection.

On behalf of the steering group I want to warmly thank all of the participants for the interesting years with this project. We learned a lot during the work. And finally, we were able to see the light in terms of promising results.

Helsinki, September 2016

Sami Mynttinen

Chief Advisor, Finnish Transport Safety Agency Trafi

# Index

## ABSTRACT

The purpose of this research study was to evaluate the impact of parental feedback on novice driver behaviour in the first six months of driving, aided by a telematic-based data recording and feedback system. Therefore, a sample of 74 pairs of novice drivers and their parents was recruited, half of the sample was randomly allocated either to an intervention group (”IG”) or a control group (”CG”).

An in-vehicle data logger was installed in novice driver’s vehicles to obtain safety-relevant data of driving behaviour. Collected parameters were vehicle location, speed choice and g-force based driving manoeuvres, such as cornering, braking, and accelerating. Collected data was automatically transferred to a web-server after trips were finished; data were processed and aggregated.

Participants of the IG received weekly email safety reports and obtained personal login credentials to access driving data, thus allowing parents to provide feedback about their kids´ solo driving.

Safety-relevant data consisted of type and counts of harsh driving manoeuvres as well as speeding information within different speed zones, classified into three safety categories: green (cautious driving), yellow (moderate driving) or red (aggressive driving).

Additionally, questionnaires for both novice drivers and parents were used to analyse acceptance among users.

Results indicate that parental feedback aided by telematic data has beneficial effects on risky teen driving as risk scores, summarizing g-force based events, were lower in the IG once feedback was established. Statistical differences or at least statistical trends were found from the third month of the observation period onwards. Regarding general speed behaviour for single speed limit zones, no statistical significant differences could be observed.

Questionnaire results among novice drivers suggest that the used approach subjectively affects individual driving style, which was supported by telematic data. Among parents, questionnaire data showed a good acceptance of the implemented tools.

Generally, authors conclude that the most promising intervention strategy to lower novice driver risk is a combination of approaches, such as coordinated programmes for accompanied driving prior to licensing involving parental feedback and telematic technology. After licensing, incentivised insurance schemes featuring parents with as much input and involvement as possible, seem most promising towards improving young driver safety.

# TIIVISTELMÄ

Tämän tutkimuksen tarkoituksena oli arvioida vanhempien antaman palautteen vaikutusta nuorten kuljettajien käyttäytymiseen kuuden ensimmäisen ajokuukauden aikana. Apuna käytettiin telematiikkapohjaista tiedonkeruu- ja palautejärjestelmää. Mukaan pyydettiin koeryhmä, johon kuului 74 nuorta kuljettajaa vanhempineen. Puolet koeryhmästä sijoitettiin sattumanvaraisesti testiryhmään ja puolet vertailuryhmään.

Nuorten kuljettajien autoihin asennettiin tiedonkeruulaite, jonka avulla saatiin turvallisuuteen vaikuttavia tietoja ajokäyttäytymisestä. Kerätyt parametrit olivat ajoneuvon sijainti, nopeusvalinta ja g-voimaan perustuneet ajoliikkeet, kuten kaarreajo, jarrutus ja kiihdytys. Kerätyt tiedot siirrettiin ajomatkojen jälkeen automaattisesti verkkopalvelimelle, jonka jälkeen ne käsiteltiin ja koottiin yhteen.

Testiryhmän osanottajat saivat viikoittain sähköpostitse turvallisuusraportit ja henkilökohtaiset kirjautumistiedot ajotietojen tarkastelua varten. Näin vanhemmilla oli mahdollisuus antaa lapsilleen palautetta yksinajosta.

Turvallisuuteen liittyviin tietoihin sisältyi äkkinäisten ajoliikkeiden tyyppi ja määrä sekä nopeustiedot eri nopeusalueilla jaettuna seuraaviin kolmeen turvallisuusluokkaan: vihreä (huomioiva ajo), keltainen (maltillinen ajo) tai punainen (aggressiivinen ajo).

Lisäksi sekä uusille kuljettajille että vanhemmille tehtiin kysely, jonka avulla arvioitiin menetelmän vastaanottoa käyttäjien keskuudessa.

Tulokset osoittavat, että vanhempien palaute yhdistettynä telematiikkatietoihin vaikutti hyödyllisesti nuorten riskialttiiseen ajamiseen, sillä g-voimaan perustuvista tapahtumista laskettavat riskipisteet olivat alhaisemmat testiryhmässä palautteen antamisen jälkeen. Tilastollisia eroja tai vähintäänkin tilastollisia suuntauksia havaittiin tarkastelujakson kolmannesta kuukaudesta eteenpäin. Merkittäviä tilastollisia poikkeamia ei voitu havaita koskien yleistä nopeuskäyttäytymistä yksittäisillä nopeusalueilla.

Nuorten kuljettajien keskuudessa tehdyn kyselyn tulokset viittaavat siihen, että käytetty lähestymistapa vaikuttaa subjektiivisesti yksilölliseen ajotapaan ja telematiikkatiedot tukevat tätä. Vanhempien osalta kysely osoitti käytettyjen työkalujen hyvää vastaanottoa.

Yleisesti ottaen tekijät päättelivät, että lupaavin tapa vähentää nuorten kuljettajien riskejä liikenteessä on eri menetelmien yhdistelmä, kuten valvotun ajamisen koordinoidut ohjelmat ennen ajoluvan saamista sisältäen vanhempien palautteen sekä telematiikkatekniikan. Ajoluvan saamisen jälkeen lupaavimmilta keinoilta nuorten kuljettajien turvallisuuden parantamisessa näyttävät kannustavat vakuutusjärjestelmät, jotka antavat vanhemmille mahdollisimman paljon vaikutus- ja seurantamahdollisuuksia.

# SAMMANFATTNING

Syftet med studien var att utvärdera effekten av föräldrarespons på körbeteendet hos oerfarna förare under deras första sex månader bakom ratten, med hjälp av ett telematikbaserat datainsamlings- och responssystem. För studien rekryterades 74 par oerfarna förare och deras föräldrar. Deltagarna indelades slumpmässigt i en interventionsgrupp och en kontrollgrupp.

En dataregistreringsanordning installerades i de oerfarna förarnas fordon för att samla säkerhetsrelevanta data om deras körbeteende. Data som samlades in var fordonets geografiska position, körhastighet och körmanövrar baserade på g-kraft, såsom att ta kurvor, bromsa och accelerera. Insamlade data överfördes automatiskt till en webbserver efter avslutad resa, och dessa data behandlades och sammanställdes.

Säkerhetsrapporter skickades ut till deltagarna i interventionsgruppen varje vecka och de fick personliga användarnamn och lösenord för att få tillgång till de unga förarnas kördata, så att föräldrarna kunde ge respons på hur barnen körde på egen hand.

Säkerhetsrelevanta data omfattade typen av och antalet hårda körmanövrar samt hastighetsinformation i olika hastighetszoner, som indelades i tre säkerhetskategorier: grön (varsam körning), gul (sansad körning) eller röd (aggressiv körning).

Enkäter riktade till både de oerfarna förarna och föräldrarna användes också till att analysera hur studien accepterades av användarna.

Resultaten visar att föräldrarespons med stöd av telematikdata har en positiv inverkan på riskfyllt körbeteende bland unga, eftersom riskpoängen för manövrar baserade på g-kraft totalt var lägre i interventionsgruppen när responssystemet hade etablerats. Statistiska skillnader eller åtminstone statistiska trender kunde observeras från och med den tredje månaden i observationsperioden. Inga statistiska skillnader kunde observeras i fråga om den allmänna körhastigheten i enskilda hastighetsbegränsningszoner.

Resultaten av enkäterna riktade till de oerfarna förarna antyder att metoden subjektivt påverkar den individuella körstilen, vilket också stöddes av telematikdata. Enkätresultaten visade att föräldrarna accepterade verktygen som användes.

Allmänt kunde vi dra slutsatsen att den mest lovande interventionsstrategin för att minska risken bland oerfarna förare är en kombination av metoder, såsom samordnade program där man kör med följeslagare innan man får körkort, inklusive föräldrarespons och telematikteknik. Efter att man fått körkortet verkar system med fördelaktiga försäkringar, där föräldrarna har så stort ansvar och engagemang som möjligt, vara det mest lovande sättet att förbättra säkerheten bland unga förare.

# EXECUTIVE SUMMARY

Young drivers are vastly over-represented in accident statistics. This fact remains valid globally until today as traffic crashes are the biggest killer of young persons aged 17-24, i.e. the age bracket where most people obtain a driving license and start solo driving.

Countermeasures are sought to tackle the issue of young driver accidents. One promising action potentially lies in merging telematic technology with feedback activities. Recent technical developments allow for affordable safety monitoring systems which are designed to aggregate and process driving data for parental feedback actions, thus potentially increasing young driver safety.

The aim of the present research study was to evaluate the impact of parental feedback on novice driver behaviour in the first months of driving, aided by a telematic-based data recording and feedback system.

**Technology**

An in-vehicle data logger was visibly installed in participants´ vehicles via 12V connection to the cigarette lighter. Hence no workshop or trained technician was required to install the equipment. Beside the data logging function, the device was also used for driver identification and feedback about the state of the system during driving.

The data logger detects movement and uses this information to wake up, start, and stop trips. The data logger records position and speed via GPS at a resolution of 1 Hz and accelerometer data. The built-in accelerometers are capable of measuring lateral and longitudinal acceleration (up to a maximum of 2g each) of the vehicle with an update rate of 100Hz. The data logger filters the acceleration with a -3db bandwidth of 10Hz and sub sample at 20Hz.

The in-vehicle data logger transmits raw data to a web server where procedures such as calculating risk indices, % of speeding are carried out. The transferred data consists of:

- Unit serial number
- GPS-based data: position, speed and direction (1Hz)
- Accelerometer data, both longitudinal and lateral (20Hz)
- Driver ID
- Information, if power supply has been removed

A project-specific website was set up to display aggregated safety data, summary statistics were indicating the trip distance, the realised maximum and average speed, the trip duration, for how long the vehicle was stationary and who was the driver.

The more detailed information consisted of driving dynamic variables, such as number and severity of driving manoeuvres, such as harsh cornering, braking or acceleration as well as speeding behaviour within the five most common speed zones.

## Method

Subjects were recruited with the help of co-operating driving schools located in Lower Austria, personal meetings were held to convey information for study procedures and participant requirements.

The participants of the study were chosen to be male novice drivers, between 17 and 19 years old and should have between at least one but not more than four months of solo driving experience after passing the category B driving test.

Another requirement for taking part in the study was that subjects should have passed their driving test within an accompanied driving scheme, denominated “L17” in Austria.

As regards car possession, participants could use their own or the family´s car for study participation. Furthermore, only participants driving on a frequent basis, i.e. at least 200 km per month were selected, and subjects´ parents should have internet access via PC and/or mobile phone.

If novice drivers chose to take part in the study, they would get an obligatory education module for free, a feedback drive which has to be carried out within the 2$^{nd}$ phase training in Austria. The equivalent value of the feedback drive module is about 130 Euros.

Thus, a sample of 74 pairs of novice drivers and their parents was recruited, half of the sample was randomly allocated either to an intervention group (”IG”) or a control group (”CG”).

Participants of the IG received weekly email safety reports and obtained personal login credentials to access driving data, thus allowing parents to provide feedback about their kids´ solo driving.

Following the screening procedure carried out by driving school staff, information sessions for novice drivers and their parents were held. During these sessions, parents of the IG were informed about the role of feedback in the learning process and were taught about the benefits of rewarding good driving behaviour. Also the aspects of using the data logger as a means to alter aggressive behaviour were openly discussed, i.e. which kind of consequences are appropriate if improper driving is recorded. Other factors, such as peer pressure or tendencies of male teen drivers to “show off” were discussed, specifically in the light of the provision of feedback. However, it was clearly pointed out, that the feedback system should not be understood as an instrument for spying in the sense of “big brother” but should rather be grasped as a supporting learning tool which helps to increase safety.

After installation of the in-vehicle data logger, participants of both groups did not receive any feedback during the first driving month of the study. After one month of driving with the in-vehicle data logger, the login data for the feedback website was sent to IG parents and the weekly e-mail summary report was started to be sent.

Subsequent to the observation period of a total of six months, the data logger was deinstalled and two types of questionnaires were filled out. One questionnaire was sent to novice drivers of both the IG and CG, the second questionnaire aimed at IG parents.

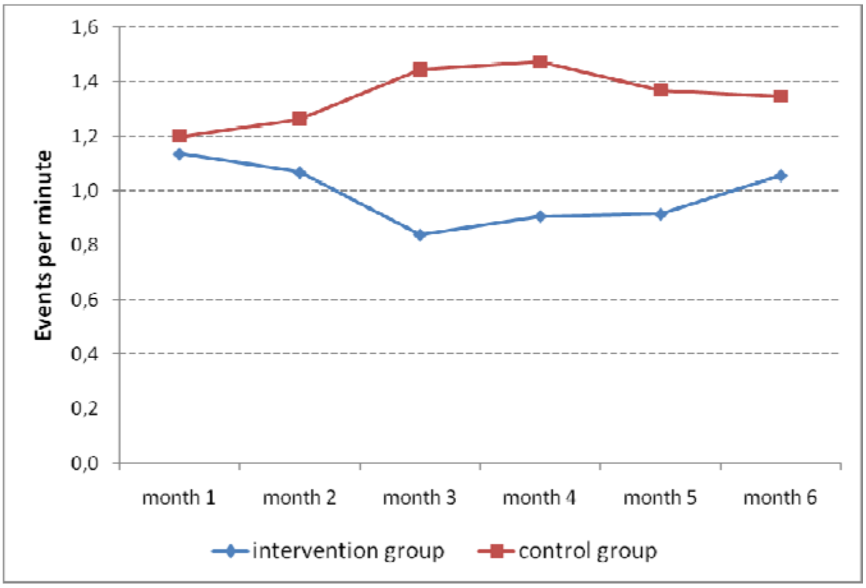
The novice driver questionnaire consisted of questions regarding socio-demographic variables and driving behaviour characteristics and was primarily used to determine, whether the random allocation of subjects to one of the investigated groups was successful or not.

The second questionnaire for parents focused on the views and opinions and on the usability of the website tool as well as acceptance and implementation issues of the whole concept, i.e. the combination of ITS technology with parental involvement during the early post-license phase of novice drivers.

**Results**

As regards comparability and randomisation, results deriving from both driving and questionnaire data, it was concluded that participants of both groups were similar.

For driving behaviour, a normalised event rate index was calculated based on harsh driving manoeuvres, expressing a sum of occurring events per minute of driving. Data was aggregated over the observation period for both groups in order to compare potential different developments of risky driving over time, where a higher index value represents a more undesirable driving style. The following graph depicts the development of the averaged event rate index for both groups over time:



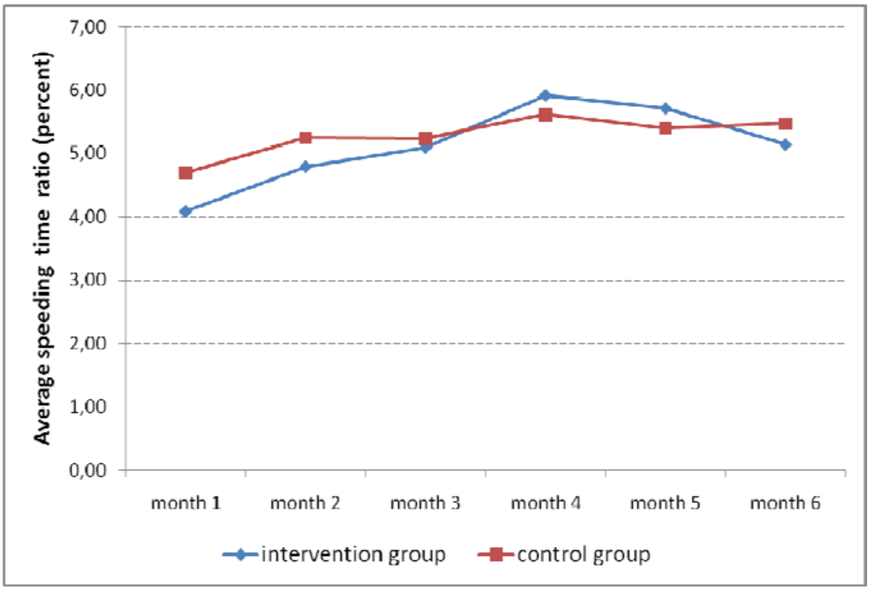

Averaged Event Rate Index per month for each group

The illustration shows average event rates as squares for each observation month. The development suggests differing progress over time for the groups, where the group receiving feedback performs towards a more favourable direction.

At project start, both groups perform quite evenly. Difference occur from month two onwards, where the novice drivers of the IG started to receive parental feedback. Statistically significant differences, or at least statistical trends, were found from the third month onwards.

These findings propose that over the first months of driving, parental feedback aided by telematic data has beneficial effects on driving. Risky teen driving develops in a different manner if parents are involved in their kids driving in such a way that from the beginning of feedback implementation, risk scores clearly decrease.

General speed behaviour was measured by a speeding time ratio, relating the time of speed below and above the posted speed limit. Aggregated monthly data was used to calculate comparisons in this respect. The figure below shows the development during the project duration.




**Averaged speeding time ratio per month for each group**

Average speeding time ratio ranged approximately between 4 and 6 percent for both groups over the observation period. Statistical procedures revealed. Findings show that the general speed behaviour is statistically identical for both groups over the period under consideration as no significant differences could be detected. A more precise analysis regarding different speed zones between the groups was made. Statistical comparisons show no significant differences between the groups, independent of analysed speed zone and month. The latter result is in line with previous findings, suggesting that general speed choice is vastly depending on external factors, such as site characteristics and traffic density at least most of the time.

Post-trial questionnaire results among novice drivers imply that the used approach subjectively affects individual driving style, which was aided by telematic data.

A high acceptance of the used system was indicated by post-trial questionnaires among IG parents. Both the email summary and more detailed website were used on a regular basis by most of the participants. An interesting potential side effect could be observed as parents claimed to think about own driving behaviour as well by the usage of the telematic system. Voluntary application of a system as used in this study was described as useful within the context of first months of teen driving, not only for the post-license period, but also before licensing. Moreover, a large share of parents would also exchange the feedback drive, which is part of the 2$^{nd}$ phase education model in Austria, for usage of a telematic system instead.

Asked participants also declared that they would appreciate an incentivised insurance scheme for their kids using a telematic system after licensing. In this context, insurance companies could support or partly substitute parental involvement as consequences of aggressive behaviour would have negative monetary side effects for novice drivers.

Generally, authors conclude that the most promising intervention strategy to lower novice driver risk is a combination of several approaches, such as coordinated programmes for accompanied driving prior to licensing involving parental feedback and telematic technology. In the first months of solo driving after licensing, insurance discount schemes, in combination with as much parental involvement as possible, seem promising for novice driver safety.

