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German smartphone survey

Part I

Prevalence of psychoactive substances and consumption patterns in traffic, based on a smartphone survey in Germany

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6th Framework Programme

Deliverable D 2.2.2

German smartphone survey

Part I

Prevalence of psychoactive substances and consumption patterns in traffic, based on a smartphone survey in Germany

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1. EXECUTIVE SUMMARY 6

2. INTRODUCTION 10

3. STUDY AND SAMPLE DESIGN 12

3.1 Study design 12

3.2 Sample design 14

4. PROCEDURE 17

4.1 Recruitment strategy 17

4.2 Time schedule 17

5. SAMPLE DESCRIPTION 21

5.1 Compliance rate 21

5.2 Sample size 22

6. TECHNICAL ASPECTS OF DATA COLLECTION 25

6.1 System overview 25

6.2 Questionnaire application on BlackBerry devices 25

6.3 Wireless data transmission 26

6.4 Database server 26

6.5 Data access and subject management 26

6.6 Performance reliability of the system 27

7. DATA POOLS 28

7.1 Smartphone data collection 28

7.1.1 Questionnaire structure 28

7.1.2 Drug use and driving interaction 29

7.1.3 Variables and adaptive layout 29

7.2 Overview of person-related data 32

7.3 Personality questionnaires 33

7.4 Structured Clinical Interview for DSM Disorders (SCID) 35

7.5 Traffic-specific performance tests (ART 2020) 36

7.6 Data integration 37

8. ADDITIONAL REQUIREMENTS 38

8.1 Ethical approval and data privacy 38

8.2 Instructions / Training 38

8.3 Financial incentive 43

8.4 Data consistency check 44
8.4.1 System-controlled consistency check 44
8.4.2 Person-controlled consistency check 45

9. DATA QUALITY 47
9.1 Comparison with existing data (representativity) 47
9.1.1 Driving 47
9.1.2 Drug use 48
9.2 Previous consumption 49
9.2.1 Description 49
9.2.2 Comparison of former and current consumption 53
9.3 Urine sample – toxicological analysis 54
9.3.1 Method 54
9.3.2 Agreement between urine and recording 54

10. DATA PRE-PROCESSING 58
10.1 Alcohol – Calculation of blood alcohol concentration 58
10.1.1 Rationale of calculation 58
10.1.2 Constraints 59
10.2 Cannabis: Calculation of THC blood plasma concentration 60
10.2.1 Rationale of calculation 60
10.2.2 Constraints 61

11. RESULTS 62
11.1 Glossary 62
11.2 Data overview 63
11.3 Main points of data analysis 64
11.4 Structure of days 64
11.4.1 Sleep-wake ratio 64
11.4.2 Structure of locations/daily activities 65
11.5 Structure of consumption: drug incidences 67
11.5.1 Drug use as a function of time 67
11.5.2 Frequency and amount of drug consumption 69
11.5.3 Consumption groups 72
11.6 Trips 74
11.6.1 Mobility as a function of time 74
11.6.2 Frequency and amount of mobility 77
11.6.3 Driving groups 80

11.7 Drug driving 81
11.7.1 Definition 81
11.7.2 Frequency 82
11.7.3 Calculation of confidence intervals 83
11.7.4 Extrapolation 84
11.7.5 Driving under influence as a function of time 87
11.7.6 Other situational characteristics 89
11.7.7 Descriptive characteristics 90
11.7.8 Identifying persons most at risk 92
11.7.9 Influence of consumption and driving frequency 94
11.7.10 Other traffic related conspicuousness 96
11.7.11 Influence of road traffic regulations 103
11.7.12 Decisions against driving under influence 104
11.7.13 Influence of perceived detection risk 117

12. DISCUSSION 120

12.1 Study aim and methodological approach 120
12.2 Study results 121
12.3 Pros and Cons of the approach 128

13. REFERENCES 131

14. ANNEX 135

14.1 Description of the website 135
14.2 Q-Start-Questionnaire 136
14.3 Q-Daily-Questionnaire 157
14.4 THC elimination curve 161
14.5 Consumption on previous day 161
14.6 Confidence intervals for BAC- / THC-positive drives 162

1. Executive summary

The present study was conducted within Work Package 2 of the EU-funded project DRUID (Driving under the influence of drugs, alcohol, and medicines) in order to estimate the prevalence of psychoactive substances within the German driver population and to identify preventive and promotive circumstances of drug driving. The results serve as major input to the discussion on drug driving, rehabilitation, and prevention.

The regular approach to estimate prevalence rates is to conduct a roadside survey. By the present study, a new methodological approach was implemented. Instead of detecting drugs in the driving population – like roadside surveys do – a sample of regular drug users out of the regular driving population were queried for four weeks about their driving and drug consumption behaviour.

In total, the sample consists of 195 drug users[1] and 100 controls out of the normal driving population stratified for sex, age (18-24-year-olds, 25-29-year-olds, 30-39-year-olds), and residence (rural, urban, and city area). To capture real-time data about drug consumption and driving, a repeated-entry diary technique was applied. A questionnaire was installed on smartphones and was filled in daily for 28 consecutive days. All activities were listed in chronological order with the focus on drug consumption and driving. Encrypted data were transmitted via GPRS and the Internet. Immediately after reception, data were checked for consistency by study assistants. In case of inconsistencies or peculiarities, the entries were discussed by phone and corrected if necessary.

The reported drug consumption and driving data were comparable to existing drug prevalence and mobility data of the general German population (ESA 2006; Kraus, Pfeiffer-Gerschel & Pabst, 2008 / “Mobilität in Deutschland” – MID 2008; for more information see http://www.mobilitaet-in-deutschland.de/engl%202008/index.htm). The synchronisation of the data about drug use and driving not only offers to assess the frequency of drug driving (i.e. prevalence rates for the general German driving population) and the situational aspects of such incidences (e.g. time, day, distance, companions). It also enables the investigation of situations that lead to refraining from driving under influence, i.e. situations that have a preventive effect on drug driving. Furthermore, an extended diagnostic part was included in the study to gather person-related characteristics (e.g. socio-demographic information, relevant previous experiences, personality variables, and attitudes). Thus, individual factors that are associated with a tendency to drug drive can be specified.