## List of figures

# List of tables

## Definitions, Acronyms and Abbreviations

| Definition / Acronym / Abbreviation | Description |
| --- | --- |
| IG | Intervention group: the group in this research study that receives the intervention being tested. Intervention means getting feedback from parents regarding safety-relevant driving style and behaviour in traffic. The underlying information source for the parental feedback stems from weekly summary safety reports and/or the use of safety-relevant information from the project website. |
| CG | Control group: the group in this research study that does not receive the intervention being studied. This group is compared to the group that receives the intervention (i.e. parental feedback), to see if and how the intervention works. |
| P-Value | In statistical testing, a result is deemed statistically significant if it is so extreme that such a result would be expected to arise simply by chance only in rare circumstances. Hence the result provides enough evidence to reject the null hypothesis of 'no effect'. A fixed number, most often 0.05, is referred to as a significance level.<br><br>In the current study, the used threshold level of the p-value was between 0.05 and above 0.01. It was assessed as significant and marked with one asterisk beneath the value. If a p-value equals 0.01 or below, the p-value was regarded as highly significant, indicated by two asterisks. |
| Effect size:<br>Cohen´s d and Eta² | An effect size is a quantitative measure of the strength of a phenomenon. The reporting of effect sizes facilitates the interpretation of the substantive, as opposed to the statistical, significance of a research result.<br><br>Cohen's d is defined as the difference between two means divided by a standard deviation for the data. The effect size given by “d” is conventionally viewed as small with a value 0.2, medium with 0.5 and large with a value 0.8<br><br>Eta squared is a measure of effect size for use in ANOVA or ANCOVA procedures. As a rule of thumb, .02 is regarded as a small effect, .13 as a medium and .26 as large effects. Source: https://en.wikiversity.org/wiki/Eta-squared |
| GDE | Goals for Driver Education |

# 1 Introduction

## 1.1 The problem of young drivers

### *1.1.1 Age and experience*

Young drivers are vastly over-represented in accidents statistics. This fact remains valid globally until today as traffic crashes are the biggest killer of young persons aged 17-24, i.e. the age bracket where most people obtain a driving license and start solo driving.

It is well understood that the elevated risk young drivers have for accident involvement is due to lack of experience, characteristics associated with youthful age, and the interaction between these two factors. All beginners are by definition inexperienced, and inexperience is known to be a crash risk factor whatever the starting age. The figure below examines the relationship between age and experience with example data from the UK (Wells et al., 2008 cited in Emmerson, 2008):

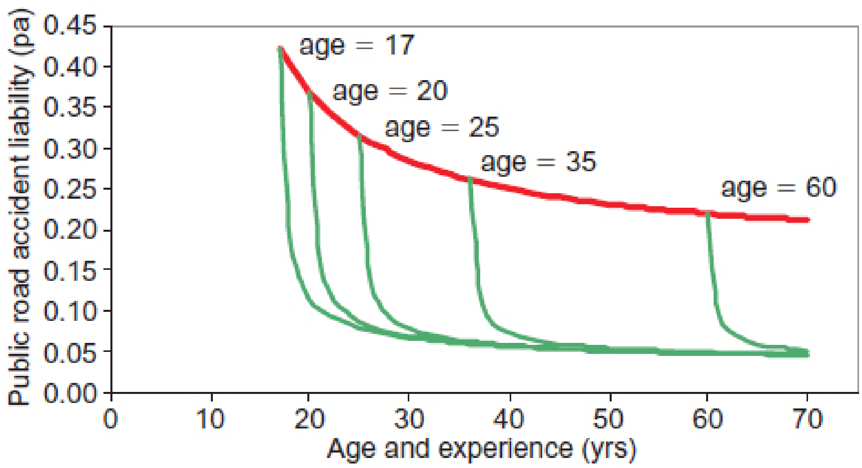



**Figure 1: Age and experience, from Emmerson 2008**[1]

The illustration shows that first few years after licensure are at high risk of post-test independent driving, highest in the first months and subsequently decreasing steadily. The figure also suggests that there is a continuum of age associated risk.

A number of studies have found that the first 1,000 kilometres driven by a new driver may be the most important for reducing collision risk (Helman et al., 2010). After novice drivers gain such amount of post-licence experience, they begin to show physiological responses to developing road hazards presented in video clips similar to those shown by experienced drivers who have three or more years of post-licence driving (Kinnear et al., 2009, in Helman et al., 2010).

Two conclusions can be drawn based on the presented correlation: Firstly, the risk is higher when persons begin driving early (age effect), although the accident risk drops off more quickly (experience effect) compared to older beginner drivers.

[1] Note, these data are presented for respondents with an average of 7,500 miles per annum. Source: unpublished data from Cohort Study II (Wells et al., 2008)

Secondly, although “entry risk” is lower for older beginning drivers, they will not reach the low risk level after years of driving compared to persons who started driving earlier.

### 1.1.2 Factors moderating young driver risk

Driving circumstances such as driving late at night is high risk (e.g. Williams & Preusser, 1997), driving with young passengers in the car (e.g. Chen at al., 2000), and the driving environment (rural/urban) play a role in accident involvement of young novice drivers as well.

However, there are factors associated with young persons living situations which play a role in accident involvement, as characteristics of adolescence may e.g. include an appetite for strong sensations and excitement, emotionality, sometimes poor judgment as well as decision making.

A taxonomy worth mentioning in this respect is the widely used GDE-matrix Hattaka et al. (1999, 2002, 2003), based on a four-level hierarchical approach firstly suggested by Keskinen (1996), who altered Michon´s (1985) three level hierarchical model of driving tasks and driving behaviour levels, i.e.

1. strategic level (high): driving tasks and behaviour are linked to, for example, planning and preparing for a journey, which route to take, and the chosen departure time;
2. tactical level (intermediate): driving tasks and behaviour are linked to situations connected to the driving itself;
3. operational level (basic): driving tasks and behaviour are connected to situations at a given moment,

by adding a fourth level, known as “Goals for Life and Skills for Living”. This uppermost level does not actually contain any driving tasks by itself or deals with actual driving behaviour, but is concerned with the more lasting driver characteristics such as personality, group identification, age, etc. (Table 1)

**Table 1: The GDE matrix, adpated from Hattaka et al. (2003)**

| | Knowledge and Skill | Risk Increasing Aspects | Self-Assessment |
|---|---|---|---|
| Goals for Life and Skills for Living | Understanding the importance of lifestyle, age group, culture, social circumstances, etc. | Understanding the importance of sensation seeking, risk acceptance, group norms, peer pressure, etc. | Understanding the importance of introspection, competence, personal preconditions for safe driving, impulse control, etc. |
| Goals for, and Context of Driving | Understanding the importance of modal choice, time-of-day, motives for driving, route planning, etc. | Understanding the impact of alcohol, fatigue, low friction, rush hour traffic, peer-age passengers, etc. | Understanding the importance of personal motives, self-critical thinking, etc. |
| Driving in Traffic | Mastering traffic rules, hazard perception, etc. Automating elements of the driving process. Cooperating with other drivers. Etc. | Understanding the risks associated with disobeying rules, close-following, low friction, vulnerable road users, etc. | Calibration of driving skills, developing a personal driving style, etc. |
| Vehicle Control | Mastering vehicle functioning, protective systems, vehicle control, etc. Understanding the impact of physical laws. | Understanding risks associated with non-use of seat belts, breakdown of vehicle systems, worn-out tires, etc. | Calibration of car control skills |

The hierarchical philosophy in the taxonomy allows the fundamental assumption that drivers´ characteristics and personality traits on this level can influence driver´s behaviours at all lower levels. As far as these lower levels are concerned, this implies knowledge and skills relevant to the ability to deal with the tasks at each level.

It is assumed that parental involvement influences the novice driver on this highest level of the GDE-matrix, thus potentially helping to create safer drivers by fostering responsible driving.

A more recent comprehensive overview of contributing factors for accident rates of novice drivers is presented by Vlakveld (2011):

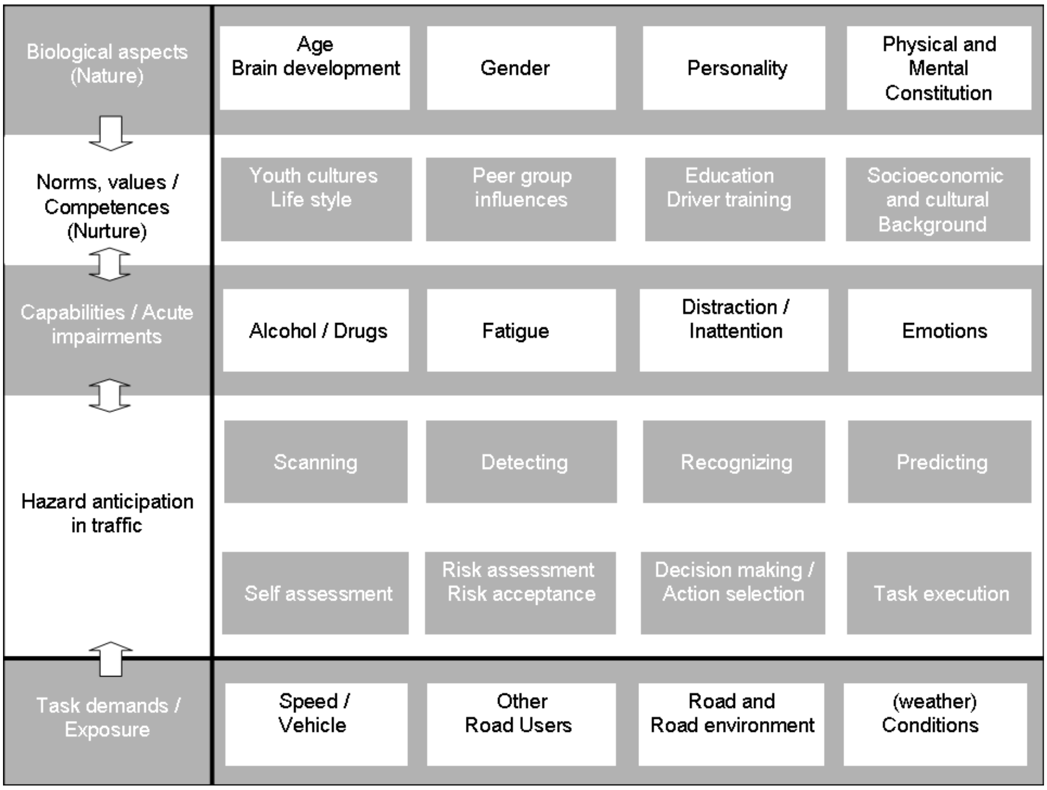



**Figure 2: Factors that influence the accident rate of young novice drivers, Vlakveld 2011**

Both the biological factors and the social and cultural factors are constituent for not only traffic behaviour, but also for what one does in other aspects of life, comparable to the fourth level of the GDE-matrix. The third category from the top concerns the transient factors that reduce instantaneous driving capabilities. The fourth category comprises factors that are relevant for hazard anticipation and the last category highlights task demands and exposure factors.

Thinking about parental feedback as a risk countermeasure, again, it seems promising focusing on actions on the “Nurture” level of the taxonomy to positively affect also the lower levels.

Vlakveld´s taxonomy also clearly shows that the “problem of young drivers” should be regarded as having multidimensional character opposed to be understood as a rather simple model to which there is a single solution.

The next section focuses on the role of gender and risk, an aspect worth examining in this context.

### 1.1.3 Young male drivers

Not all adolescents are equally vulnerable, but there is a high risk subgroup of special interest, which are male drivers. Laapotti et al. (2001) conclude that gender differences in young drivers' behaviour may be explained by their different "goals for life and skills for living", the fourth level on the GDE matrix, described above.

Austrian accident statistics for example, show that the share of novice driver aged 15-24 amongst fatalities is about a quarter of all fatalities (Figure 3):

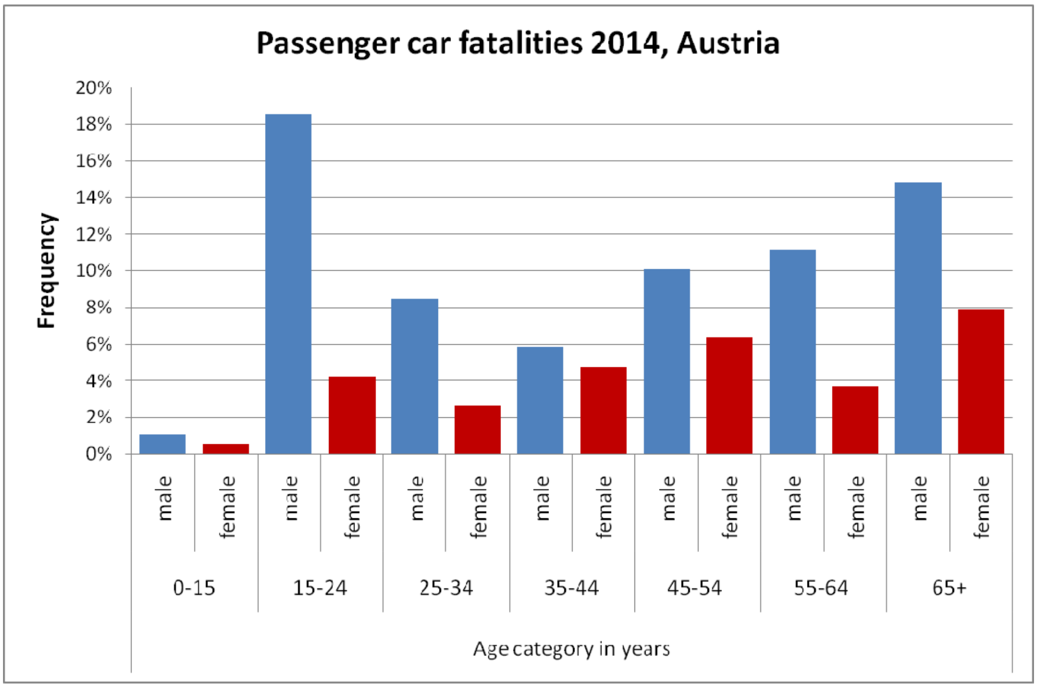



**Figure 3: Passenger car fatalities 2014, Austria**

In Austria, within the group of 15-24 year olds, males were killed nearly five times more than females in the year 2014. One explanation for the difference between male and female accident statistics pattern is that young males and females behave differently as drivers (Laapotti, 2003). Research suggests that female drivers tend to be more safety-oriented than males (Meadows and Stradling 1999; Laapotti 2003).

Among others, Gregersen and Berg (1994) and Schulze (1990) have also related males' high traffic accident risk to a greater tendency of this group to take risks in comparison with females.

Within the framework of this research project, it was decided to examine the potential impact of parental feedback on male drivers only. However, when it comes to countermeasures focusing on risk reduction for novice drivers, certainly all beginners despite of gender are legitimate targets for intervention actions.

## 1.2 The role of parental involvement in the post-license learning process

OECD/ECMT report (2006) presents a good overview of the benefits of parental involvement during the learning process but also highlights the importance of parental care as a “great deal remains to be learned” after licensure mentioned by Simons-Morton & Hartos (2003). Mulvihill et al. (2005) and Cattan et al. (2008) state that parental monitoring during both learning-to-drive and post-license driving has also been found to positively influence their teen’s driving behaviour.

Especially in the first six post-license months of driving where novice driver risk is greatest which is also perceived by parents (Mayhew et al., 2006), parental involvement has a huge potential to positively influence their kids driving behaviour when parenting style is appropriate (OECD/ECMT, 2006). Such an appropriate parenting style is characterised by an “authorative” approach and involves behavioural influence by dialogue, negotiation and knowledge regarding the child´s activities.

### *1.2.1 The concept of vigilant care*

Recently, Omer et al. (2016) proposed the model of ”vigilant care”, an example approach not only to be used within driver education framework but for all other aspects of parental education. It is understood as an integrative solution defined as a ”flexible framework within which parents adjust their level of involvement to the warning signals they detect. By justifying moves to higher levels of vigilance with safety considerations and expressing their duty to do so in a determined but noncontrolling manner, parents legitimise their increased involvement both to the child and to themselves.”

Authors stress the difference to terms ”supervision” and ”monitoring” as these expressions are connotated with either a detached or an intrusive inspectional character. Therefore, parental attitude should be grasped as ”caring presence” in this context. The described ”supervision” resembles higher levels of vigilant care when, having detected signs of alarm, i.e. aggressive driving, hence parents should move over to a more decided and focused kind of watchfulness.

Effects of parental vigilant care and feedback on novice driver risk were examined recently (Lotan et al., 2012; Farah et al., 2014; Shimshoni et al, 2015). Within a sample of 217 Israeli families, three levels of feedback regarding safe driving were evaluated. The novice driver group receiving highest level of feedback was found to be performing best regarding safe driving behaviour, collected via in-vehicle data recorders. For a more thorough review of study findings see section 1.3.

It should be noted that the novice driver group getting highest level of feedback in this study not only had access to safety-relevant driving data of each driver using the equipped car, but parents of this group additionally received dedicated personal training in vigilant care, including personal training sessions, printed materials, regular initiated phone calls by the project team and an established phone “hot line” for further guidance. At this point, the ecological validity of such an elaborated approach should be discussed, as e.g. practical implementation in the form of a legal measure seems at least challenging due to the associated operative and logistic efforts.

### 1.2.2 Insurance involvement

As described, literature suggests that parents should have an important role to play in reducing young driver risk. In this respect it must be noted that for a considerable number of novice drivers, parental feedback and support can´t be obtained due to a variety of circumstances. Therefore, other means of feedback should be sought, for instance the role of the insurance industry could be discussed in this context. As of today, more and more insurance companies predominantly in the US, the UK and Italy (Box & Wengraf, 2013) advertise technology-based insurance products whereby teen drivers are offered the option of putting a GPS-based black box in their vehicle to receive a possible discount for insurance premiums.

In some countries, insurance premiums for young people are rather high and thus reflect their increased risk of injury, both to themselves and others. In a recent UK study where young drivers were asked about their views on insurance-based telematics, it was clear that there was an awareness of the technology in general terms (Watt et al., 2013, cited in & Wengraf, 2013 ), but young drivers involved were more likely to perceive it negatively. On the other hand, benefits were also recognised as they comprise assessment being based on actual driving, which should help to encourage safer and cheaper driving as well as the opportunity for the car to be tracked if it was stolen. In the same report, it is estimated that by the year 2017, some 19 million drivers worldwide will use some form of insurance-based telematic system, with 75% of subscribers expected to come from Italy and the UK solely.

Generally, such insurance-driven measures can be seen as additional effort to support parental involvement, but also be understood as a proxy procedure if involvement from the parent’s side is not possible. Some insurance-led studies showed promising results reducing driver risk and increasing safe driving. Despite this significant potential, the market may still face some challenges, such as self-selection bias, potential adverse outcomes from curfews and public concerns about driver monitoring.

## 1.3 In-vehicle Data Recorder studies

In-vehicle Data Recorders (IVDR) collect driving behaviour data such as location, speed, and acceleration-based information. The purpose of these telematic systems rests not only in documentation of behaviour but merely has the aim to enhance traffic safety. In the light of improving driving behaviour, IVDR systems have been evaluated in this respect since devices emerged.

The mechanism to alter driving behaviour for the better is founded on the following principles:

1 Collection: IVDR collect objective safety-relevant driving data

2 Norms: data put in perspective according pre-defined norms and limits

3 Feedback: driving performance fed back to driver

4 Consequence: reinforcing safe and weakening unsafe behaviour

5 Maintenance: keeping up the feedback loop

These five principles are understood by authors as pre-requisites to establish and maintain a feedback loop aiming at safety improvement.

As regards the consequence principle, it should be mentioned that “consequences” should not be understood having exclusively negative and punishing character. On the contrary, reinforcing good behaviour by incentivising safe driving is surely also one powerful key element of altering driving performance for the better or maintaining safe driving manners.

Some studies have tried to assess the impacts of the described feedback axis among professional and novice drivers:

One example examining the value of feedback is a system developed in Iceland (SAGA), a collection and information system for monitoring and reporting driver behaviour (OECD/ECMT, 2006). IVDR systems were installed in commercial vehicles and safety-relevant driving data was fed back to drivers on a weekly basis via email. Results show that substantial improvements in driver behaviour have been noted, including less speeding, a reduction in accidents and less operational fleet costs.

In Finland, Anttila and Peltola (2006) analysed Intelligent Speed Adaptation (ISA), a system collecting speed, acceleration, and deceleration behaviour among taxi drivers and impacts of feedback. Individual drivers were given information about their speed behaviour and the speed recording system and secondly, group feedback in a case of unwanted driving behaviour. They conclude that neither the speed information nor the group feedback had strong effects on drivers´ speed behaviour, only in the higher speed zone ranges they detected safety improvements, i.e. less speeding. The further deduct that for ISA systems to be effective, periodical and individual feedback (no group feedback) should be provided.

McGehee et al., (2007) studied driving learning processes using an event-triggered video device in the US. By pairing the technology with parental feedback in the form of a weekly video review and graphical report card, parents´ ability to teach their teens after they have begun driving independently was extended. The IVDR captured 20-sec clips of the forward and cabin views whenever the vehicle exceeded lateral or forward threshold accelerations. Their findings suggest that the combination of technology with parental weekly review and feedback of safety-relevant incidents more positively influences at-risk teen drivers.

A study was done by Baugh et al. (2012) in the UK, where among other data sources, IVDRs were used for data gathering and to provide in-car feedback of aggressive driving manoeuvres (excessive lateral and longitudinal forces). Behaviour changes were measured pre-, during, and post-trial through a combination of data. Study results indicate significant improvement in driving behaviour. During the trial "a sharp fall" in undesirable events was observed, post-trial IVDR data (up to eight months post-trial data) remained at these lower levels, encouraging the belief that the amendments were permanent "new habits" rather than temporary effects. Finally, pre- and post-survey responses showed enhancement in some attitudinal and behavioural aspects of driving.

A comprehensive study carried out by Lotan et al. (2012) in Israel, already mentioned under section 1.2.1, showed positive results among young drivers for their first driving year when using IVDR technology and feedback. Four study groups of young male drivers, one control group and three feedback groups were compared against each other as regards safety driving performance. The three feedback groups differed in the amount of feedback they received. Project results indicate major benefits for all feedback groups, but best results in the feedback group where parents received personal guidance. Furthermore, high correlations between safety performance of young drivers and their parents were found as well as correlations between certain personality traits (e.g. aggressiveness) and risky driving events.

A parallel study to the one presented in this report was recently undertaken in Finland by Tarkiainen et al. (2014) which also looked at potential impacts of IVDR technology and parental feedback on novice driving behaviour. Seventy-five young male drivers together with their parents participated in the study, separated in a control group and a feedback group. Safety relevant information regarding driving style and eco-friendly driving was collected and feedback provided via website, smartphone and a weekly feedback report. Unlike the research results from Anttila and Peltola (2006), findings suggest significant safety benefits for novice driver receiving parental feedback, especially regarding speeding behaviour. In contrast to the aforementioned study, feedback was provided periodical and on individual basis. Both, teen drivers and parents indicated positive response to the implemented and evaluated feedback concept. However, authors also highlight the challenge to involve novice drivers in the study who are at a high-risk level, thus suggesting a self-selection moment that might have occurred regarding study participant selection.

## 1.4 Safety relevant driving behaviour variables

### 1.4.1 Speed choice

There are numerous of interacting factors which determine an individual driver's choice of speed in a specific situation. These factors are likely to vary from time to time and from trip to trip depending on a range of personal and trip related factors (Quimby et al., 1999). Authors conclude that speed variation can be summarised by four main explaining factors:

1. Site effects, having the largest influence on driver speed, e.g. lane characteristics, traffic density, speed of other vehicles, weather, visual range, speed limit, etc. For a thorough analysis of different factors see also Ruwenstroth, at al., 1989.

2. Driver effects, such as age, sex and exposure

3. Psychological variables, such as tendencies to violate traffic rules, sensation seeking and robustness against stress

4. Other effects, like trip purpose presence and number of passengers, car characteristics and occupational group of the driver

Hence the actual realised speed in a given situation is understood as predominantly influenced by site characteristics compared to other influences.

### 1.4.2 Speed and risk

Speed choice is a doubtlessly major component of a driver's behaviour on the road, and one that plays a crucial role in the frequency of accidents on the one hand and its severity on the other. However, the exact relation between speed and accident involvement is far more difficult to establish precisely.

Over the last decades, there has been extensive research trying to analyse the relationship between speed and accidents. Lynam and Hummel (2002) for instance present a literature overview about the work which has taken place in many countries in this respect.

Obviously, accident involvement and severity increase with speed, on any particular road or for any particular driver. The differences in the estimates of the size of this effect reflect the different uncertainties introduced by each collection method. Research studies have used different parameters of speed, such as mean speed, variation in speed, proportions of excess speeders, etc., each of which give different insights into how speed influences other aspects of driver behaviour, and how it is associated with risk.

The very simple, but commonly used rule, that a 1 km/h (1 mp/h) change in speed can be expected to result in a 3% (5%) change in the number of accidents, appears to have fairly general validity as an average estimate across a wide range of studies, but this effect seems to vary with road and traffic type (Lynam and Hummel, 2002, Taylor et al., 2000). This variation may explain some of the relationship differences observed in the results of different studies and meta-analyses (Andersson et al., 1997, Nilsson 2004, Elvik et al, 2004).

As regards the robustness of speed behaviour, Elvik et al. (2004) conclude that “the relationship between speed and road safety can to some extent be modified by the road environment, by vehicle-related factors, and by driver behaviour, but the effects of speed on road safety appear to be remarkably consistent across different contexts.”

As an alternative to speed measurements for individual traffic accident involvement, newer research suggests that parameters based on acceleration can be used to describe driver risk as well.

### 1.4.3 Acceleration-based risk variables

Some authors have proposed a relationship between realised acceleration and accidents and/or safety-related behaviour (e.g. Robertson et al., (1992), Lajunen et al. (1997), Ogle (2005), Wahlberg (2006), Toledo, Musicant and Lotan (2008) and Prato et al. (2010). Wahlberg (2006) states within his developed “driver celeration behavior theory” that acceleration-based variables are better than other variables as a predictor of individual traffic accident involvement, even including the speed parameter.

Typically, two approaches are applied to construct acceleration-based risk parameters:

The first approach is to derive risk indicators from an entire trip data stream by creating simple and representative values of summative character, such as average or standard deviation of acceleration data. Here, acceleration values are meant to sufficiently represent a more general expression of driver risk. Such an assumption is exemplified by Wahlberg (2006), stating that “...every behaviour that causes a change in speed also carries an infinitesimal risk of accident, which add up to a sum total equalling to the total number of accidents experienced.”.

The second approach is to identify specific driving manoeuvres and generate risk parameters only for pre-defined situations (=“events”), such as harsh braking, accelerating and cornering. By segmenting a trip into continuous sequences of driving manoeuvres on specific road segments, it is possible to classify each and every manoeuvre carried out during a trip in manifold ways, for example by severity level, relative direction (left or right), duration, or speed. Thus, a risk index can be calculated as function of frequency and possibly severity level of realised manoeuvres (e.g. Toledo et al., 2008, Tarkianinen et al., 2014).

In this study, the latter approach was used to identify harsh driving manoeuvres by defining certain events beforehand.

# 2 Method

A sample of 74 male novice drivers was selected, where half of the sample was randomly allocated either to an intervention group (”IG”) or a control group (”CG”). The difference between the groups was based on the provision of feedback in the IG, (or its absence in the CG), regarding individual driving style which was measured by a specifically developed in-vehicle data logger. The data logger measured safety-relevant driving parameters thus allowing parents to provide feedback about their kids´ solo driving by means of weekly safety reports sent by email and a web-based safety diary.

## 2.1 Participant requirements

The participants of the study were chosen to be male novice drivers, between 17 and 19 years old, and should have between at least one but not more than four months of solo driving experience after passing the category B driving test.

Another requirement for taking part in the study was that subjects should have passed their driving test within an accompanied driving scheme[2], named “L17” in Austria.

As regards car possession, participants could use their own car for study participation or use the family´s car. Furthermore, only participants who were driving on a frequent basis, i.e. at least 200 km per month, were selected.

Finally, subjects´ parents should have internet access via PC and/or mobile phone.

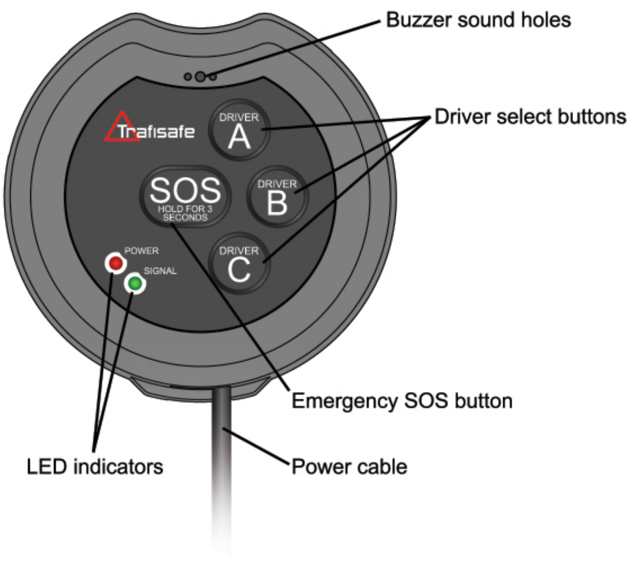
## 2.2 Description of feedback technology

An in-vehicle data logging system was used to obtain safety-relevant driving parameters and to transfer this data to a web server where the data was processed further and illustrated on a website. Furthermore, aggregated safety relevant data was automatically sent every week to the parents allocated to the IG.

### *2.2.1 In-vehicle data logger system*

The in-vehicle data logger is a small box which was visibly installed in participants´ vehicles. Beside the data logging function, the device was also used for driver identification and feedback about the system state during driving:

[2] In Austria, young learner drivers have the option of completing the “L17”- model. According to this scheme, drivers can begin their training already at the age of 16 , instead of the usual 17½ years earliest. The training is a combination of driving school education and lay instruction (covering a minimum of 3000km driven before the test can be taken).




(a)

(b)

**Figure 4: (a): On-board data logger; (b) unit installed in vehicle**

The left picture shows an illustration of the data logger, the right displays a mounted data logger in the car. There are three buttons for driver identification A, B and C. If there was more than one driver allocated to the vehicle in the website settings (see section 2.2.2), typically when the family´s car was used, novice drivers were instructed to press the “A” button, parents the “B” button, other drivers should use the “C” button for identification. Additionally, the data logger beeped to remind the driver to identify in case more than one driver was allocated to the car.

The LED indicators inform about the status of the data logger: the red LED is for displays if the unit is connected to power, the green LED shows if a trip is recorded or if the data logger and the vehicle is stationary.

The SOS button can be used at any time to alert the account´s registered mobile phone via text message of the vehicle´s location. This can be used for accidents, breakdowns, etc. The text message includes a web link to show the location on Google® Maps.

For installation on the windshield, a self adhesive foam is used. The box is powered via connection to the 12V cigarette lighter. In case the connector was pulled out, the data logger displays power loss via blinking red LED. For such cases, the device has an internal battery, thus allowing further data recording for about 48 hours.

The feedback data logger detects movement and uses this information to wake up, start, and stop trips. Opening one of the car doors typically triggers waking up the unit and starts recording. A trip ends once no movement is detected for longer than 120 seconds. When a trip is finished, it is automatically uploaded to the web server via GPRS. If there is no movement for further 5 minutes, the data logger changes into a “sleep mode” in order to consume only minimal current. The feedback data logger can be woken again from this mode by either pressing a button, or with sensed movement.

The data logger records position and speed via GPS at a resolution of 1 Hz and accelerometer data. The built-in accelerometers are capable of measuring lateral and longitudinal acceleration (up to a maximum of 2g each) of the vehicle with an update rate of 100Hz. The data logger filters the acceleration with a -3db bandwidth of 10Hz and sub sample at 20Hz.

Furthermore, the data logger has an internal storage which provides enough capacity for 50 hours of continuous driving at the described resolution for cases if no GPRS signal is available.

The in-vehicle data logger transmits raw data, procedures are carried out by internet server, such as calculating risk indices, % of speeding, etc. The transferred data consists of:

- Unit serial number
- GPS-based data: position, speed and direction (1Hz)
- Accelerometer data, both longitudinal and lateral (20Hz)
- Driver ID
- Information, if power supply has been removed

When a trip is finished and uploaded via SIM card, the data is processed on the web server to be shown on a website. The following illustration depicts the system architecture:

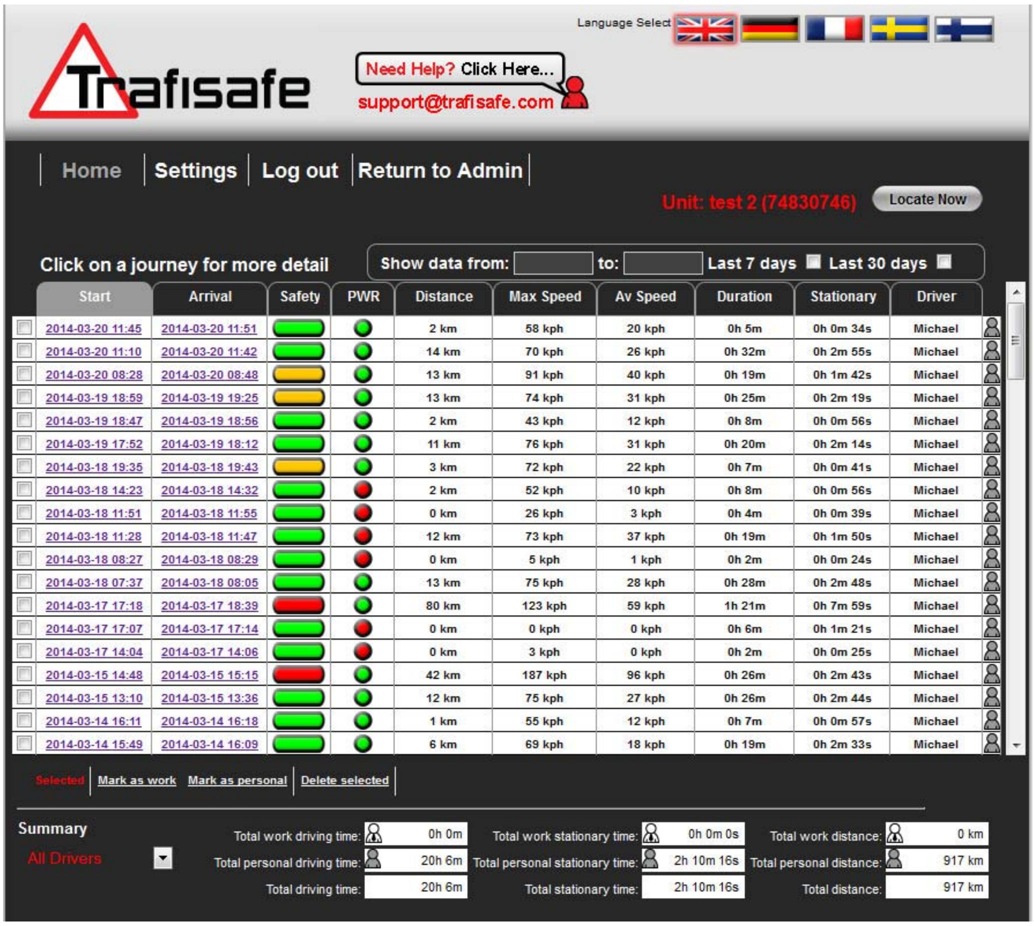

Figure 5: Trafisafe system architecture

After logging in to the Trafisafe website, parents could see the driving diary and aggregated safety-relevant data on trip level.

### 2.2.2 Website and weekly summary emails

Once the data is collected and uploaded to the web server, data processing and aggregation is carried out in order to present trip and safety-relevant summary information for novice drivers´ parents of the IG.

A driving diary is shown, containing summary information regarding single trips after logging-in to the website:




| Start | Arrival | Safety | PWR | Distance | Max Speed | Av Speed | Duration | Stationary | Driver |
|---|---|---|---|---|---|---|---|---|---|
| 2014-03-20 11:45 | 2014-03-20 11:51 | | | 2 km | 58 kph | 20 kph | 0h 5m | 0h 0m 34s | Michael |
| 2014-03-20 11:10 | 2014-03-20 11:42 | | | 14 km | 70 kph | 26 kph | 0h 32m | 0h 2m 55s | Michael |
| 2014-03-20 08:28 | 2014-03-20 08:48 | | | 13 km | 91 kph | 40 kph | 0h 19m | 0h 1m 42s | Michael |
| 2014-03-19 18:59 | 2014-03-19 19:25 | | | 13 km | 74 kph | 31 kph | 0h 25m | 0h 2m 19s | Michael |
| 2014-03-19 18:47 | 2014-03-19 18:56 | | | 2 km | 43 kph | 12 kph | 0h 8m | 0h 0m 56s | Michael |
| 2014-03-19 17:52 | 2014-03-19 18:12 | | | 11 km | 76 kph | 31 kph | 0h 20m | 0h 2m 14s | Michael |
| 2014-03-18 19:35 | 2014-03-18 19:43 | | | 3 km | 72 kph | 22 kph | 0h 7m | 0h 0m 41s | Michael |
| 2014-03-18 14:23 | 2014-03-18 14:32 | | | 2 km | 52 kph | 10 kph | 0h 8m | 0h 0m 56s | Michael |
| 2014-03-18 11:51 | 2014-03-18 11:55 | | | 0 km | 26 kph | 3 kph | 0h 4m | 0h 0m 39s | Michael |
| 2014-03-18 11:28 | 2014-03-18 11:47 | | | 12 km | 73 kph | 37 kph | 0h 19m | 0h 1m 50s | Michael |
| 2014-03-18 08:27 | 2014-03-18 08:29 | | | 0 km | 5 kph | 1 kph | 0h 2m | 0h 0m 24s | Michael |
| 2014-03-18 07:37 | 2014-03-18 08:05 | | | 13 km | 75 kph | 28 kph | 0h 28m | 0h 2m 48s | Michael |
| 2014-03-17 17:18 | 2014-03-17 18:39 | | | 80 km | 123 kph | 59 kph | 1h 21m | 0h 7m 59s | Michael |
| 2014-03-17 17:07 | 2014-03-17 17:14 | | | 0 km | 0 kph | 0 kph | 0h 6m | 0h 1m 21s | Michael |
| 2014-03-17 14:04 | 2014-03-17 14:06 | | | 0 km | 3 kph | 0 kph | 0h 2m | 0h 0m 25s | Michael |
| 2014-03-15 14:48 | 2014-03-15 15:15 | | | 42 km | 187 kph | 96 kph | 0h 26m | 0h 2m 43s | Michael |
| 2014-03-15 13:10 | 2014-03-15 13:36 | | | 12 km | 75 kph | 27 kph | 0h 26m | 0h 2m 44s | Michael |
| 2014-03-14 16:11 | 2014-03-14 16:18 | | | 1 km | 55 kph | 12 kph | 0h 7m | 0h 0m 57s | Michael |
| 2014-03-14 15:49 | 2014-03-14 16:09 | | | 6 km | 69 kph | 18 kph | 0h 19m | 0h 2m 33s | Michael |

**Figure 6: Trafisafe website: driving diary**

The illustrated trip-related variables are date and time of a trip's start and arrival and a general safety assessment of the trip. The trip can be assessed in three ways: green (cautious driving), yellow (moderate driving) or red (aggressive driving). Furthermore, the web site provides information if the power connection of the data logger was lost (column PWR) e.g. by pulling the cigarette lighter connection.