The data referred to daily activities, daily trips, drug consumption and driving, and the frequency and circumstances of drug driving of users and controls, respectively. The results show differences between users and controls on several variables. The users go to bed later at night and get up later in the morning compared to controls. In the evening and at night they stay out more often at private locations (i.e. at friends’) whereas controls more often visit public locations, like restaurants, clubs, etc.. In general, users are more

[1] Originally 200 users, 5 were excluded from all analyses because they did not use cannabis within the study period.

mobile at night compared to controls who are more mobile at usual rush-hour times. So, the controls' days proceed more along a daily working routine. Even if controls are less mobile at night, they conduct more drives as driver whereas users more often use alternative modes of transportation at that time. Compared to controls, drug users consume alcohol more frequently and in higher doses. At the same time, they drive more than twice as often under the influence of alcohol than controls.

For defining a drive as being under influence, BACs and THC blood plasma levels were calculated using the information given by the subjects in their daily reports about the consumed amount of alcohol and cannabis and the time delay between consumption and driving. For the BAC calculation, the Widmark formula was applied (Widmark, 1932), for the calculation of THC blood plasma levels, the elimination curve determined by Sticht (G. Sticht, personal communication, December 2009). A drive was classified as under influence if the corresponding BAC was 0.01% or higher and the THC blood plasma level was 1ng/ml or higher, respectively. For all other substances, the doubled half life (Schulz & Schmoldt, 2003; Passie, Seifert, Schneider & Emrich, 2002; Prisinzano, 2005) was used to define a drive as drive under influence: Drives within the doubled half life time after consumption were classified as drug-positive.

Averaged per person, 20.5% of the users' drives were under the influence of drugs. The most prevalent drug found while driving was cannabis. The mean percentage of drives under the influence of cannabis alone was 13.1% (total – i.e. drug combinations included: 14.8%). On average, 4.1% of the users' drives were under the influence of alcohol (total: 5.4%) and 1.5% under the influence of stimulants (amphetamine, ecstasy, cocaine – total: 2.2%). The mean percentage of drives under the influence of multiple drugs was 1.8% (cannabis/alcohol, cannabis/stimulants, alcohol/stimulants, cannabis/heroin, cannabis/alcohol/stimulants). The most frequently found drug combination was alcohol and cannabis (1%). The cut-off values for defining a drive as drive under influence are rather low (BAC≥0.01%, THC blood plasma level≥1ng/ml). When applying higher cut-off values, like a BAC of 0.05% and a THC blood plasma level of 4ng/ml[2], the mean percentage of drives under influence within the user sample drops by around 40% from a previous 20.5% to 13.1%.

Via existing mobility measures and prevalence data for drug use in Germany (ESA 2006, MID 2008), the survey results were extrapolated into alcohol, THC, and stimulants[3] prevalence rates for the general German driving population. According to this estimation, the prevalence for THC-positive drives (THC blood plasma level≥1ng/ml) in Germany is 0.14% (95% CI: 0.09% - 0.2%). For drives under the influence of stimulants (cocaine in- or excluded), the prevalence is 0.02% (95% CI: 0.01% - 0.04%). For drives under the influence of multiple drugs (any drug combination, alcohol included), the prevalence is 0.02% (95% CI: 0.01% - 0.03%). For drives under the influence of alcohol in combination with an illegal drug, the prevalence is 0.01% (95% CI: 0.006% - 0.02%). For the 18-24-year-old German population, the prevalence for alcohol-positive drives (BAC≥0.01%) is 1.57% (95% CI: 0.52% - 2.7%) and 3.3% (95% CI: 1.63% - 5%) for 25-39-year-olds.

Compared to the results of the German roadside survey (Cannabis: 0.57%; alcohol: 18-24-year-olds: 3.76%; 25-49-year-olds: 5.48%) from 1994 (Krüger et al., 1996), the prevalence rates found within the present study seem fairly low. However, amendments to

[2] According to Berghaus, Sticht and Grellner (2011) a THC blood plasma concentration of 3.8ng/ml corresponds to a BAC of 0.05% concerning the performance impairing effects of the substance.
[3] Stimulants=amphetamine, ecstasy, cocaine.

traffic regulations for drink and drug driving within the last few years might serve as an explanation for changed prevalence rates for drives under influence in Germany. In 1998, the legal BAC limit for driving a motor vehicle in traffic was lowered from 0.08% to 0.05%. Moreover, the 0.00% BAC limit for novice drivers[4] was introduced in 2007. A positive trend concerning alcohol drives within the last years can also be shown by other traffic related indicators. Alcohol-related accidents (Vorndran, 2009) and alcohol related records at the Central Register of Traffic Offenders (Federal Motor Transport Authority – Jahresbericht 2004, Jahresbericht 2009) decreased within the last few years. Furthermore, it was not until 1998 that a law was introduced in Germany that makes driving under the influence of illegal substances prosecutable in the first place. Since then, the screening of illegal drugs in traffic has become more prevalent and the detection devices more precise. So, the probability of being detected while driving under the influence of an illegal drug has become higher. Because of the higher deterrence effect, drug users may have altered their drug driving behaviour towards more conformity with the law within the last few years.

But who then is contributing to the occurrence of DUI? Does every drug user commit drives under influence or is it a special sub-group that particularly shows unlawful behaviour in traffic by drug driving? When considering drives with a positive THC blood plasma level of 4ng/ml and higher and/or drives with a positive BAC above the legal limit, only 20% of all users were responsible for 80% of all substance-positive drives and 19% of all users had no substance-positive drive at all.

A striking predictor for frequent drug driving and highly impaired driving in general is a high consumption frequency. Excessive substance users especially commit most substance-positive drives and have higher substance blood levels while driving compared to moderate or heavy drug users. Moreover, the subjective impairment for alcohol was found to be dependent on the substance blood level while driving in the case of moderate to heavy alcohol users: the higher the BAC while driving, the higher the subjects felt impaired. For cannabis this dependency was also found for moderate to heavy cannabis users but not for excessive users. So, the more one consumes the lower the correlation between objective intoxication and subjective impairment is. Even if excessive users are more intoxicated while driving, they do not feel more impaired. These findings indicate a lower threat for traffic safety in the case of moderate substance use whereas excessive substance use is associated with a higher frequency of drug driving, a higher intoxication while driving, and a lower subjective feeling of impairment. Further on, it was found that the height of the valid BAC limit for driving (0.00% for novice and young drivers, 0.05% for all other drivers) has an effect on the frequency of BAC-positive drives. If the lower limit applies, controls drive less often under the influence of alcohol.

Other factors of influence are the perceived risk of being stopped by police, the distance, the availability of alternative modes of transportation, and the presence of companions. The more probable a person thinks a police stop could occur, the more often the person decides against drug driving. Moreover, a drive under influence occurs less likely, the longer the distance is that needs to be travelled. In rural areas and bigger cities the probability of driving under influence rises compared to smaller cities. In smaller cities the persons can walk or use the bike to cover the rather short distances. Even if in bigger cities the availability of public transport in general is high, this offer is limited especially at times when drug driving is most prevalent, i.e. at night and on weekends. The results also

[4] All drivers between the ages of 18 and 21 and newly licensed drivers of any age for the first two years of having a licence.

suggest that female companions while driving lower the probability of drives under influence, especially when the driver is male.

The present study could also demonstrate that users do not seem to be more at risk in road traffic than controls. This finding is based (1) on the records that are stored in the German Central Register of Traffic Offenders and (2) on self-reported dangerous traffic situations within the study period. So, except from driving under influence, there is no evidence to suggest that DUI offenders also show problematic behaviour according to other traffic-related measures.

When conducting the study, two challenges were faced – the recruitment of the subjects and the implementation of the new method of using smartphones as study devices. Much effort had to be spent on a transparent picture of the study in the public and on a broad and intense recruitment strategy. Thus, the final sample comprises of 195 regular drug users who were willing to participate in the study and who reported their illegal behaviour, namely their drug use. Random sampling was not viable, but the comparison of the sample with confounding population parameters showed that it reflects the general population quite satisfactory. The new method was developed in an iterative process. The developmental work consisted of the conceptual design of the rather complex smartphone questionnaire, the planning and organising of the study schedule, and the intense and comprehensive control of the data for data inconsistencies immediately after receiving them.

All in all, it seems that the new method implemented by the present study does not have too many restrictions compared to the complex design of roadside surveys. Instead, it establishes a database for not only quantifying the drug driving prevalence but also for analysing mediating and modifying factors.

2. Introduction

One main objective of the DRUID project is to determine the prevalence and accident risk of alcohol and other psychoactive substances in the general driving population in Europe. There are numerous methodological approaches for estimating the relative risk (e.g. case-control-studies, culpability studies) whereas there is only one reliable approach for estimating prevalence rates, i.e. conducting a roadside survey. Nevertheless, only few roadside surveys have been carried out in Europe so far (for example, Krüger, Schulz & Magerl, 1996). One reason for this is the time and organisational effort as a large sample size is necessary, especially when looking for substances with a low prevalence in traffic. Another reason is legal restrictions that impede the realisation of roadside surveys.

For estimating the prevalence of drug consumption in general, representative data documented by national and international institutions every few years can be used. In Germany, the data of the "Epidemiological Survey on Substance Abuse Among Adults in Germany 2006" (ESA 2006; Kraus, Pfeiffer-Gerschel & Pabst, 2008) are available. There are also representative data about driving behaviour from the survey "Mobility in Germany 2008" ("Mobilität in Deutschland" – MID 2008; for more information see http://www.mobilitaet-in-deutschland.de/engl%202008/index.htm). Nevertheless, what has been lacking up to now is the combination of data about the consumption of psychoactive substances and driving behaviour in order to get information about the frequency of driving under the influence of psychoactive substances (DUI) in Germany

The basic intention of the present study, which is part of Work Package 2, is to close this gap by introducing a new methodological approach. Instead of detecting drugs in the driving population, as roadside surveys do, drug using subjects who regularly drive a motor vehicle were queried about their drug consumption and driving behaviour. An electronic questionnaire presented on smartphones had to be filled in by the subjects each day for 28 consecutive days. Synchronizing these data about drug consumption and driving incidences makes it possible to determine the occurrence of drug driving. Furthermore, the circumstances under which drug driving occurs can be analysed, as surrounding conditions like situation, time of day, and companions were recorded as well. Another advantage of this approach is that portable recording devices like smartphones allow the subjects to report behaviour promptly after it has been occurred. Therefore, biases resulting from retrospective reporting can be minimized and the overall quality of data maximized.

Moreover, information about current consumption and driving habits, data about former experiences, relevant socio-demographic data, personality traits, and attitudes towards drug driving were gathered by paper and pencil questionnaires. Thereby, the characteristics of drug driving individuals can be specified in order to give recommendations for rehabilitation and prevention.

To cover the whole population of interest, a sample was drawn stratified according to driving-relevant variables (gender, age, and residence). In total, 195[5] drug users and 100 controls (no use of illicit drugs; alcohol consumption allowed) were included. The sample structure of the control group resembles the sample structure of the user group, as for every second user a matched pair in the control group exists. Consumption data were validated by a urine sample and as the driving data compared to representative data (ESA 2006, MiD 2008). The representative data also served as a database from where weights were deduced from to extrapolate the number of drug driving incidences found within the sample into representative figures.

[5] Originally 200 users, 5 were excluded from all analyses because they did not use cannabis within the study period.

3. Study and sample design

3.1 Study design

The intention of the survey was to combine driving and drug use behaviour of a sample drawn from the general population in order to make assumptions about the frequency and the circumstances of drug driving. The intended sample should reflect the population of interest as close as possible to be able to make generally valid statements about drug driving incidences. In order to reach the demand for representativity of the sample, the following considerations were taken into account:

1) The whole population consists of drivers and non-drivers. To make general assumptions about driving, the sample needs to be drawn from the driver population

2) The whole population consists of drug users and non-users. To make general assumptions about drug use, the sample needs to be drawn from the user population

3) The closest representation of the real amount of driving and drug use will be achieved by sampling those persons who show the behaviour of interest frequently. Persons who drive or use drugs rather infrequently only account for a little proportion of the whole phenomenon and are therefore negligible. The chance to drive under the influence of drugs is minimized as soon as the person practically never or almost never drives or uses drugs.

According to representative data about driving behaviour in Germany (MID 2008) up to 80% of all drives are travelled by persons who drive daily or weekly. According to representative data about drug use in Germany (ESA 2006), the highest prevalence rates for current drug use are found for the population of 18-39-year-olds[6]. The population of 18-39-year-old persons who use drugs on a regular basis (defined as >3x in 30 days) accounts for around 80% of all drug incidences.

After these considerations, the inclusion criteria were determined as follows.