Further summary statistics shown are the trip distance, the realised maximum and average speed, the trip duration, for how long the vehicle was stationary and finally who was the driver. On the bottom of the page, overall summary information is presented.

By clicking and thus selecting on an individual trip, more detailed information is presented:

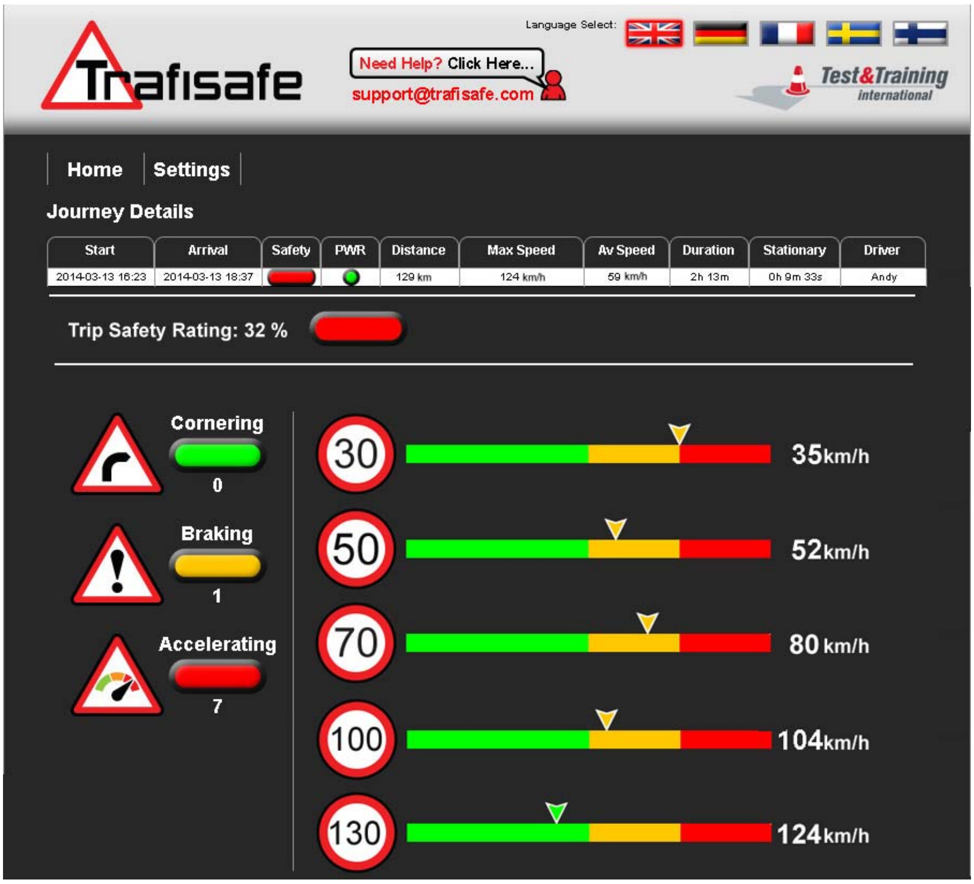



Figure 7: Trafisafe website: detailed trip information

The trip summary details are presented on top. An overall trip safety rating in percent is displayed below. This safety score is a summary score composed by both driving dynamic variables, such as harsh cornering, braking or acceleration manoeuvres as well as speeding behaviour. The more unobtrusive the behaviour is in these respects, the better the overall trip safety rating score, where value “0” is the worst, “100” is the best score. In the figure shown above, the trip safety rating is 32% (red).

On the left, driving dynamic variables are presented as coloured bars (green, yellow, red) as well as the number of harsh manoeuvres below the respective bars. If a certain number of harsh events is reached, the bar colour turns from green to yellow. If even more harsh manoeuvres were detected, the colour of the bar changes from yellow to red. In the example shown in Figure 7, the driver performed no harsh cornering manoeuvres (green bar), 1 harsh braking manoeuvre (yellow bar) and 7 harsh acceleration manoeuvres (red bar).

On the right side of the page, speed information is presented. The five most common speed zones are displayed and represent all respective speed zones that the driver was driving through. For every speed zone, a coloured bar is displayed, indicating different speed thresholds within the speed zone.

The green bar ranges from 0 km/h to the actual speed limit, e.g. 50 km/h. The yellow range starts from 51 km/h to 55 km/h and the red range of the bar starts from 56 km/h. Moreover, the realised maximum speed for different speed zones is indicated on the coloured speed bar by a yellow arrow. For example, if a driver drove through 7 zones with a speed limit of 50 km/h, the maximum speed of all zones is indicated by the arrow. In the presented figure, the maximum speed of all approached 50 km/h speed zones was 52 km/h, exceeding the speed limit of 2 km/h, therefore the arrow points to yellow range of the bar where 52 km/h is located.

### 2.2.3 Speeding classes

Between 2009 and 2011, the KFV has undertaken n=17.002 speed measurements in real traffic. The example of the 30 km/h zone is presented in Figure 8:

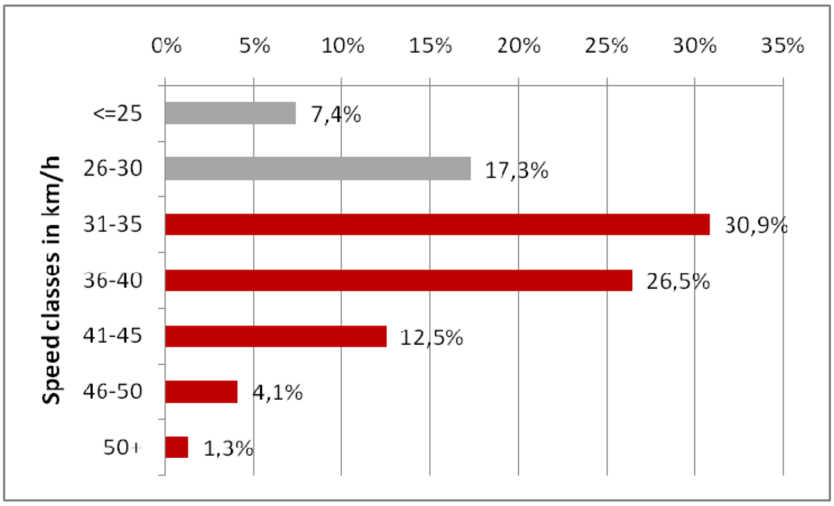



Figure 8: Speed measurements in 30 km/h zone; from KFV Annual report 2011

Based on the illustrated speed zones, the following speeding classes and thresholds were defined (Table 2):

Table 2: Speeding classes

| Speed zone (km/h) | Speeding class | | | |
|---|---|---|---|---|
| | No speeding | Moderate Speeding | High Speeding | Extreme Speeding |
| 30 | -30 km/h | >30-35 km/h | >35-49 km/h | 50+ km/h |
| 50 | -50 km/h | >50-55 km/h | >55-69 km/h | 70+ km/h |
| 70 | -70 km/h | >70-77 km/h | >77-89 km/h | 90+ km/h |
| 100 | -100 km/h | >100-110km/h | >110-129 km/h | 130+ km/h |
| 130 | -130 km/h | >130-143 km/h | >143-159 km/h | 160+ km/h |

These speeding categories were used to differ between the speeding magnitude, using a 10 percent threshold of the given speed limit to classify moderate speeding and above that for high speeding. The category of extreme speeding was defined on a limit with i.e. practical impact insofar as a novice driver being caught at this speed level would lose the driving license(s) and the probationary period would be extended.

An exception was the 30 km/h zone, as the moderate speeding threshold was not set to a 10% threshold, but a slightly higher limit (35 km/h). This is mostly due to carried out speed measurements by the Austrian Road Safety Board, showing that about 50% of all drivers are realising up to 35 km/h:

Hence, for 30km/h speed limits, a cut-off limit of 35km/h was chosen as threshold value for moderate speeding. For all other speed zones, a 10 percent threshold was used in the individual category.

### 2.2.4 Event rate index and speeding time ratio

As described above, the data logger identifies harsh manoeuvres, such as aggressive cornering, braking and accelerating. Based on these three driving manoeuvre types, an event rate index was defined as a sum of occurring events per minute of driving, thus normalising the index.

General speed behaviour was measured by a speeding time ratio. The ratio relates the time of realised speed below the speed limit with the time spent above the posted speed limit.

## 2.3 Parental involvement and the role of feedback

As noted earlier, only novice drivers were chosen who completed the L-17 driving education, which is characterised by a longer learning and experience period. One important aspect within this scheme is parental involvement and feedback. As learner drivers are obliged to complete 3000 km before taking the driving test, they are typically accompanied by one parent who provides feedback about the driving. As a consequence, L17- educated drivers already have experience in receiving parental feedback when completing the driving test. However, after the driving test parents don't have any further role or involvement in the following development phases currently. Within this project, the philosophy of parental involvement and feedback is understood to be extended to the first months after the novice driver took the test on a voluntary basis.

During an information session before data logger installation, parents of the IG were informed about the role of feedback in the learning process. Above, parents were taught about the benefits of rewarding good driving behaviour. In contrast, also the aspects of using the data logger as a means to alter aggressive behaviour were openly discussed, i.e. which kind of consequences are appropriate if improper driving is recorded.

At the same time, the significance of driving style as a proxy of accidents was pointed out when explaining safety relevant driving parameters. However, as serious accidents are relatively rare events, feedback based on such seldom occasions will not be sufficient to induce more careful driving. Moreover, novice drivers might even be regularly motivated to arrive at a destination as fast as possible. Other factors, such as peer pressure or tendencies to "show off" were discussed, specifically in the light of the provision of feedback.

It was clearly pointed out, that the feedback system should not be understood as an instrument for spying in the sense of "big brother" but should rather be grasped as a supporting learning tool which helps to increase safety. Surely, this could be a balance act between enforcement and caring. Recent studies discussed the significance regarding the degree of information to be shown and used by parents and novice drivers.

For instance, if trip information is very detailed, i.e. allowing for localisation and driving information of every second, this could be an obstacle for establishing such a system especially within the learning setting as the relationship between parents and their kids may be negatively affected as indicated by Guttman & Gesser-Edelsburg (2010). In this case, the acceptance from both users, from novice drivers and their parents, would not be given.

### *2.3.1 Change of trip illustration*

Due to the before mentioned considerations and previous research findings, changes have been made in the initial phase of the underlying project, leading to an altered trip illustration. As a consequence the used design of this aspect, shown in Figure 7, depicts only aggregated data. Initially, the trip analysis was designed to show the driven path on a map:

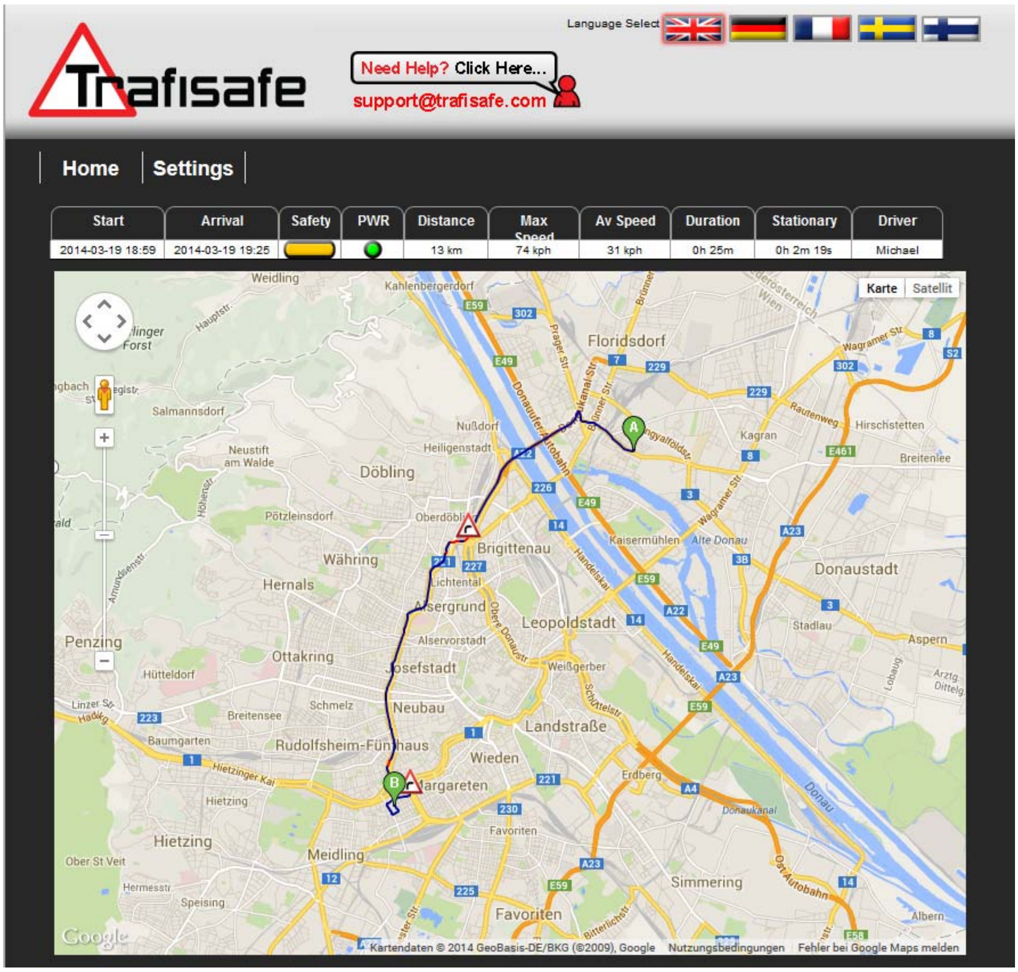



Figure 9: Trafisafe website: omitted trip information

Green framed letter ”A” indicating the point of trip start, the blue line representing the driving path, the red parts of the line being the sections where the driver was speeding, the traffic symbols highlighting where harsh manoeuvres took place (improper cornering manoeuvres in the shown example) and finally where the trip ended, shown as green framed letter ”B”. For trip illustration Google Maps® were used, so users would have the ability to “zoom” into the map, thus magnifying more trip detail.

However, due to privacy issues and specifically regarding the aforementioned acceptance considerations, authors decided to omit this type of trip representation.

# 3 Study Design

## 3.1 Main research questions

Young and novice drivers are vastly overrepresented in traffic accidents. Due to only small alterations since the last decades, new countermeasures are sought to tackle this problem. One promising way to go is exploring the potential benefits of new technologies such as monitoring systems, predominantly known as “black boxes”. This technology allows for registering information regarding the driver’s performance, the vehicle and traffic situations. Combined with feedback about individual driving behaviour, this approach is used to increase safety among drivers.

This method seems to be in particular interesting among the young and novice drivers, due to mainly two reasons. As especially young male drivers are at risk, it was decided to only focus on this group. Secondly, young male drivers are at highest risk in the first year of driving, hence the study period was set within this timeframe to evaluate potential effects within this safety-critical period.

Therefore, the main research questions of this study are two-fold:

1. If and how a monitoring system in combination with parental feedback affects risk among young, male drivers

2. If such an approach is interesting enough for parents to acquire such devices during the first months of their kids driving

The latter being also of potential interest for insurance companies as e.g. economic incentives connected with lower insurance premiums when such systems are employed.

## 3.2 Recruiting of test subjects

Subjects were recruited with the help of three co-operating driving schools located in lower Austria. The driving school owners were informed about the general purpose of the study, i.e. the impact of parental feedback on driving behaviour and the requirements for participant selection. Therefore, personal meetings were held to convey information for study procedures and participant requirements. Subsequently, driving schools organised potential candidates.

As driving schools frequently communicate with novice drivers and/or their parents due to the completion of the obligatory post-license $2^{nd}$ phase modules, it was easy for driving school staff to identify and organise required test persons. One of the obligatory modules is a feedback drive in real traffic, organised and provided by driving schools. If novice drivers chose to take part in the study, they would get the feedback drive module for free which is normally priced in the range of 120-150 Euros.

It should be noted that during recruiting activities, some of the potential study participants refused to take part in the project after they learned more about the scope of the study. Not knowing whether they would take part either in the control or intervention groups, some of the potential candidates refused taking part in the study due to expectation of possibly very negative consequences if driving data is accessible to their parents. This circumstance leading to possible self-selection bias of study participants is further discussed under section 5.

After driving schools screened and found potentially interested participants and parents, an informational event for 6-10 persons was organised, where the study scope and procedures were explained by the project team. Within information events for potential participants of the IG, the feedback website usage and rules of feedback were explained as well.

Within the info events, which typically lasted for about 30-40 minutes, participants could finally choose again whether or not to participate in the study. Fortunately, only few people rejected study participation after the info sessions. Immediately after the info event, subjects were randomly allocated to a study group (CG or IG) and subsequently data loggers were installed either in participants´ own vehicle or in the parents´ car.

## 3.3 Study timeline

Following the selection procedure carried out by driving school staff and installation of the in-vehicle data logger, participants of both groups did not receive any feedback during the first driving month of the study (Figure 10):

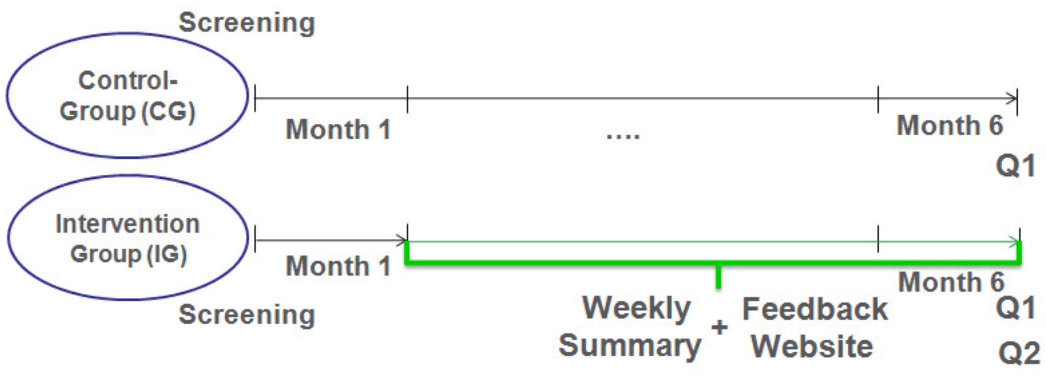



Figure 10: Study timeline of control and intervention group

One month after start of driving with the in-vehicle data logger, the login data for the feedback website was sent to parents and the weekly e-mail summary report was started to be transmitted. Subsequent to the observation period of a total of 6 months, the data logger was de-installed and questionnaires were filled out. One questionnaire (Q1) for both, the CG and the IG, the second questionnaire (Q2) was filled out by the parents of the IG.

Q1 consisted of questions of both socio-demographic and behavioural nature. This questionnaire was primarily used to determine, whether the random allocation of subjects to one of the investigated groups was successful or not.

The second questionnaire (Q2) focused on the views and opinions of the involved parents of the IG. Questionnaire items focused on the usability of the website tool (described under section 2.2.2) as well as acceptance and implementation issues of the whole concept, i.e. the combination of ITS technology with parental involvement during the early post-license phase of novice drivers.

## 3.4 Statistical methods

### 3.4.1 Randomisation data

In order to see if randomisation of participant allocation to one of the groups was successful, mean sample values were compared using Mann-Whitney-Wilcoxon (“U”-tests) or T-tests for two independent samples were applied. Moreover, Chi-Square tests were used to calculate potential differences regarding the driving data (frequency and distribution characteristics) in the first month of observation.

As effect size estimator, Cohen´ s d was used, indicating how “significant” an effect translates into practice (see section “Definitions”).

### 3.4.2 Questionnaire data

Questionnaire data was compared to identify potential differences by using non-parametric Mann-Whitney-Wilcoxon tests for two independent samples (also known as “U-tests”).

### 3.4.3 Driving data

ANOVA (analysis of variance) procedures were carried out in order to reveal possible significant differences for speeding behaviour (speeding time ratio), also for different speed zones.

ANCOVA (analysis of co-variance) procedures were used to identify significant differences regarding driving events (event rate index) between groups and estimate potential confounding or interacting variables such as exposure at the same time. Levene's test was used to assess the homogeneity of variances.

Effect sizes were estimated by using Partial Eta Square, typically applied within ANOVA or ANCOVA procedures (see section “Definitions”).

# 4 Results

## 4.1 Sample description

### 4.1.1 Driving data

It should be mentioned that the presented results are based on the initial raw data, before data cleaning procedures were carried out (see section 4.1.2) and provides statistics for the overall sample.

#### 4.1.1.1 Data collection period

First informational sessions with subsequent data logger installation were carried out in December 2014, the last data logger was de-installed in April 2016. Hence, the data collection period lasted for 17 months in total.

The illustration (Figure 11) below provides an overview regarding the ongoing data collection:

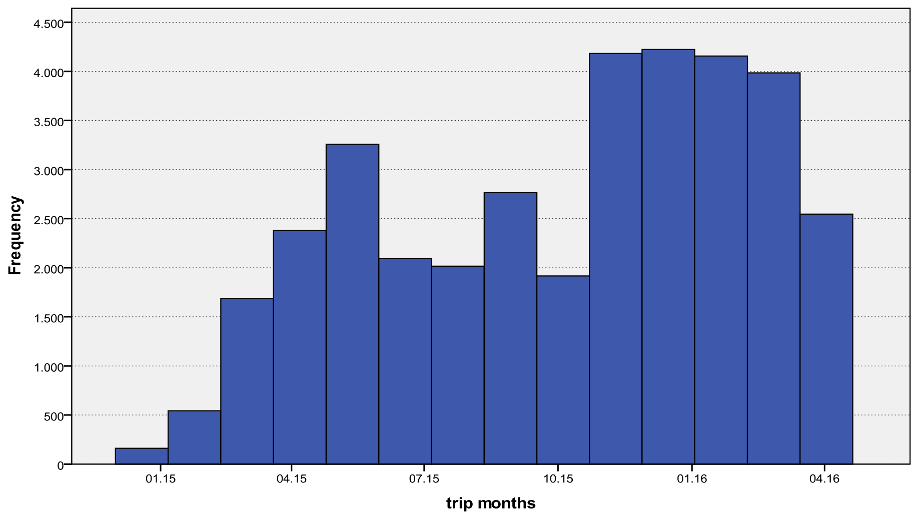



**Figure 11: Number of monthly collected trips during data collection**

#### 4.1.1.2 Exposure summary

The following table provides an overview about all recorded trips during the whole data collection period:

**Table 3: Sample description: number and mileage of trips**

| driver | Number of trips | | Mileage (km) | | |
|---|---|---|---|---|---|
| | Frequency | Percent | Km sum | Km mean | Km Std. Dev. |
| novice driver | 48.074 | 91,4 | 471.744 | 9,81 | 16,62 |
| parent | 4.449 | 8,5 | 48.851 | 10,98 | 22,12 |
| other | 70 | 0,1 | 1.184 | 16,91 | 25,43 |
| total | 52.593 | 100 | 521.779 | | |

In total, more than 52.000 trips and over 500.000 km of driving data were recorded. The mean trip distance was about 10 km per undertaken trip.

In terms of duration, over 12.000 hours of recorded data were gathered, as Table 4 shows:

**Table 4: Sample description: trip duration**

| driver | Trip duration | | |
|---|---|---|---|
| | Minimum (minutes) | Maximum (minutes) | Sum (in h) |
| novice driver | 2,0 | 239,2 | 11.072 |
| parent | 2,0 | 200,4 | 1.006 |
| other | 2,4 | 97,9 | 20 |
| total | | | 12.099 |

As the minimum time of a trip was defined as being at least two minutes, this value also occurred in the data at shortest trip duration. The longest recorded nonstop trip was undertaken by a novice driver and lasted almost four hours.

#### *4.1.1.3 Exposure details*

The subsequently presented results focus only on the novice driver group characteristics. Statistics include the whole data collection period.

Figure 12 illustrates the trip distribution over the week.

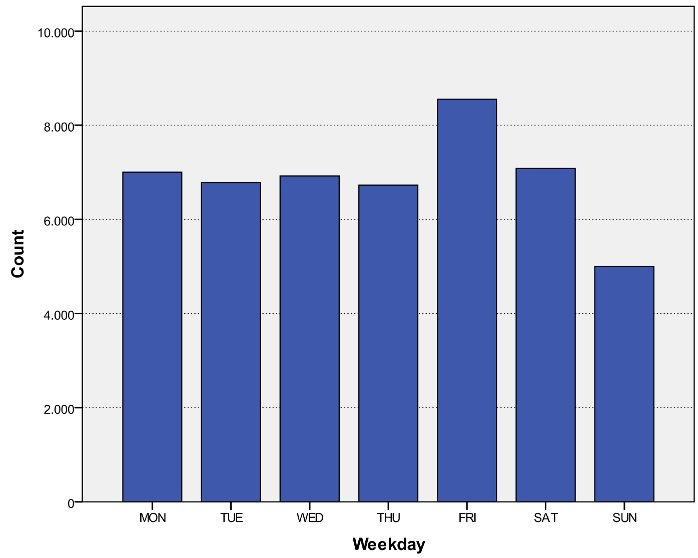



**Figure 12: Exposure: trip distribution, day of week**

Clearly, most trips were undertaken on a Friday. Other days were comparable regarding the number of undertaken trips, except Sunday, where least trips were made.

As regards time of the day, the figure below presents the distribution in this respect:

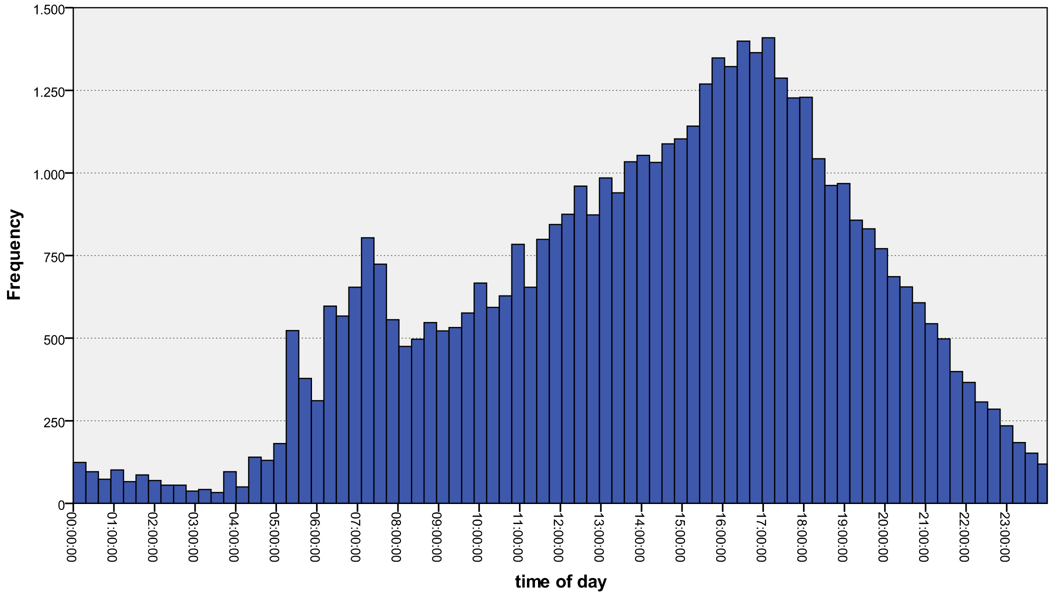



**Figure 13: Exposure: trip distribution, time of day**

Most frequently trips are undertaken between 15pm and 18pm in the afternoon. During morning hours between 5am and 8am onwards, study participants were also en route, most likely to work or to school.

#### *4.1.1.4 Feedback start within intervention group*

For comparison reasons, especially to examine if the random allocation of subjects to a group was successful, it was important that participants of the IG did not receive any form of data about their driving or data-based feedback of their parents during the first four weeks of driving.

Therefore, no subject of the IG received feedback before at least one month of driving with the installed data logger. The distribution regarding when data-based feedback services were enabled is shown in Table 5:

**Table 5: Week of feedback start for IG**

| group | week of feedback start | | | | | | |
|---|---|---|---|---|---|---|---|
| | 5 | 6 | 7 | 8 | total | mean | std. deviation |
| intervention group | 11 | 14 | 11 | 1 | 37 | 5,05 | ,848 |

On average, both the web services were turned on and weekly driving summary emails were sent not before the fifth week of the data collection. However, the website for parents and the weekly driving summary was enabled for most of the IG participants in the sixth week after data logger installation.

### 4.1.2 Data cleaning procedures

The first cleaning procedure was already made on the web server as trips with duration below 120 seconds were filtered out of the data sample.

In a next step, trips undertaken by other persons than the novice drivers were omitted, except in such cases, where analyses focused on other drivers as well. The fraction of trips not made by novice drivers was 8,6% in the overall sample.

Another requirement for a trip to be considered as valid and included in the database was an availability of GPS over at least 75% of trip time. This was the case for more than 99% of all recorded trips.

The speed threshold for a whole trip was set to a maximum of 20 km/h, trips with a realised maximum trip speed below were excluded, equalling a value of 8,3% of the overall trip sample.

Furthermore, speeding classes for respective speed zones were generated, for which lower and upper top speed thresholds were defined, as the following table shows:

**Table 6: Data cleaning: top speed thresholds**

| Speed limit | Threshold | |
|---|---|---|
| | Lower limit | Upper limit |
| 30 | 20 | 70 |
| 50 | 40 | 90 |
| 70 | 50 | - |
| 100 | 75 | - |
| 130 | 110 | - |

Values being outside the respective value ranges were omitted in further analyses.

Finally, drop-outs of persons occurred mostly due to changes of vehicles, or other changes in driving parameters such as joining the army, insurance eligibility, etc.

Other reasons for invalid or loss of data were related to the technology, such as the system´s malfunctioning or (partial) loss of driving information.

Due to the combination of circumstances mentioned, data set was reduced from initially 74 participating novice drivers down to a minimum of 45 persons for which full data sets could be obtained until the sixth month of the observation period.

As a consequence, subsequent analyses only include data cleaned as described above.

### 4.1.3 Randomisation according to driving data

The following section provides information of the data set derived from in-vehicle data loggers. Comparable to the approach used with questionnaire data, it can be concluded that potential differences found in driving behaviour are most likely due to the parental involvement and/or feedback and, in contrast, not due to differences that existed before the (feedback) intervention.

In the present study, randomisation was successful if driving data would not differ between both the CG and IG within the first month after data logger installation as subjects of both groups did not receive any data or feedback, whatsoever.

For parents of the IG, access granted to the website was not given until at least a month of data collection. Typically, the website services and weekly driving summaries for this group were established between the first and second month after data logger installation. For a more thorough overview see Table 5.

To calculate potential statistical differences for the driving data, Mann-Whitney or t-tests for two independent samples or Chi-Square tests were used.

It should be noted that with very large samples, even a small value of the test statistic can result in the null hypothesis being rejected. Although such an effect may be entitled as statistically significant, it may not be a very large effect in practice. The effect size has the advantage of not depending on the sample size, and so can provide a standard measure of whether the size of an effect is meaningful.

Therefore, effect size estimation was used to assess the potential significant differences where appropriate. As effect size estimator, Cohen´ s d is used (see section “Definitions”), indicating how “significant” an effect translates into practice.

#### 4.1.3.1 Randomisation: trip distance and duration

The distribution of the trip distance is presented in the illustration below, Figure 14:

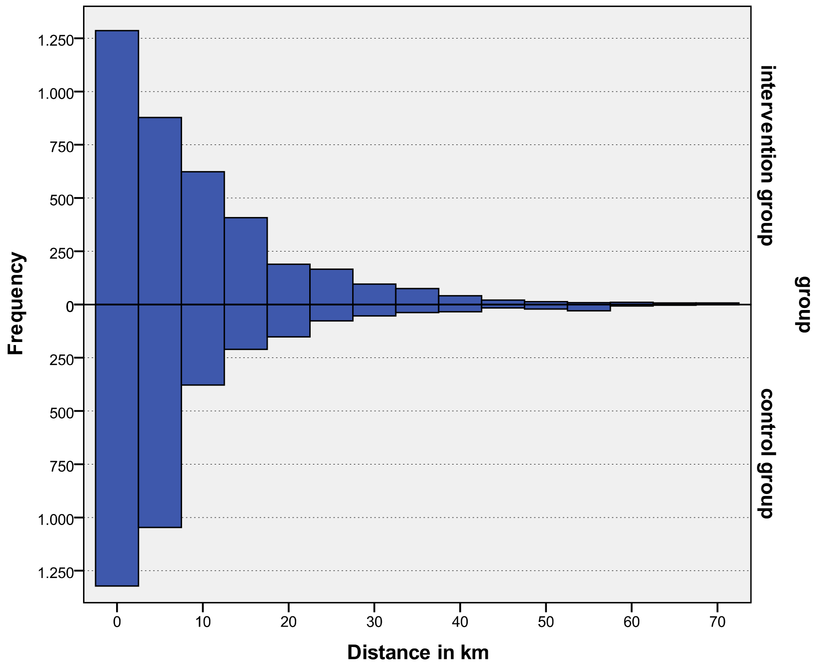



**Figure 14: Randomisation: distribution comparison of trip distance during first month**

As the figure illustrates, most of the driven distances are rather short, naturally this correlates with the trip duration. Here, a significant difference of the mean distance was found, however, the effect size (Cohen´s d) resulting in a value of 0,11 (shown in Table 7) reveals nearly identical trip distance distribution in practice.

**Table 7: Randomisation: descriptives of trip distance during first month, both groups**

| group | trip length in km | | | | | |
|---|---|---|---|---|---|---|
| | n | mean | std. deviation | std. error mean | p | Cohen´s d |
| control group | 3422 | 8,85 | 15,407 | 0,263 | 0,000** | 0,11 |
| intervention group | 3868 | 10,56 | 15,626 | 0,251 | | |

The table shows that the average trip distance was about 10 km in the first month of driving.

Figure 15 indicates trip duration for different classes. It can be seen that most trips are less than 60 minutes for the first month of driving.

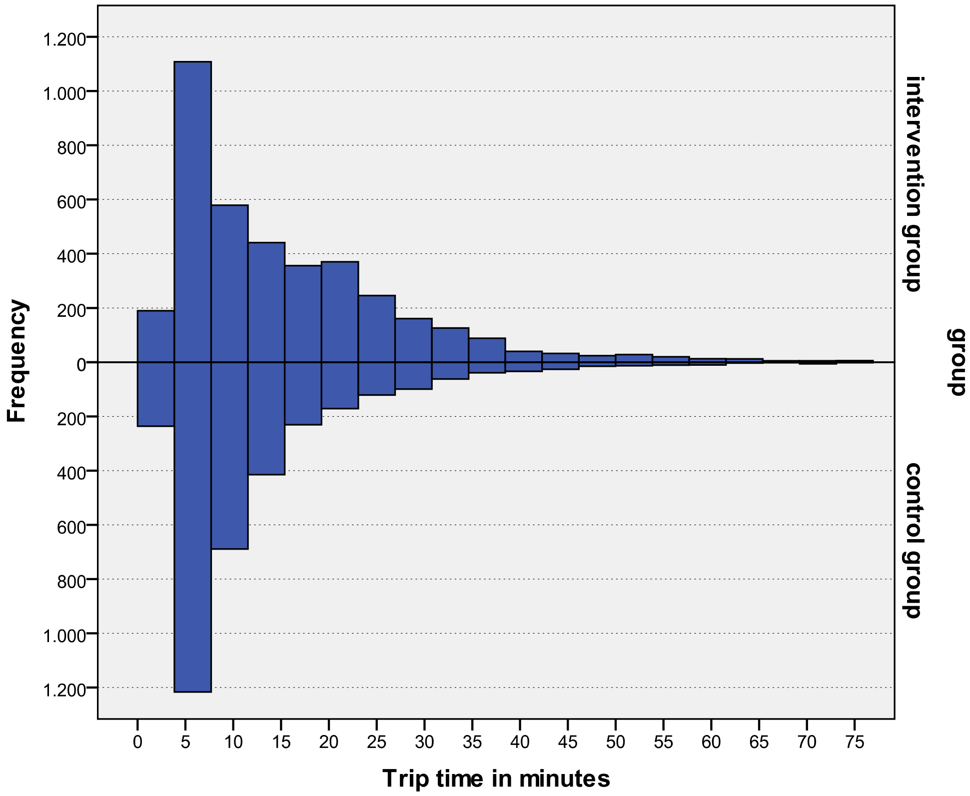



**Figure 15: Randomisation: distribution comparison of trip duration during first month**

Again, as expected due to large sample sizes, significant differences occurred from t-test, however, effect size can be interpreted as very small since Cohen´s d value was 0,219 (Table 8). In practice, this result means that the distribution is slightly different (see section "Definitions").