1) Age 18-39

2) Availability of a vehicle and weekly driving

3) Weekly drug use

There is clear evidence that characteristics of driving strongly depend on gender, age, and residence (MiD 2008). The same holds true for the consumption of psychoactive substances, at least for the factors age and gender (ESA 2006). To cover the whole population of interest, the sample was stratified concerning these variables.

[6] 30-days-drug-prevalence for different age categories: 9.2% (18-20-year-olds), 8% (21-24-year-olds), 5.1% (25-29-year-olds), 3% (30-39-year-olds), 1.2% (40-49-year-olds), 0.3% (50-59-year-olds), 0% (60-64-year-olds).

The stratification variables were determined as follows:

1) Age group: 18-24, 25-29, 30-39

2) Gender: Male and female

3) Residence: Rural (<50,000), urban (<500,000), and city areas (>500,000)

For every second drug user, a paired control was admitted to the study. The pairs were matched based on the variables gender, age, and residence. Thus, for the control group the same sample structure was realized as for the user group. It was also tried to match only those subjects for whom the same legal alcohol limits apply. In Germany, the zero tolerance applies for persons with a probationary licence and young drivers aged below 21. For all other drivers, the legal BAC amounts to 0.05%.

On the supposition that the sample corresponds to the population of interest on the relevant variables, the results of the survey can be extrapolated into representative figures. Existing national mobility and drug use data that were referred to earlier (MiD 2008, ESA 2006) served as a database from where weights were deduced from to estimate the proportion of drives that are travelled by persons who regularly drive and regularly use drugs.

By the realization of this design (Figure 1) three main questions can be answered:

1. Are there any differences between drug users and non-users concerning driving and alcohol consumption?

2. How high is the prevalence rate for driving under influence (DUI) in the general population, estimated on the basis of the results of this survey?

3. Under which circumstances does driving under influence occur?

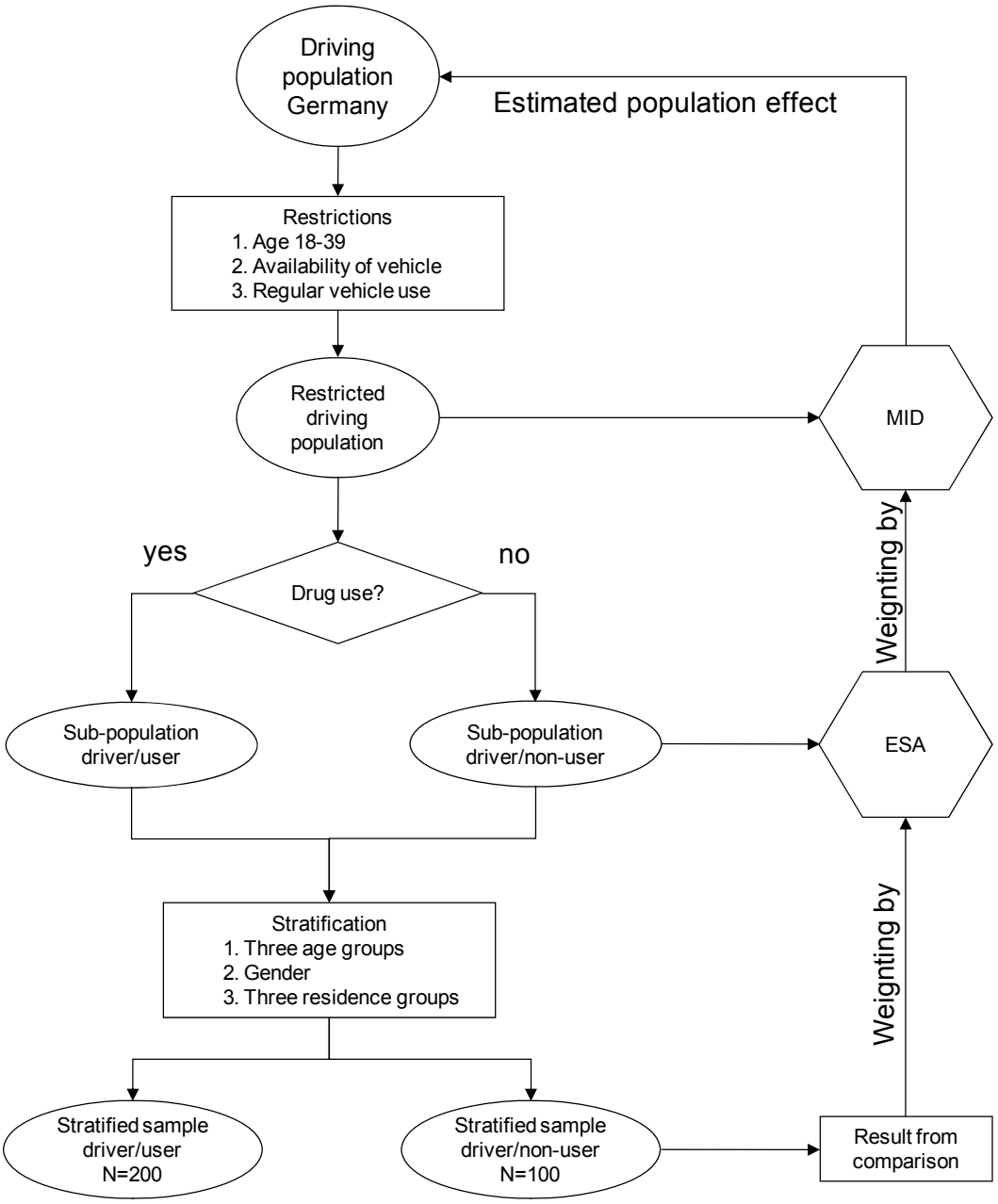


Figure 1: Overview over the study design.

3.2 Sample design

The sample in the present study was stratified on the variables gender, age, and residence, which were assumed to serve as confounders for driving and drug use, respectively. The target sample size was 200 drug users and 100 paired controls (matching based on gender, age, and residence) recruited from rural, urban, and city areas in Bavaria (Würzburg, Munich, and respective environs). The originally intended sample size was larger. But because of limited time and financial resources, a final sample size of 300 subjects in total was realized. In epidemiological studies, a higher number of controls than cases is used in general. This helps to increase the power of the design. In the present study a new methodological approach was introduced with the focus on detailed information about drug use and driving behaviour of drug users. For the purpose of com-

paring the driving and alcohol use behaviour between users and controls the relatively low number of controls was considered as sufficient – especially because the controls were matched on all relevant variables. So, more resources could be spent to investigate the main object, i.e. the behaviour of drug users.