**Table 8: Randomisation: trip duration during first month, both groups**

| group | trip duration | | | | | |
|---|---|---|---|---|---|---|
| | n | mean (minutes) | std. deviation | std. error mean | p | Cohen´s d |
| control group | 3422 | 13,04 | 12,42 | 0,212 | 0,000** | 0,219 |
| intervention group | 3868 | 15,92 | 13,75 | 0,221 | | |

A more detailed frequency analysis is shown in Table 9:

**Table 9: Randomisation: percentiles of trip duration during first month, both groups**

| group | trip duration in minutes - percentiles | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% |
| control group | 4,15 | 5,20 | 6,22 | 7,37 | 8,93 | 10,90 | 13,63 | 18,16 | 26,96 |
| intervention group | 4,48 | 5,55 | 6,98 | 9,11 | 11,95 | 15,43 | 19,58 | 23,76 | 31,65 |

The table reveals that about 90 percent of all undertaken trips in the first month are below or up to 30 minutes driving time.

#### *4.1.3.2 Randomisation: time of day and day of week*

The first month of both groups were analysed with regard to the time of day when trips were started. The figure below depicts the distribution:

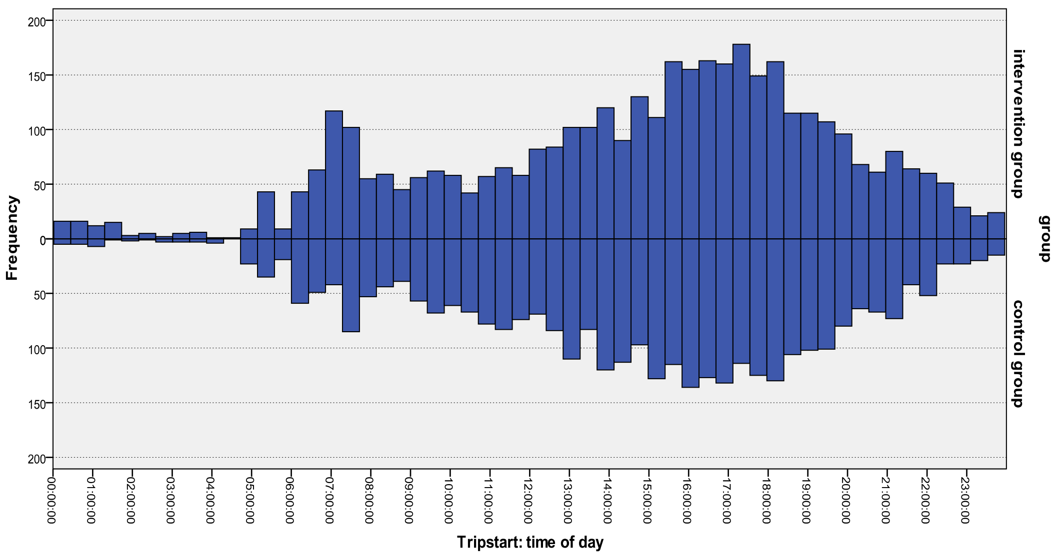



**Figure 16: Randomisation: distribution comparison of trip start: time of day**

The majority of the trips started between 15pm and 19pm, followed by a trip start peak in the morning hours. No significant differences between the groups could be observed (p=,388).

Analysing the distribution according to weekdays, the following result occurred (Figure 17):

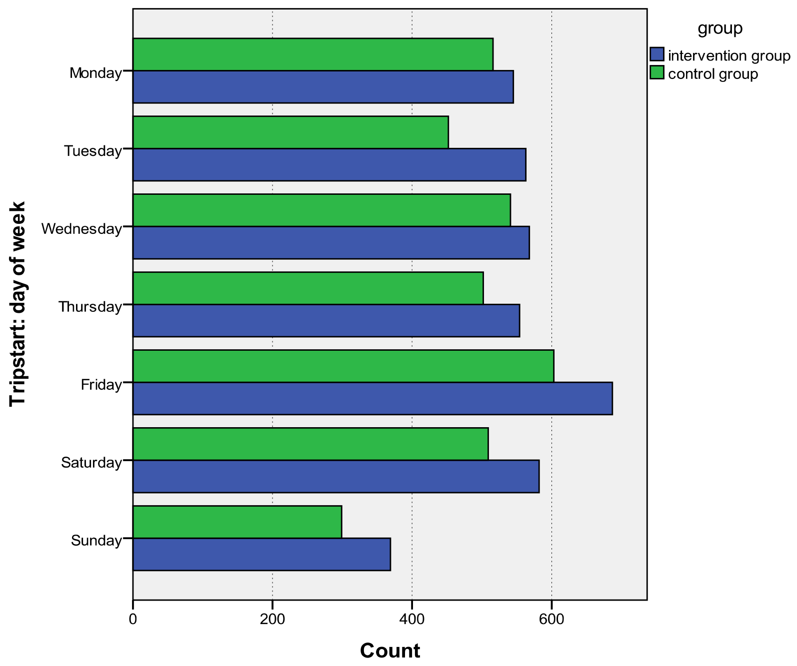



Figure 17: Randomisation: distribution comparison of trip start: day of week

Most of the trips began on a Friday, least frequently on a Sunday. Chi square test showed no statistical difference concerning the distribution in both groups (p=,362), hence the distribution in both groups can be regarded as identical.

Furthermore, a distinction between day- and night time was made and simply based on a cut-off-value: Driving between 19:00pm and 4:59am was considered night time driving, driving between 5:00am and 18:59pm as daytime driving. The figure below illustrates the percentage distribution of both groups:

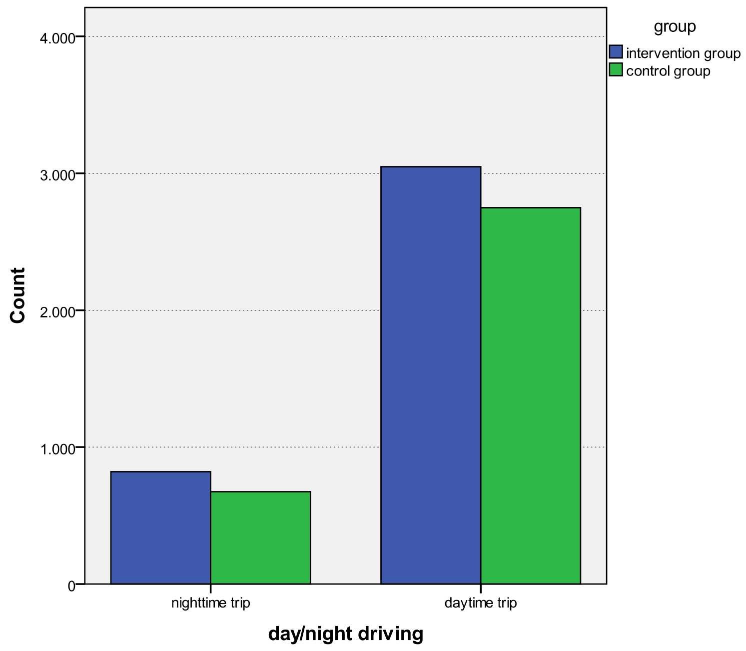



Figure 18: Randomisation: distribution of day / night-time driving

As the illustration shows, the distribution of day- or night time trips was equal among the groups, no significant difference occurred as a Chi-Square test revealed (p=,112).

#### 4.1.3.3 Randomisation: Event rate index

Described under section 2.2.4, normalised event rates were calculated for both driving dynamics as well as speeding events.

The distribution regarding the driving dynamics event rate is presented below:

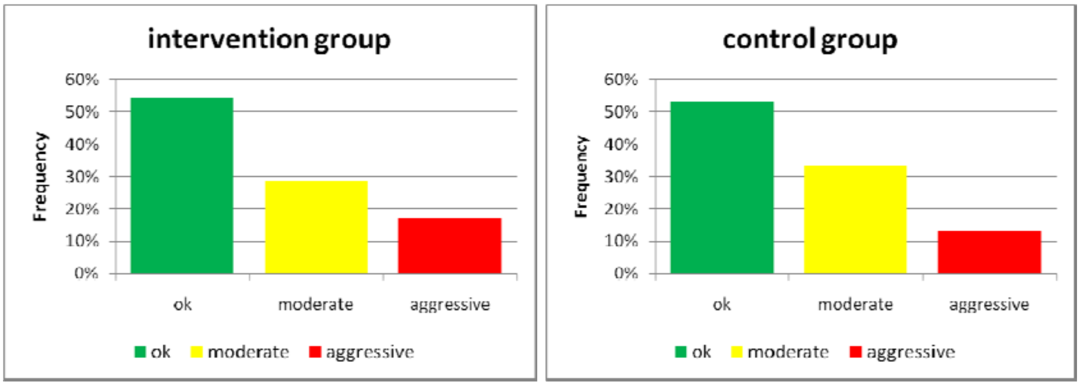



**Figure 19: Randomisation: distribution of driving dynamics event rate**

The figure demonstrates that for both groups, driving dynamics event rate prior to feedback is distributed in the same way – most common class is “ok” interpreted as safe driving, followed by the “moderate” and “aggressive” class. Chi Square test shows no significant difference (p=,872).

#### 4.1.3.4 Randomisation: Speeding time ratio

General speed behaviour was measured by the speeding time ratio. As explained above, the ratio relates the time of realised speed below the speed limit with the time spent being over the speed limit (defined as at least moderate speeding, see Table 2). It was used to detect possible differences between the groups prior to feedback. Note that for some participants of the control group, equalling to approx. 600 trips, this variable was not available due to technical reasons. As a consequence, a reduced data set was used. The table presented below provides an overview of respective mean ratios:

**Table 10: Randomisation: speed limit time ratio**

| group | speed limit time ratio | | | | |
|---|---|---|---|---|---|
| | n | Mean | Std. Dev. | p | Cohen´s d |
| control group | 2.886 | 5,68 | 10,41 | 0,000** | 0,118 |
| intervention group | 3.684 | 4,58 | 8,30 | | |

As illustrated above, most of the time novice drivers did not speed, as the mean values of speeding is about 5 percent for both groups. Although the p-value of the t-test is significant, effect size value suggests the conclusion that both groups are practically comparable in this respect.

#### 4.1.4 Questionnaire data of novice drivers and randomisation

In order to ensure comparability between the groups, questionnaire data was compared to identify potential differences. To calculate differences, non-parametric Mann-Whitney-Wilcoxon tests (also known as “U-tests”) were used; respective p-values are shown in the right columns indicating statistical significance (see section “Definitions”).

##### 4.1.4.1 Age and duration of license holding

The table below presents the age distribution within both analysed groups (Table 11):

Table 11: Questionnaire novice drivers: Distribution of age

| group | age in years | | | |
|---|---|---|---|---|
| | 17 | 18 | 19 | p |
| control group | 10 | 26 | 1 | 0,857 |
| intervention group | 10 | 25 | 2 | |
| total | 20 | 51 | 3 | 74 |

There was no statistical difference as regards age distribution among the groups.

It was checked whether group subjects differ regarding their driving experience made until the start of the study. Table 12 illustrates the distribution in this respect:

Table 12: Questionnaire novice drivers: Distribution of license holding duration

| group | months of cat. B license holding since test | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | p |
| control group | 8 | 12 | 6 | 11 | 0,965 |
| intervention group | 11 | 9 | 7 | 10 | |
| total | 19 | 21 | 13 | 21 | 74 |

Again, both groups were comparable as regards the number of months holding a category B license at the beginning of the data collection.

##### 4.1.4.2 Vehicle usage and frequency of accompanying persons

Asked about vehicle usage frequency, subjects of both groups stated to use the vehicle on a frequent basis. This reflects the prerequisite of study participation as regular driving was a requirement to take part in the study. The following table shows the distribution.

Table 13: Questionnaire novice drivers: Distribution of vehicle usage

| | vehicle usage frequency | | | | | |
|---|---|---|---|---|---|---|
| | daily | 2-3 times per week | 1-2 times per week | seldom | never | p |
| control group | 22 | 11 | 4 | | | 0,411 |
| intervention group | 25 | 10 | 2 | | | |
| Total | 47 | 21 | 6 | | | 74 |

No statistical difference occurred for vehicle usage frequency.

Novice drivers of both groups are accompanied quite often by friends, occasionally by work- or school colleagues and their parents as the next table shows:

**Table 14: Questionnaire novice drivers: Distribution of accompanying persons**

| person | group | frequency | | | | | |
|---|---|---|---|---|---|---|---|
| | | very often | often | occasionally | seldom | never | p |
| friend | control group | 6 | 13 | 11 | 6 | 1 | 0,15 |
| | intervention group | 11 | 14 | 6 | 5 | 1 | |
| | total | 17 | 27 | 17 | 11 | 2 | 74 |
| parents | control group | 1 | 4 | 12 | 19 | 1 | 0,64 |
| | intervention group | 0 | 6 | 10 | 17 | 4 | |
| | total | 1 | 10 | 22 | 36 | 5 | 74 |
| work/school colleague | control group | 2 | 7 | 13 | 8 | 7 | 0,226 |
| | intervention group | 4 | 10 | 12 | 5 | 6 | |
| | total | 6 | 17 | 25 | 13 | 13 | 74 |

There was no statistical difference as regards different types of accompanying persons between both analysed groups.

#### *4.1.4.3 License distribution and car ownership*

The following analysis presents the possession of different types of driving licenses among both groups (Table 15):

**Table 15: Questionnaire novice drivers: Distribution of licenses**

| license holding | B - cars | | AM - moped | | A1 – motorc. - 11kw | | A2 - motorc. - 35kw | | C, CE, C1 or C1E | | D, DE, D1, or D1E | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | yes | no | yes | no | yes | no | yes | no | yes | no | yes | no |
| control group | 37 | | 19 | 18 | 4 | 33 | 1 | 36 | | 37 | | 37 |
| intervention group | 37 | | 20 | 17 | 3 | 34 | 4 | 33 | | 37 | | 37 |
| p-value | | 1 | | 0,817 | | 0,693 | | 0,168 | | 1 | | 1 |

Of course, all participants have a category B license as prerequisite of study participation. About two thirds also have a license to ride a moped, whereas only few subjects are allowed to ride a motorcycle. No subject, whether CG or IG had a C or D licence. Again, no statistical differences occurred regarding the possession of different licences.

Another area of interest was if there would be difference regarding car ownership, i.e. if the novice driver can use an own car or drive with a vehicle belonging their parents. As Table 16 shows, about half of the study participants already possessed a car:

**Table 16: Questionnaire novice drivers: Distribution of car ownership**

| | car ownership | | |
|---|---|---|---|
| | own car | family´s car | p |
| control group | 19 | 18 | 0,351 |
| intervention group | 23 | 14 | |
| total | 42 | 32 | 74 |

Slightly more persons of the IG already used an own vehicle for the study participation, although this was not statistically different to the CG.

#### *4.1.4.4 Trip purpose and self-assessed exposure*

Subjects of both groups were asked about the circumstances they undertake journeys with specific regard to the trips´ purpose. The table presented below provides the overview about the participant's statements in this respect:

**Table 17: Questionnaire novice drivers: Distribution of trip purposes**

| trip purpose | group | frequency | | | | | |
|---|---|---|---|---|---|---|---|
| | | daily | 2-3 times per week | 1-2 times per week | seldom | never | p |
| way from/to school | control group | 6 | 6 | 14 | 2 | 9 | 0,665 |
| | intervention group | 11 | 7 | 3 | 5 | 11 | |
| | total | 17 | 13 | 17 | 7 | 20 | 74 |
| running errands | control group | 2 | 7 | 13 | 13 | 2 | 0,25 |
| | intervention group | 2 | 12 | 12 | 9 | 2 | |
| | total | 4 | 19 | 25 | 22 | 4 | 74 |
| leisure | control group | 6 | 12 | 13 | 6 | | 0,188 |
| | intervention group | 11 | 12 | 9 | 5 | | |
| | total | 17 | 24 | 22 | 11 | | 74 |
| way from/to work | control group | 12 | 2 | 0 | 6 | 17 | 0,717 |
| | intervention group | 11 | 2 | 1 | 4 | 19 | |
| | total | 23 | 4 | 1 | 10 | 36 | 74 |
| fun | control group | 1 | 5 | 5 | 9 | 17 | 0,973 |
| | intervention group | 4 | 1 | 4 | 12 | 16 | |
| | total | 5 | 6 | 9 | 21 | 33 | 74 |
| other | control group | 1 | 4 | 3 | 14 | 15 | 0,858 |
| | intervention group | 2 | 2 | 4 | 13 | 16 | |
| | total | 3 | 6 | 7 | 27 | 31 | 74 |

Trip purposes can be regarded as equally distributed as no significant statistical differences could be observed.

An additional important parameter for comparability of the study groups is exposure. One item of the questionnaire asked about self-assessed exposure, the distribution of both groups regarding this aspect is illustrated in the following table:

**Table 18: Questionnaire novice drivers: Distribution of monthly exposure self assessment**

| group | monthly exposure | | | | | |
|---|---|---|---|---|---|---|
| | up to 250km | up to 500km | up to 750km | up to 1000km | more than 1000km | p |
| control group | 8 | 14 | 8 | 3 | 4 | 0,416 |
| intervention group | 9 | 11 | 1 | 8 | 8 | |
| total | 17 | 25 | 9 | 11 | 12 | 74 |

From a statistical angle, self-assessed exposure was identical as no significant differences were found in this respect.

#### 4.1.4.5 Usage of internet and connected devices

Study participants were asked about their internet usage habits. The following table presents the distribution of answers for both groups:

**Table 19: Questionnaire novice drivers: Distribution of internet usage**

| group | internet usage frequency | | | | | |
|---|---|---|---|---|---|---|
| | daily | 2-3 times per week | 1-2 times per week | seldom | never | p |
| control group | 31 | 3 | 1 | 2 | | 0,926 |
| intervention group | 31 | 5 | 0 | 1 | | |
| total | 62 | 8 | 1 | 3 | | 74 |

Both groups state more or less identical internet usage frequency. More precisely, authors asked which devices and how often they are used:

**Table 20: Questionnaire novice drivers: Distribution of smartphone, PC and tablet usage**

| device | group | frequency | | | | | |
|---|---|---|---|---|---|---|---|
| | | very often | often | occasionally | seldom | never | p |
| Smartphone | control group | 27 | 10 | | | | 0,59 |
| | intervention group | 29 | 8 | | | | |
| | total | 56 | 18 | | | | 74 |
| PC | control group | 10 | 15 | 6 | 6 | | 0,486 |
| | intervention group | 7 | 14 | 13 | 3 | | |
| | total | 17 | 29 | 19 | 9 | | 74 |
| tablet | control group | 4 | 5 | 4 | 8 | 16 | 0,266 |
| | intervention group | 3 | 3 | 2 | 9 | 20 | |
| | total | 7 | 8 | 6 | 17 | 36 | 74 |

Nearly every participant stated to use the smartphone frequently, followed by PC usage. Participants of both groups declare to use tablets less compared to other devices. For all three devices, usage was identical from a statistical point of view.

#### 4.1.4.6 Awareness and impact of data logger presence

Study subjects were asked about how often they themselves noticed the presence of the data logger during a trip and secondly, how often their attention was drawn to the data logger by accompanying persons. Results for both questions are illustrated in the following table:

**Table 21: Questionnaire novice drivers: Distribution of general awareness of data logger presence**

| awareness | group | frequency | | | |
|---|---|---|---|---|---|
| | | permanently | occasionally | never | P |
| themselves | control group | 11 | 25 | 1 | 0,948 |
| | intervention group | 12 | 23 | 2 | |
| | total | 23 | 48 | 3 | 74 |
| accompanying persons | control group | 12 | 22 | 3 | 0,323 |
| | intervention group | 16 | 19 | 2 | |
| | total | 28 | 41 | 5 | 74 |

Nearly all subjects of both samples were permanently or occasionally aware about the presence of the in-car data logger during trips and likewise, both were frequently asked by co-drivers about the visibly installed device. Analysing their own attention for the data logger, study participants of both investigated groups stated nearly identical experiences as the p-value was close to 1.

As regards the stated behaviour of accompanying persons, the difference between the groups is smaller, although not statistically significant. Table 22 provides an overview about different situations which draw drivers' attention to the data logger. Subjects of both groups were asked at which occasion they have been reminded of the data logger installation, i.e. when entering the car, during trip start and at some stage during the trip.

**Table 22: Questionnaire novice drivers: Distribution of awareness of data logger presence in different situations**

| situation | group | yes | no | p |
|---|---|---|---|---|
| car entry | control group | 29 | 8 | 0,428 |
| | intervention group | 26 | 11 | |
| | total | 55 | 19 | 74 |
| trip start | control group | 19 | 18 | 0,41 |
| | intervention group | 15 | 21 | |
| | total | 34 | 39 | 73 |
| during trip | control group | 8 | 29 | 0,13 |
| | intervention group | 14 | 23 | |
| | total | 22 | 52 | 74 |

When entering the car, almost all participants noticed the presence of the data logger, presumably as the device beeps when waking up from sleep mode, typically triggered by movement such as opening the door.

Subjects were reminded of data logger presence with less frequency during a trip. This result is in line with the result shown in the previous table, i.e. drivers were occasionally reminded about the data loggers' presence. However, no statistical differences were found between the groups, independently of the situation.

One main interest of the project was if the data logger influences drivers´ own subjective driving style. Statements of both groups are presented within the next table:

**Table 23: Questionnaire novice drivers: Distribution of data loggers´ influence on own driving style**

| group | influence on own driving style | | |
|---|---|---|---|
| | yes | no | p |
| control group | 3 | 34 | 0,034* |
| intervention group | 10 | 27 | |
| total | 13 | 61 | 74 |

Here, a significant difference between the investigated groups could be found. As this question was posed at the end of the data collection, the result provides an indication that obviously the presence of the data logger in correlation with parental feedback had a subjective impact on driver’s behaviour, at least for some of the study participants.

From the above described comparison results, it can be concluded that on the basis of self-reported data collected by questionnaire; both groups do not differ from each other in a statistical sense and are therefore comparable. As a consequence, based on questionnaire data, the random allocation of test subjects to one of the groups can be regarded as successful.

### 4.1.5 Randomisation conclusion

Comparing the results deriving from questionnaire data, it can be concluded that participants of both groups are similar.

Referring to trip mileage, differences between the groups occurred, but due to very small effect sizes these differences are assessed as negligible and therefore both groups are claimed to be comparable. Nevertheless, subsequent analyses were based on normalised data, e.g. event rates per driving minute.

All other trip characteristics showed no significant difference between the groups.

In terms of safety-relevant driving parameters, no significant differences could be observed during the first month without parental feedback.

Therefore, results regarding subjective statements, demographics as well as safety-relevant driving behaviour suggest that randomisation can be regarded as successful.

Consequently, changes occurred after the observational periods without feedback, expressed by means of observed safety-relevant parameters, are therefore most likely

- attributed to behavioural changes of novice drivers, which were
- triggered by parental feedback,
- stemming from novice drivers´ driving data representation,
- received via weekly summary safety reports and/or the website safety information.

## 4.2 Comparison of safety relevant behaviour by means of driving data

### 4.2.1 Event rate index

Described in section 2.2.4, a normalised event rate index was calculated based on harsh driving manoeuvres, expressing a sum of registered events per minute of driving. Data was aggregated over the observation period for both groups in order to compare potential different developments of risky driving over time, where a higher index value represents a more undesirable driving style. The figure below depicts the development of the averaged event rate index for both groups over time:

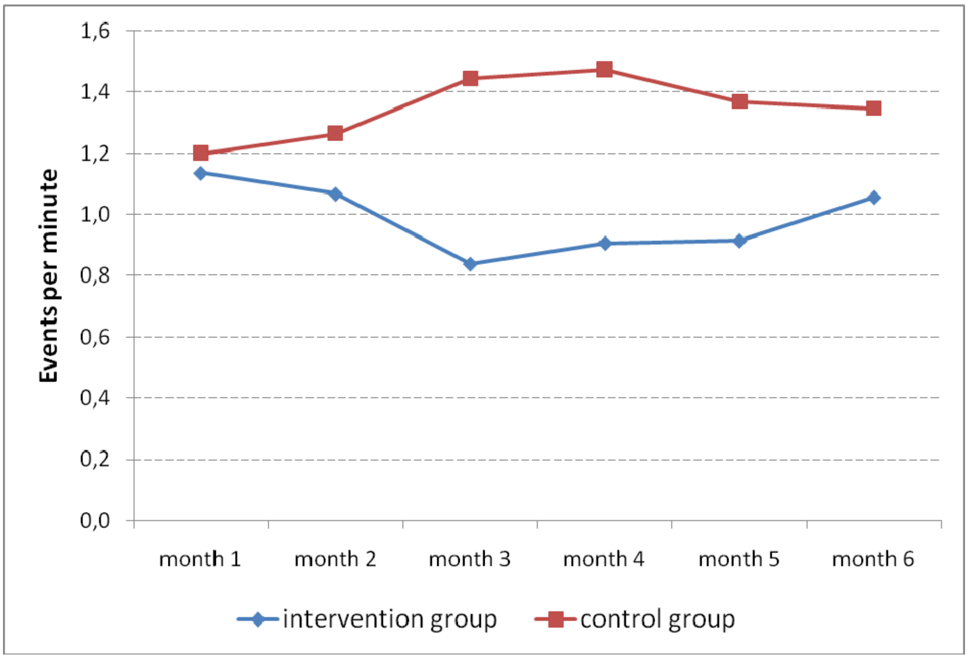



**Figure 20: Results: Averaged Event Rate Index per month for each group**

The graph shows the average event rate as squares for each observation month. The development suggests differing progress over time for the groups, where the group receiving feedback performs towards a more favourable direction.

At the beginning of the project, both groups seem to perform quite evenly. This assumption is supported by the findings described in the previous chapter. At least visual difference occurs from month two onwards, where the novice drivers of the IG started to receive parental feedback.

To examine whether or not the groups differ also in statistical terms, analysis of co-variance (ANCOVA) procedures were uses to identify significant differences between groups and estimate potential confounding or interacting variables such as exposure at the same time.

As homogeneity of variances is required for ANCOVA procedures, Levene´s test of homogeneity of variances was calculated for each month:

**Table 24: Results: Event rate index, homogeneity of variances**

| month | Levene Statistic | df1 | df2 | p |
|---|---|---|---|---|
| month 1 | ,276 | 1 | 63 | 0,609 |
| month 2 | 1,747 | 1 | 63 | 0,191 |
| month 3 | 2,866 | 1 | 61 | 0,096 |
| month 4 | 7,023 | 1 | 60 | 0,01* |
| month 5 | 2,211 | 1 | 54 | 0,143 |
| month 6 | 1,036 | 1 | 45 | 0,314 |

Note that homogeneity of variances was not given in month 4, indicated by a significant value. The subsequent ANCOVA table presents differences between investigated groups regarding the dependent variable, which was the event rate index. Effect sizes are displayed in the “Partial Eta Squared” (see section “Definitions”) column:

**Table 25: Results: Event rate index, ANCOVA table**

| month | variable | Mean Square | F | p | Partial Eta Squared |
|---|---|---|---|---|---|
| month 1 | group | ,114 | ,182 | ,671 | ,003 |
| | exposure | ,325 | ,520 | ,474 | ,008 |
| month 2 | group | 1,000 | 1,562 | ,216 | ,025 |
| | exposure | ,379 | ,591 | ,445 | ,009 |
| month 3 | group | 3,992 | 7,906 | ,007** | ,116 |
| | exposure | ,051 | ,101 | ,752 | ,002 |
| month 4 | group | 5,042 | 6,983 | ,011* | ,106 |
| | exposure | ,082 | ,114 | ,737 | ,002 |
| month 5 | group | 2,841 | 3,575 | ,064 | ,063 |
| | exposure | ,173 | ,218 | ,642 | ,004 |
| month 6 | group | 2,671 | 3,507 | ,068 | ,074 |
| | exposure | ,979 | 1,286 | ,263 | ,028 |

From the table it can be seen that both groups differ significantly from month 3 and 4, the difference between the groups in month 5 and 6 can be interpreted as a statistical trend. No significant effects occurred regarding exposure as potential influencing variable (covariate) on the event rate index.

Effect sizes increase over time, peaking in month 3, decreasing until month 6 again. The maximum observed eta square value of ,116 for the group factor in the third month, and value over ,1 in month 4 are regarded as moderate effects.

The differing development graphs in the presented illustration and the significant differences of the event rates among both groups from month 3 onwards suggest that parental feedback on driving behaviour based on telematic data can notably alter teen driving towards a safer driving style during first months after licensure.

### 4.2.2 Speeding time ratio

General speed behaviour was measured by a speeding time ratio, relating the time of speed below and above the posted speed limit. Aggregated monthly data was used to calculate comparisons in this context. Figure 21 indicates its development during the project duration:

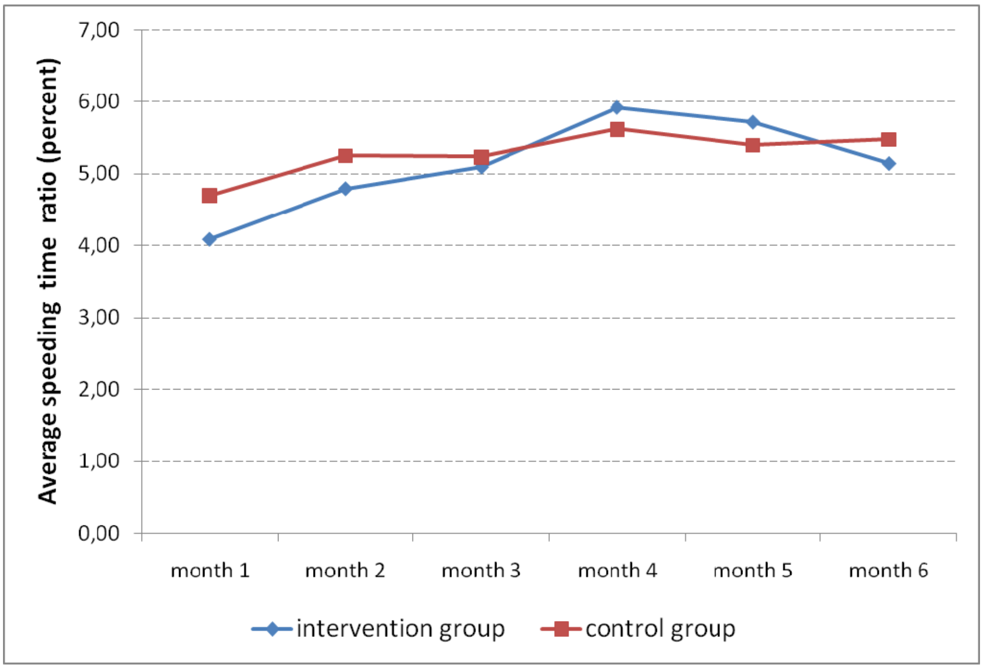



**Figure 21: Results: Averaged speeding time ratio per month for each group**

For both groups average speeding time ratio ranged approximately between 4 and 6 percent, over the observation period. ANOVA procedures were used to compare averaged speeding time ratios, the table below illustrates Leven´s test of variance homogeneity:

**Table 26: Results: Averaged speeding time ratio all zones, homogeneity of variances**

| month | Levene Statistic | df1 | df2 | p |
|---|---|---|---|---|
| month 1 | 1,972 | 1 | 65 | 0,165 |
| month 2 | ,374 | 1 | 65 | 0,543 |
| month 3 | ,155 | 1 | 65 | 0,695 |
| month 4 | 2,136 | 1 | 63 | 0,149 |
| month 5 | ,335 | 1 | 56 | 0,565 |
| month 6 | ,111 | 1 | 47 | 0,740 |

Homogeneity of variances was given in all months for both groups, which are therefore comparable in this respect.

The ANOVA table presents the test statistics of the averaged speeding time ratio for every month, between groups:

**Table 27: Results: Averaged speeding time ratio all zones, ANOVA table**

| month | Mean Square | F | p |
|---|---|---|---|
| month 1 | 6,175 | ,389 | ,535 |
| month 2 | 3,496 | ,271 | ,604 |
| month 3 | ,318 | ,018 | ,892 |
| month 4 | 1,415 | ,071 | ,791 |
| month 5 | 1,394 | ,071 | ,791 |
| month 6 | 1,340 | ,055 | ,816 |

Results show that the general speed behaviour is statistically identical between the groups over the observation period as no significant differences could be observed.

A more precise analysis regarding different speed zones between the groups is presented in the figures below.

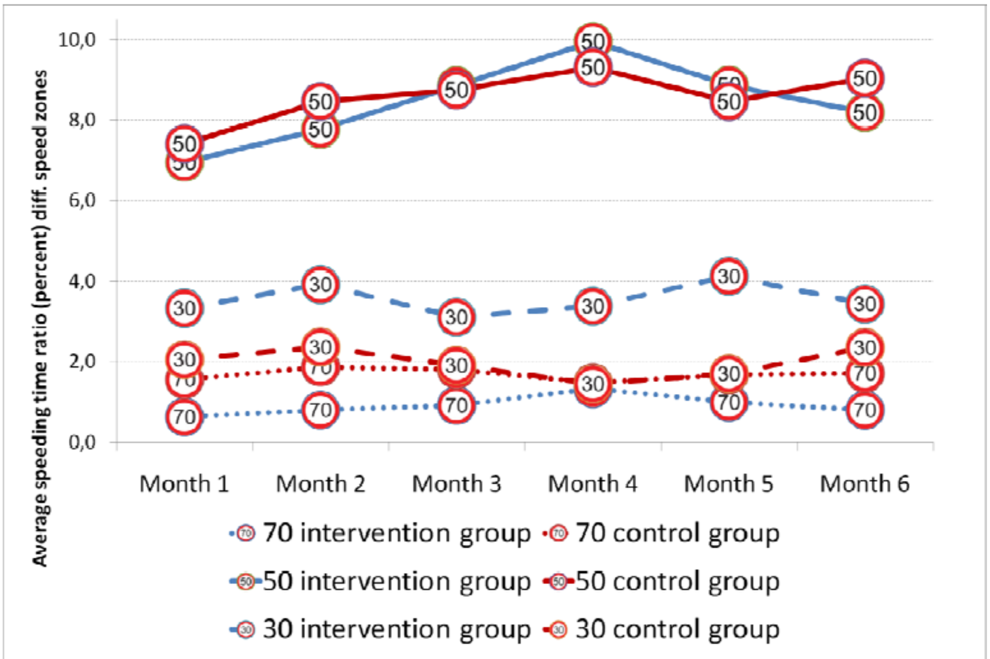



**Figure 22: Results: Averaged speeding time ratio, zones 30-50 km/h**

In the graphs, common developments over time are illustrated in all three presented speed zones. Mostly, speed choice over the posted limit was registered in 50 km/h zones, followed by 30 km/h zones. To a lesser extent, speeding was recorded in 70 km/h zones. Developments within speed zones of 100 km/h and 130 km/h are described in the illustration below:

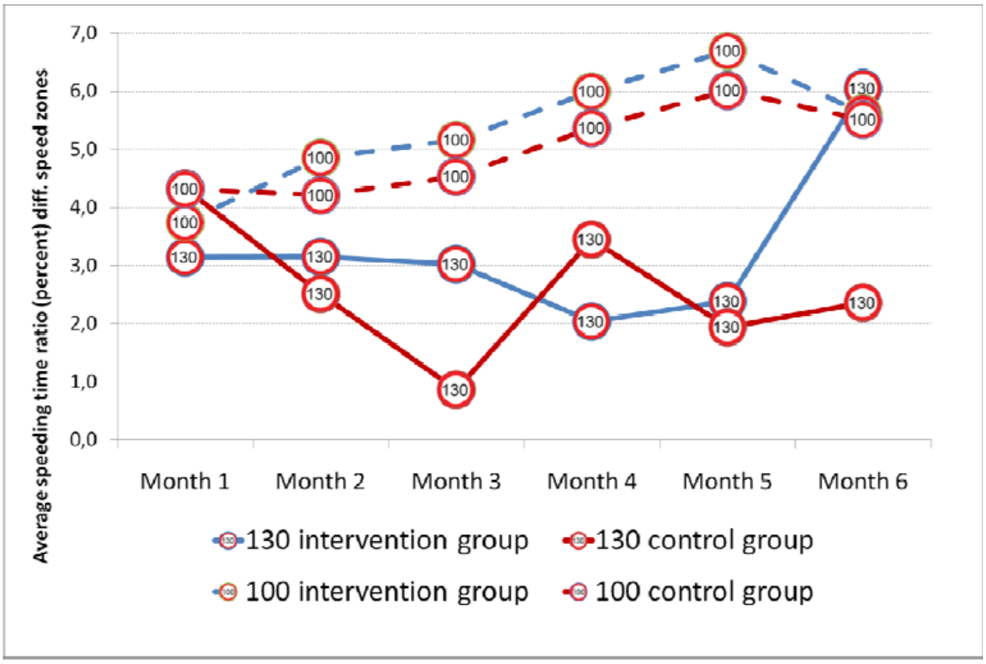



Figure 23: Results: Averaged speeding time ratio, zones 100 and 130 km/h

The graphs show comparable development within the 100 km/h zone, whereas in the highest speed zone, more variation in speeding was recorded. Here it should be noted that 130 km/h zone was less frequented by young drivers in comparison to lower speed zones.

ANOVA procedures were carried out in order to reveal possible significant differences for separate speed zones. Table 28 represents p-values stemming from comparisons of averaged speeding time rations between both novice driver groups for each speed zone and for every month:

Table 28: Results: Averaged Speeding time ratio, different speed zones

| speed zone | p-value per month | | | | | |
|---|---|---|---|---|---|---|
| | month 1 | month 2 | month 3 | month 4 | month 5 | month 6 |
| 30 km/h | ,291 | ,184 | ,227 | ,109 | ,088 | ,598 |
| 50 km/h | ,787 | ,659 | ,957 | ,760 | ,833 | ,732 |
| 70 km/h | ,116 | ,078 | ,206 | ,822 | ,388 | ,386 |
| 100 km/h | ,647 | ,589 | ,636 | ,708 | ,734 | ,959 |
| 130 km/h | ,632 | ,708 | ,165 | ,413 | ,724 | ,299 |

The values show that no statistical differences between groups could be found, independent of analysed speed zone and month.