Inclusion criteria were age 18 to 39 years, having a car always/sometimes available and using it weekly (i.e. on 1-2 days a week; the cut off was less than seven days in four weeks), regular drug use (i.e. once a week; the cut off was less than three days in four weeks) for users and no drug use within the last year for controls.

From existing population data (Statistical Yearbook 2009), mobility data (MiD 2008), and drug prevalence data (ESA 2006) of Germany, percentage values were deduced for the general German population to estimate the size of the population in each stratum. Because the recruitment of the subjects was constrained to Bavaria (Würzburg, Munich, and surrounding areas), the corresponding percentage values for the general Bavarian population were also calculated (Table 1).

Table 1: Data of the general German population and the general Bavarian population aged 18-39 for estimating the intended sample size.

			Male			Female		
			18-24	**25-29**	**30-39**	**18-24**	**25-29**	**30-39**
18-39-year-old[1] (***Age***)	**Germany**		15.4%	11.2%	24.3%	14.8%	10.9%	23.4%
	Bavaria		15.3%	11.2%	23.9%	14.8%	11.2%	23.5%
			Germany			**Bavaria**		
Residence[2] (***Res***)	**< 50,000**		60.3%			74.1%		
	< 500,000		23.8%			11.4%		
	> 500,000		15.9%			14.5%		
			Male			**Female**		
			18-24	**25-29**	**30-39**	**18-24**	**25-29**	**30-39**
Regular driving[3] (***Driv***)	**Germany**	**< 50,000**	89,8%	89,8%	94,6%	92,0%	94,9%	96,0%
		< 500,000	75,8%	78,7%	85,5%	73,2%	81,6%	83,6%
		> 500,000	61,6%	56,3%	70,5%	62,4%	51,1%	59,5%
	Bavaria	**< 50,000**	85%	91.9%	96.6%	91.5%	99.2%	98.7%
		< 500,000	85.4%	89.8%	89.3%	83.5%	93.9%	92.9%
		> 500,000	40.3%	47.1%	59.1%	64%	29.5%	59%
			Male			**Female**		
			18-24	**25-29**	**30-39**	**18-24**	**25-29**	**30-39**
Regular drug use[4] (***Drug***)	**Germany**		6.8%	4.2%	2.9%	2.6%	0.8%	1.1%
	Bavaria		5.7%	4.9%	2.6%	3.6%	0%	0.9%

[1, 2] Statistical Yearbook 2009, [3] MiD 2008, [4] ESA 2006

Within the 18-39-year-old German population 85.1% drive regularly and 2.8% use drugs at least once a week. In Bavaria, 89.2% of the 18-39-year-old population drive regularly and 2.8% use drugs at least once a week (not listed in Table 1). The sample size gets smaller as more selection criteria are applied. Therefore, the values for the Bavarian population could be less reliable. Because there are no data that integrate gender, age, and residence as well as drug use, residence, and driving, two assumptions had to be adopted.

- Age/gender and residence are independent variables
- Drug prevalence is independent of residence and having a car available

The following example demonstrates the estimation of each stratum's size given an overall target sample size of 200. For the stratum *male*/*18-24*/*<50,000*, the corresponding

values (*Age*, *Res*, *Driv*, *Drug*) of Table 1 were multiplied, divided by the sum of the so calculated values of each stratum (sum=0.02098538), and multiplied by 200.

Figure 2 reflects the proportion of males/females, 18-24-/25-29-/30-39-year-olds, and persons from city/urban/rural areas in Germany and Bavaria, respectively.

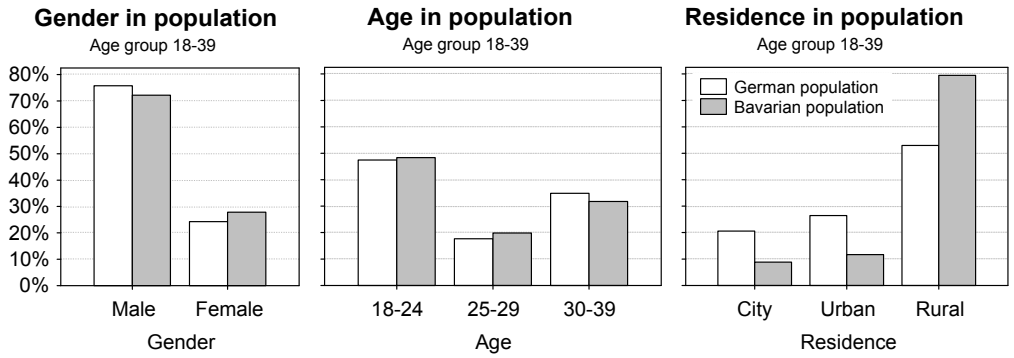


Figure 2 Proportion of gender, age, and residence in the 18-39-year old German and Bavarian population that drives a car and use drugs regularly.

Table 2 shows the intended size of each stratum calculated in the above mentioned manner when applying the percentage values for the general German population. The control group was planned to reflect the same sample structure. For every second user, it was planned to admit one control.

Table 2: Target sample.

		male			female			
		18-24	**25-29**	**30-39**	**18-24**	**25-29**	**30-39**	
Controls	**rural area**	19	8	14	7	1	4	
	urban area	9	4	7	3	1	2	
	city area	7	3	5	3	1	2	**100**
Users	**rural area**	37	15	29	14	3	9	
	urban area	18	8	14	6	2	5	
	city area	14	6	10	5	1	4	**200**

4. Procedure

4.1 Recruitment strategy

To inspire participants with trust, attention was paid to a transparent presentation of the survey in the public. A website was created (www.doyoudrugdrive.de / www.dydd.de) (Annex 14.1) on which interested persons found information about the intention of the study, the procedure, the costs and benefits, and the experiences and opinions of former participants. In addition, a hotline and an email account were setup for the subjects to ask for further details.

In order to reach a population as broad as possible and to meet the demands concerning the representativeness of the sample, participants from rural, urban, and city areas were recruited through different methods[7]:

- Financial reward for successful word-of-mouth-recommendation through participants (49.3%) and non-participants (13.7%)
- Flyer distribution at local leisure/work places for young adults (clubs, cafes, bars, cinemas, sports facilities, secondary schools, vocational training schools) (9.7%)
- Articles, interviews, and press releases in local newspapers (7.7%)
- Publications on the Internet (5.3%)
- Recruitment within the social environment of the members of the study group (5%)
- Advertisements in city magazines/city guides (4.7%)
- Radio features, radio interviews, and radio headline news (3%)
- Recruitment within an existing test driver panel from previous studies (1.7%)

The media relations were very important for promoting the study at the beginning of the recruitment process. But word-of-mouth recommendation was most effective.

4.2 Time schedule

Figure 3 depicts the study procedure schematically. Broken lines within the illustration point to study events that were not definitely timed.

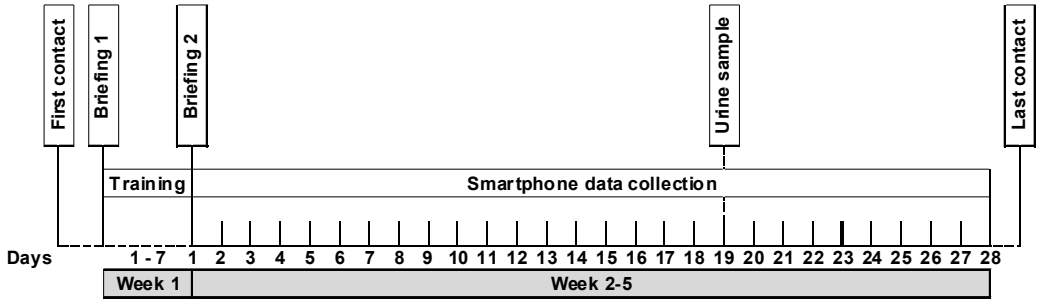


Figure 3 Study timeline.

[7] The numbers in brackets refer to the percentage of subjects recruited by each strategy.

In the next section the different study events are summarized in bullet points stating the location and the modality of each event, respectively, followed by a detailed description of the procedure.

First contact by telephone/email/face-to-face:

- subject screening
- time scheduling

The subjects contacted the investigators via telephone, email or visited the study centre directly. At this first contact the subjects were screened for their driving and drug consuming behaviour and shortly briefed on the study. If the inclusion criteria were fulfilled and the person decided to take part, two appointments were arranged at the study centre at intervals of several days. For persons who wanted to enrol for the control group the matching criteria were screened and saved on a waiting list. They were only admitted to the study if their values on the confounding variables were similar to those of a subject in the user group. All subjects were instructed to show their driver licence and vehicle registration certificate at the first briefing to indicate that they have a car available and drive regularly.

Briefing 1 at study centre:

- information
- informed consent
- agreement on data request at the Central Register of Traffic Offenders
- smartphone handling
- daily questionnaire structure
- questionnaire on driving and drug experience

The first briefing at the study centre included a detailed description of the study procedure. The subjects had to sign that they were voluntarily participating in the study, that they were comprehensively informed and that they were given a smartphone in exchange for a deposit of either 150 euros or a copy of their identity card. The deposit was safely stored at the study centre for the duration of the study and was returned to the subjects at the last contact. To be able to query the registered traffic offences at the Central Register of Traffic Offenders, the subjects had to sign a written authorisation and name their full name and address. A large part of this first briefing was intended to explain the handling of the smartphone and the structure of the daily questionnaire which was implemented on it. At the end of this meeting the subjects filled in a paper and pencil questionnaire on previous experiences concerning driving, drug use, and drug driving, corresponding attitudes, and relevant socio-demographic and social characteristics (Q-Start; Annex 14.2).

Smartphone training at home:

- probationary protocols
- questionnaire on personality

Between the first and the second briefing, the subjects were required to fill in two probationary protocols and another paper and pencil questionnaire containing eight personality questionnaires (Q-Pers; Chapter 7.3). The relevance of the personality questionnaires on drug driving was derived from a literature review that was conducted prior to the study.

Briefing 2

at study centre:
- protocol review
- training of critical recording rules
- SCID interview

The purpose of the second briefing at the study centre was to review the probationary protocols and discuss any associated difficulties. In order to illustrate critical and difficult instructions on how to structure the daily routine, the subjects had to process corresponding exercises. The main part of the session was used for carrying out the SCID-I (Structured Clinical Interview on DSM-IV Axis I Disorders) (Wittchen, Zaudig & Fydrich, 1997). Major mental disorders and the psychiatric history of each subject were queried with the focus on alcohol and/or drug misuse and abuse.

Smartphone data collection

at home:
inquiry by telephone in the case of...
- data inconsistency
- recording problems
- dangerous traffic occurrences

For each of the following 28 consecutive days the subjects had to fill in the questionnaire on the smartphone specifying their daily routine with the focus on drug consumption and driving. It was possible to save the answered part of the questionnaire on the smartphone. So, the subjects were able to fill in the questionnaire at several times a day whenever they had the time to do so. They could autonomously determine the time and the locality for processing the questionnaire on condition that they sent the record of a day at the latest two days later. In order to provide an incentive to fulfil the task in due time, a reward system was compiled based on the time delay between the recorded day and the day the questionnaire was sent (Chapter 8.3). The intention was to receive 28 records per person. Each record should represent a regular day within the subject's usual environment. If the normal daily routine was disordered for more than three days because of a medical condition, a domestic or an international journey, the subjects were asked to extend the study period at the end by the same number of days. The recordings were promptly checked for data inconsistencies after they were received at the study centre. If any inconsistencies became apparent, the subjects were called by telephone to discuss the recordings in question. Another reason for calling the subjects was given when a dangerous traffic situation was recorded. In this case, the subjects were asked about the circumstances and about subjective causes. Of course, the subjects always had the possibility of calling the study centre in the case of problems or questions related to the study.

Urine sample

at study centre:
- urine sample
- ART 2020

at Institute of Legal Medicine Würzburg/Munich:
- toxicological analysis

The subjects were informed that they would have to deliver a urine sample to prove their drug use and in the case of the controls to monitor their drug abstinence. In Würzburg, this appointment was also used for assessing the traffic-relevant performance of the par-

ticipants by a series of seven subtests of the Act & React Test System (ART) 2020 Standard test battery (Chapter 7.5), developed by the Austrian Road Safety Board (ARSB). Within the 4-week study period the subjects were called spontaneously to come to the study centre to perform the ART2020. It was not mentioned that the urine sample would also be collected at this occasion. So, it was possible to collect it without previous announcement. In Munich, the ART 2020 test was not conducted for logistical reasons. To guarantee that the urine test could not be anticipated by the participants, they were asked to come to the study centre within 24 hours after an unexpected phone call. If the appointment could not take place within the intended timeframe, the subjects were told that they would get called again another time. This was repeated until the attempt to arrange a spontaneous appointment was successful. The urine samples were analysed by the Institute of Legal Medicine in Würzburg and Munich, respectively. Detailed information about the agreement between the test results and the previous drug use behaviour that was reported in the daily questionnaire is given in Chapter 9.3.