These results suggest that the intervention had no statistical significant effect on the general speed behaviour among analysed novice driver groups.

This conclusion is in line with previous findings, indicating that general speed choice is vastly depending on external factors, such as site characteristics and traffic density at least most of the time (see section 1.4.1).

## 4.3 Post-trial questionnaire for parents

After the trial period, parents of novice drivers belonging to the IG were asked about their experiences with the feedback system, with 28 parents (11 female, 17 male) of the group filling out this questionnaire.

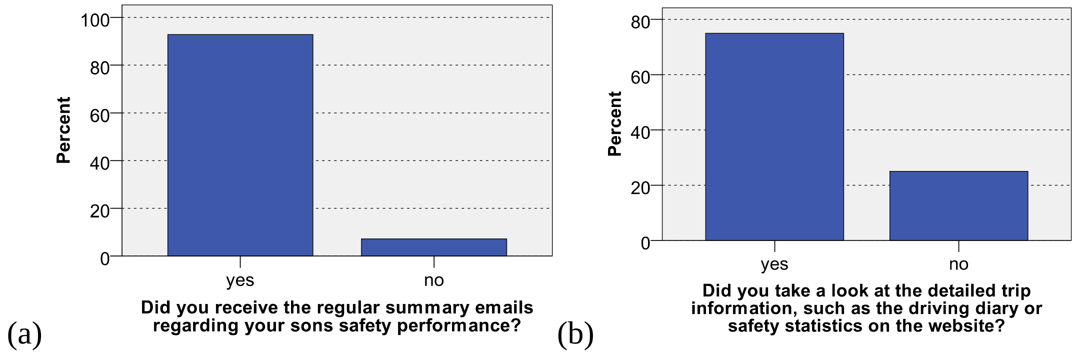



Figure 24: Post-trial questionnaire: (a) reception of summary emails, (b) website usage

Most of the parents stated that they received the safety summary emails and most of them also sought for more detailed trip information (Figure 24).

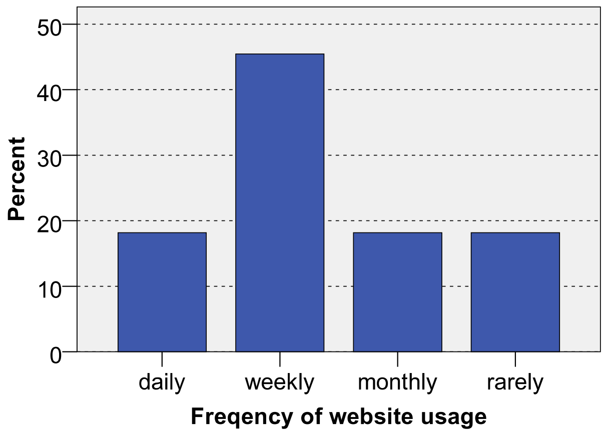



Figure 25: Post-trial questionnaire: website usage frequency

Figure 25 shows that nearly 20 percent of the parents using the website mentioned to have used it on daily basis, almost half of the parents stated to have a weekly look at the website. Another third used the detailed webpage less frequent.

Parents were also asked to assess the level of information of both, the weekly summary emails and the website. The following figure depicts these assessments:

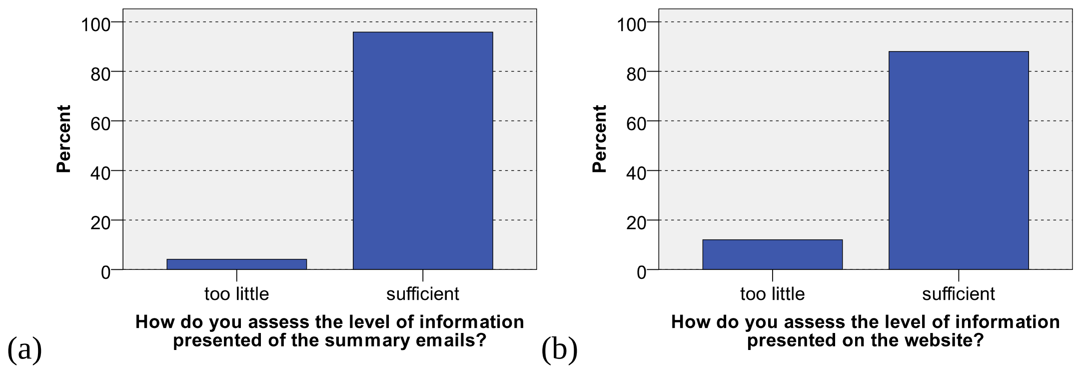



Figure 26: Post-trial questionnaire: assessment of info level (a) emails and website (b)

It was identified that “too little” information for summary emails meant, that it was unclear, how the overall trip categories green, yellow or red assessments exactly differ from each other. For the website, “too little” information on the website meant that parents asked for a detailed route information displayed on a map, as exemplary described and shown under section 2.3.1, Figure 9.

Furthermore, too little information resembled the request for more background information regarding the displayed website illustrations.

80 percent of the parents stated that they discussed about their kids driving behaviour, 50 percent of parents mentioned that the kid also viewed the website, whereas 20 percent of parents said that kids did not take a look at the data.

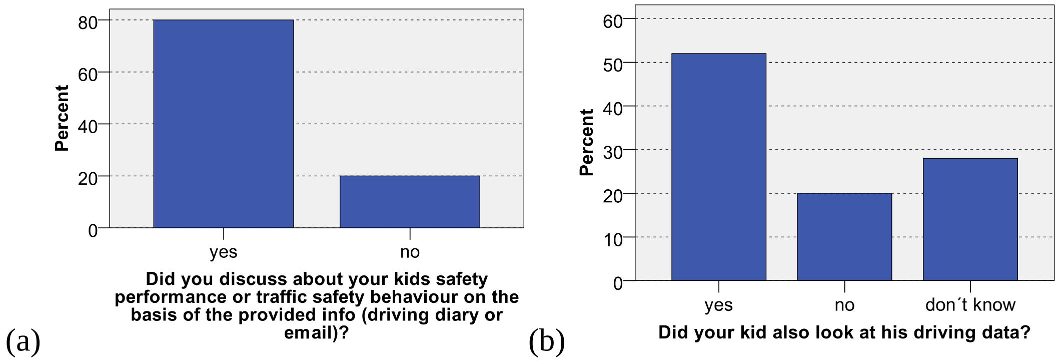



Figure 27: Post-trial questionnaire: assessment of info level (a) emails and website (b)

However, all asked parents assessed the system being useful for their kids driving. Regarding the satisfaction with the used system, almost all of the parents stated to be very or rather satisfied (Figure 27, a).

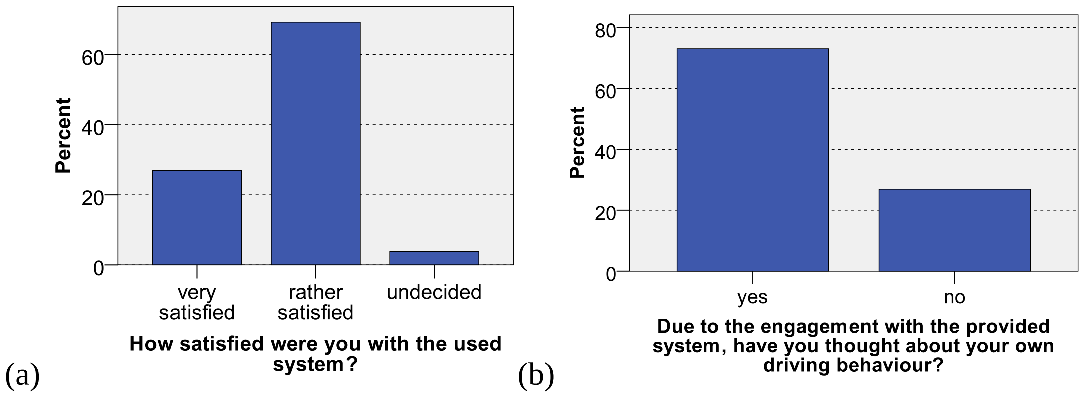



Figure 28: Post-trial questionnaire: (a) satisfaction with system (b) own behaviour thoughts

Figure 27 (b) illustrates an interesting result regarding parents´ own behaviour, as about 70 percent of parents stated that due to the engagement with the system, they thought about their own driving behaviour as well. This is a surprising result insofar as it could be possible that such an approach has potential effects not only on novice drivers, but could also affect parents driving behaviour as a side effect.

About 90 percent of the parents think that such a system should be used in the beginning of novice driver’s career, as

Figure 29 indicates:

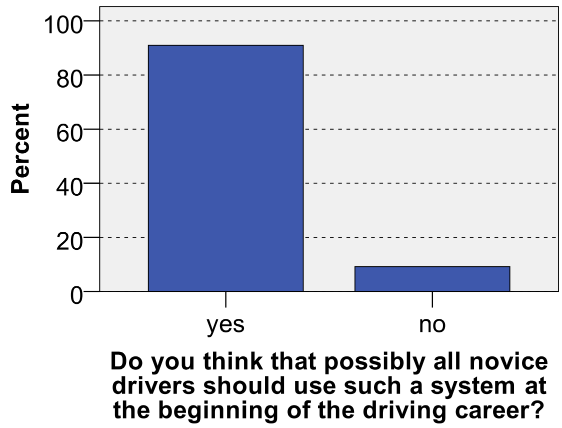



**Figure 29: Post-trial questionnaire: parents view regarding all novice drivers**

Parents, who answered “no” to this question, mentioned that such systems should be applied not for all novice drivers, but for traffic offenders. Furthermore, it was noted that such systems should be used on voluntary basis only.

Another question was if parents think about using such a system instead of existing modules of the 2nd phase training in Austria, if costs for these modules would be omitted. 40 percent would not omit any modules of the training in exchange for a telematic system, whereas for 60 percent of the respondents it could be an imaginable approach (Figure 30):

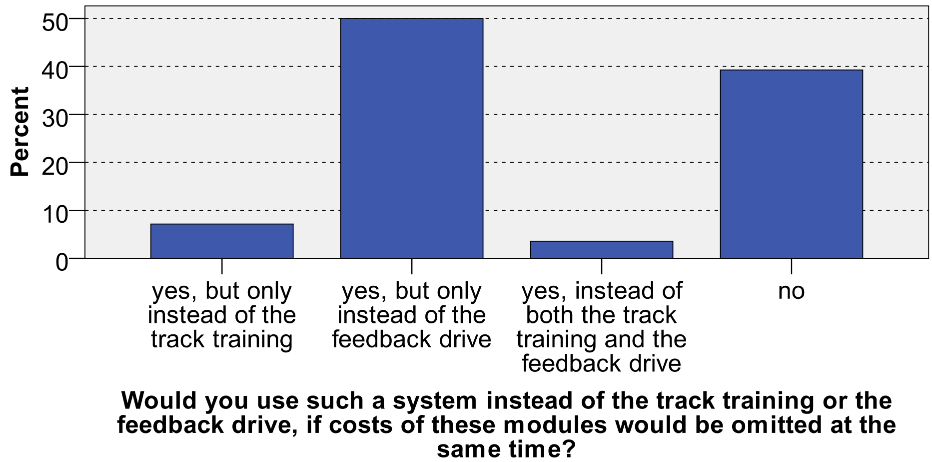
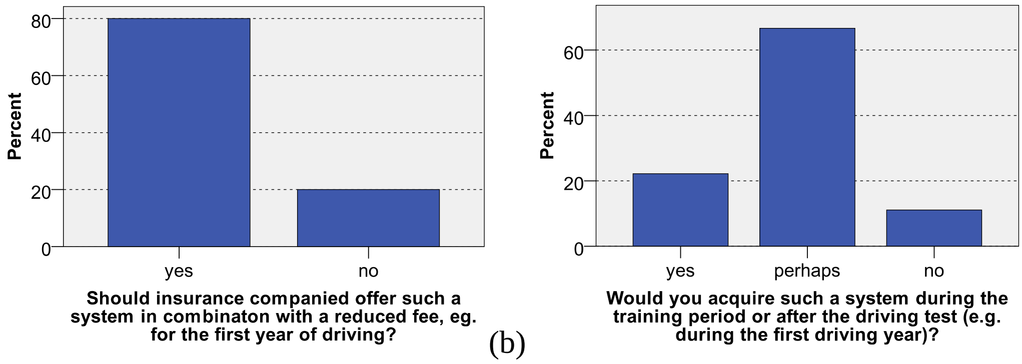



**Figure 30: Post-trial questionnaire: telematic feedback system instead of 2nd phase modules**

More precisely, half of the parents would use a telematic system only instead of the feedback drive. For about 10 percent of the parents, such an approach could replace at least the track training and/or the feedback drive of the 2nd phase education.

Lastly, parents were asked whether such systems should be offered by insurance companies for novice drivers, especially with an incentive, such as a reduced insurance fee for the first year of driving and if they would be prepared to acquire such a telematic system during the training period or after the driving test, again for the duration of the first driving year. Figure 31 below provides the results:




(a) (b)

**Figure 31: Post-trial questionnaire: (a) insurance companies (b) acquisition willingness**

The larger part of respondents (80 %) think that insurance companies should offer such systems in combination with a reduced fee, e.g. for the first driving year (Figure 31, a). Figure 31 (b) shows, that independent of an insurance product for novice drivers, the same large share of respondents would perhaps or surely buy such a telematic product during the training or post-license period.

Moreover, 70 percent of parents who would perhaps or surely acquire such a system would pay up to 100 Euros for a unit, whereas 30 percent of the respondents would spend up to 200 Euros.

### 4.3.1 Summary of post-trial questionnaire for parents

In general, the results of the post-trial questionnaire indicate a high acceptance of the used system. For instance, both the email summary and more detailed website were used on a regular basis by most of the participants. The level of information presented via these communication channels were rated as sufficient, however there is room for improvement, especially regarding transparency of the algorithms, e.g. how trips are rated or classified.

A large share of novice driver parents stated to have used the collected and processed data to provide feedback of their kids driving behaviour. An interesting potential side effect could be observed as parents claimed to think about own driving behaviour as well by the usage of the telematic system. Hence, such an approach may have not only an impact on novice drivers themselves, but additionally on parental driving behaviour.

Usage of the system was described as useful within the context of first months of teen driving, not only for the post-license period, but also before licensing.

Results investigating a common use of such a system among all novice drivers indicate a high acceptance among the surveyed sample, if implemented on voluntary basis. Moreover, a large share of parents would also exchange the feedback drive, as part of the 2$^{nd}$ phase education model, for usage of a telematic system instead.

Another finding concerns involvement of insurance companies: asked participants declared that they would appreciate an incentivised insurance scheme for their kids using a telematic system.

This outcome suggests high approval among novice driver parents, as a large share claimed to acquire a telematic system for feedback purposes. However, this conclusion must be cautiously interpreted as possible self-selecting mechanisms for study participation may have occurred.

# 5 Discussion, limitations and implications

The aim of this research study was to evaluate the impact of parental feedback on novice driver behaviour in the first six months of driving, aided by a telematic-based data recording and feedback system. Therefore, a sample of 74 pairs of male novice drivers and their parents was recruited, half of the sample was randomly allocated either to an intervention group (”IG”) or a control group (”CG”).

An in-vehicle data logger was installed in novice driver’s vehicles to obtain safety-relevant data of driving behaviour. Collected parameters were vehicle location, speed choice and g-force based driving manoeuvres, such as cornering, braking and accelerating. Collected data was automatically transferred to a web-server after trips were finished; data were processed and aggregated.

After a baseline month, participants of the IG received weekly email safety reports and obtained personal login credentials to access driving data, thus allowing parents to provide feedback about their kids´ solo driving.

Safety–relevant data was aggregated to an event risk score, summarising harsh driving manoeuvres of cornering, braking and acceleration and normalised against driving time. Speed behaviour was operationalised by creation of speeding time ratio by relating time of realised novice driver driving speed below and above posted speed limits.

Comparing both groups during the first months of driving, parental feedback aided by telematic data had beneficial effects on driving apparently. Risky teen driving develops in a different manner if parents are involved in their kids driving in such a way that from the beginning of feedback implementation, risk scores start to decrease. Largest effects were found in the third feedback month, where differences between both groups were most salient and statistically significant.

Viewing these results in the light of frameworks such as the GDE matrix or Vlakveld´s overview of contributing accident rate factors, it seems that parental feedback mostly impacts higher levels of described models, highlighting the importance of potentially provoked self-reflection processes leading to effects of personal preconditions for safe driving and impulse control.

Outcomes are also specifically comparable with two other recent study results (Lotan et al., 2012, Tarkiainen et al., 2014), where parental feedback aided by telematic data during the first months of novice driver solo driving was associated with less risky driving behaviour.

Conversely, for speed choice and speeding, no such distinct relationship was found, as speeding time ratio parameter did not statistically differ between the analysed groups during the observation period. This result applies for all five different investigated speed limit zones. Tarkianinen et al. (2014), who carried out a parallel study in Finland, found that provision of speeding maps for parents, indicating where speeding has happened, had a positive impact on novice driver speed behaviour. Nonetheless, the approach used in the underlying study omitted detailed speeding maps, mostly due to privacy reasons for novice drivers. Moreover, it was expected that too detailed speeding information may have an adverse effect on the relationship between parents and their kids, which authors did not want to affect.

However, the decision of researchers using or omitting detailed speeding maps has to be considered from case to case (or country to country), as different cultural aspects have to be taken into account, ranging from a broader societal point of view to a microscopic family level.

Results from the post-trial questionnaire for parents indicate a good acceptance of the general feedback approach and the used technical tools. From their view, such a system used voluntarily would not only make sense after licensing, but also in the learning period before. After licensure, parents would also appreciate an incentivised car insurance product for their kids, thus fostering safe driving as well.

Furthermore, it was found that parents potentially benefit from the measure as well as triggering of self-reflection processes regarding their own traffic behaviour was reported.

Despite the positive results, effects must be interpreted cautiously as authors point out that the sample may have been self-selected, which leads to a potentially biased picture. On the one hand, obtained results may lead towards too optimistic conclusions as findings are possibly not broadly transferable to all teen drivers and their parents. There may be some groups of persons who will not benefit from the investigated approach due to different personal and/or commercial reasons.

On the other hand, safety effects may be underestimated as some potential study participants refused to take part. They worried about the possible unveiling of inappropriate vehicle handling or severe traffic offences, also explicitly referred to as excessive speeding, leading to serious consequences, if undesired behaviour would be detected by their parents. However, revelation of such improper or even dangerous novice driving behaviour would likely end up in improved teen driving behaviour. In this context, insurance companies could take over the parental role as consequences of aggressive behaviour would at least have negative monetary impacts.

Generally, authors conclude that the most promising intervention strategy to lower novice drive risk is a combination of several approaches, such as coordinated programmes for accompanied driving prior to licensing involving parental feedback and telematic technology. In the first months of solo driving after licensing, insurance discount schemes, featuring parents with as much input and involvement as possible, seem promising.

It is recommended that future research should further focus on evaluating feedback technology among other target groups, predominantly in the field of professional drivers. Here, insights of a more structured and standardised feedback could be gained by investigating e.g. especially positive consequences and incentivised safety programmes within a professional framework.

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