Last contact at study centre

- payment
- evaluation
- advisory service recommendation if indicated

After the subjects completed the recording period, the last contact was arranged to pay out the credits and to collect the smartphone. Moreover, an interview was conducted (Q-End). The subjects had the opportunity to evaluate the study and were asked about their knowledge about legislation and sanctions concerning drug driving, about their academic and occupational background, and about their relationship to their parents. They were also asked to voluntarily add a guestbook comment on the study website that should encourage other potential subjects to take part. In the case that a risky consumption pattern was observed, the person concerned was urged to consult a drug advisory service. A list with all relevant contact details of drug advisory services in their vicinity was delivered to all subjects.

5. Sample description

5.1 Compliance rate

The study design does not allow for a non-responder analysis because nothing is known about the characteristics of the users who did not take part in the study. The only experience that could be made refers to persons who contacted the study centre and decided against participating after this first contact. Conspicuously those persons were often of the 30-39-year-old age group and expressed doubts about data discretion as reasons for not taking part. They thought that the participation in the study could conceal adverse consequences regarding their family and job. They were afraid that they would have problems with the police if they took part.

The drop-out rate was very low. Nine subjects (N_{User}=4, $N_{Control}$=5) who were already in the study cancelled the participation or were excluded because of the following reasons:

- Time trouble/bad compliance (3)
- Strong suspicion of false statements (2)
- Smartphone handling/reporting problems (2)
- Licence withdrawal (1)
- Sudden prolonged illness (1)

There was no fail-safe method to find out if subjects were cheating regarding their drug consumption and availability of a vehicle. But various precautionary measures were implemented to reduce the possibility of those subjects taking part.

- At the first contact the subjects had to give a detailed report on their driving und drug using behaviour, habits and circumstances.
- At the first contact they also had to show the vehicle registration certificate of the vehicle they drive most frequently.
- Within the study period they had to deliver a urine sample without previous announcement to prove the drug use stated in the daily reports.

Consequently, 19 subjects (all users) were excluded afterwards because they had reported either less than three days with drug consumption or less than seven driving days within the four week study period. Table 3 shows the excluded subjects and the drop-outs according to their characteristics concerning gender, age, and residence. The greatest part of the excluded subjects was 18-24-years-old and from city areas. While conducting the study, it became apparent that subjects from Munich were saliently less reliable. Besides the high number of persons from this area that had to be excluded, an also high number of persons from Munich arranged an appointment but did not appear in the end. In total, it was more difficult to recruit people there. Because of the higher anonymity in bigger cities in general, persons from Munich could not be reached as easily as persons from Würzburg and the surrounding areas.

Table 3: Excluded subjects and drop-outs distributed over the stratification variables (N_{User}=23, 10.3%; $N_{Control}$=5, 4.8%).

	male			Female			
	18-24	**25-29**	**30-39**	**18-24**	**25-29**	**30-39**	
rural area	3	1	1	0	0	0	
urban area	1	1	1	4	1	1	
city area	8	2	2	1	0	1	**28**

Over the two-year study period data of approximately 200 control persons who were not admitted to the study were saved on a waiting list. Controls were only admitted to the study if the intended number within the stratum in question was not higher than approximately one half of the number of users within the same stratum.

Detailed information about persons who applied to participate in the study but did not fulfil the inclusion criteria is not available. In approximately one of five cases participation had to be refused because the persons used drugs and/or drove too infrequently.

Of the subjects who constitute the final sample size, 39 subjects (13%) provided incomplete datasets (four subjects are included in two of the following categories):

- Four subjects (1.3% of the sample) cancelled the study after approximately two weeks because of personal problems, health problems, a sudden move or time trouble, respectively.
- Six subjects (2%) interrupted the study period because of sudden holidays, an accident, a hospital stay or an injury, respectively.
- 33 subjects (11%) omitted protocols. The number of omitted protocols ranged from one to five and was higher in the user group (15% of users, 3% of controls).

The subjects were urged to add the corresponding number of omitted protocols in the end, but 20 (6.7%) subjects failed to do so and reported less than 28 days. All in all, 139 days are missing (1.6% of all days).

5.2 Sample size

Table 4 shows the number of subjects and the percentage within each study group for the different strata.

Table 4: Sample size.

		male						female						
		18-24		**25-29**		**30-39**		**18-24**		**25-29**		**30-39**		
		n	**% N**	**n**	**% N**	**n**	**% N**	**n**	**% N**	**n**	**% N**	**n**	**% N**	
Controls	**rural area**	12	12%	4	4%	4	4%	8	8%	4	4%	2	2%	
	urban area	13	13%	4	4%	5	5%	8	8%	5	5%	3	3%	
	city area	10	10%	6	6%	3	3%	4	4%	3	3%	2	2%	**100**
Users	**rural area**	37	19%	9	5%	7	4%	16	8%	9	5%	4	2%	
	urban area	24	12%	8	4%	8	4%	17	9%	8	4%	4	2%	
	city area	17	9%	12	6%	3	2%	7	4%	6	3%	4	2%	**200**

Figure 4 shows the proportions of the population and the sample numbers on the different values of the stratifying variables. The strata do not exactly fit the distribution of the general German/Bavarian regularly drug using population that always/sometimes has a car available. More female subjects, 18-29-year-old subjects, and subjects from city and urban areas were recruited whereas male subjects, 30-39-year-old subjects, and subjects from rural areas are underrepresented within the sample. Nevertheless, except for the 30-39-year-old population for all small-sized strata a larger sample size was realized. Thus, the estimates achieved for these small-sized populations are more reliable. The reason for the low number of 30-39-year-old subjects within the sample could be due to the higher responsibility this age-group usually carries in job and family. Many 30-39-year-old persons who contacted the study centre expressed fear of punishment and doubts about data discretion wherefore they often decided against participating in the study.

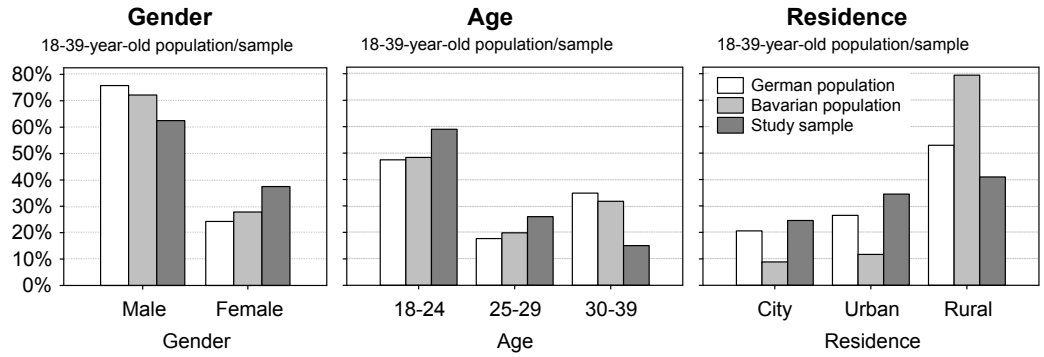


Figure 4 Gender, age, and residence proportions in the German/Bavarian population and in the study sample.

The intention to match only those subjects for whom the same legal alcohol limits apply could not entirely be fulfilled. Three matched pairs included one subject for whom the zero tolerance applied and another one for whom it did not.

Table 5: Characteristics of the subjects on confounding variables.

		User	$User_{Matched}$	Control
Gender	**male**	62.5%	61%	
	female	37.5%	39%	
Age	**mean**	24.41	24.85	24.84
	sd	5.29	5.24	5.02
Residence	**rural**	41%	34%	
	urban	34.5%	38%	
	city	24.5%	28%	
Vehicle available	**always**	90.5%	90.9%	98%
	sometimes	9.5%	9.1%	2%
Employment status	**full time employed**	26.5%	35%	35%
	half time employed	9.5%	6%	5%
	minor employed	2.5%	3%	0%
	apprentice	12%	12%	11%
	pupil	17.5%	14%	18%
	student	25.5%	28%	28%
	before job/apprenticeship/university	2%	0%	0%
	unemployed	3%	1%	2%
	housewife/houseman	0%	0%	1%
	retiree/pensioner	0.5%	0%	0%
	civilian service/military service	1%	1%	0%

Users and controls are fairly equally distributed among the categories of the matching criteria (Table 5). The employment status is also listed to give an impression of the approximate work/leisure ratio within each study group. The conformance between users and controls is of course higher when solely those users are regarded who were assigned to a paired control.

6. Technical aspects of data collection

6.1 System overview

The data collection system for the daily questionnaires was implemented by using the following components (Figure 5):

- RIM BlackBerry 7290 (50 pieces) on which the subjects filled in the daily questionnaire
- Wireless network (GPRS data service by Vodafone Germany)
- Mobile Data Services (MDS) by the BlackBerry vendor RIM (Research in Motion) for the encrypted data transport
- Dedicated server (PC with 2x Intel Xeon 3.2 GHz processor, 2 GB RAM, Microsoft Windows Server 2003 operating system, MySQL 5.0 data base) for the data processing and storage
- OpenVPN virtual private network for encrypted transport to the workstations
- Workstations with data analysis software (Statistica 8) and data control software (Microsoft Access 2007)

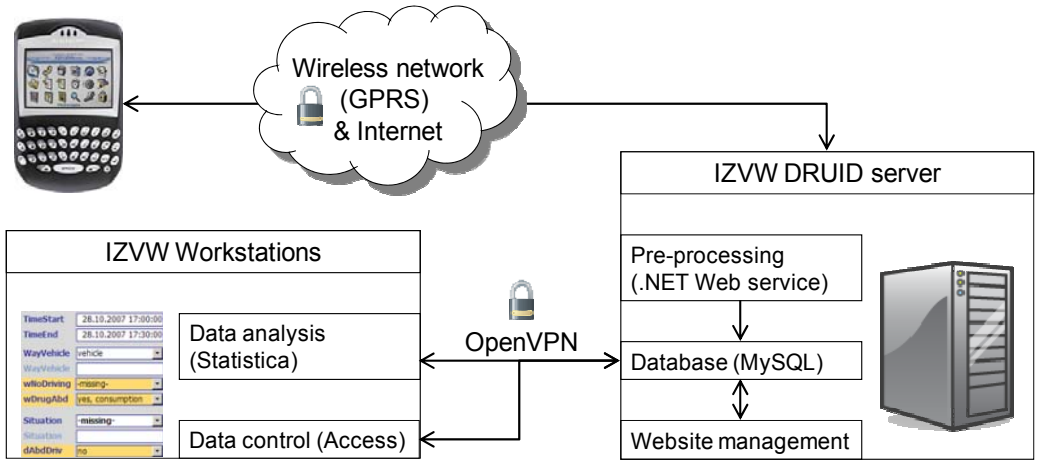


Figure 5: System overview.

6.2 Questionnaire application on BlackBerry devices

The use of smartphones as study devices was achieved by writing an application programme using the BlackBerry graphical user interface and network access. Thus, the application can be directly operated by the respondent using the smartphone's controls (scroll wheel, confirm and cancel buttons, QWERTY keyboard) and all data can be sent in encrypted form through the RIM Mobile Data Services over the wireless connection for immediate further processing.

The data entry was simplified by providing response options. In most cases only one alternative could be selected. Only few questions allowed multiple choices (e.g. mode of transport, kind of drug consumed). For some questions a "miscellaneous" response was

listed. If the experience of the respondent could not be expressed by the predetermined responses, the subject selected this field and a text field appeared to describe the answer in their own words. The application reflected a hierarchical structure of a course of a day (Chapter 7.1.1). The questionnaire structure was adaptive allowing for the reproduction of individually different daily activities by marking out questions that are not relevant for current entries. Conflicting data entries were reported immediately and had to be corrected before sending the questionnaire. A full description of the consistencies checked by the programme is presented in Chapter 8.4.1.

6.3 Wireless data transmission

The BlackBerry vendor RIM operates a world-wide network ("Mobile Data Services", MDS) for secure business communication. The BlackBerry device connects to a server operated by RIM in its local wireless network via GPRS, which then routes the data over the Internet to the customer's (in this case: to the IZVW study centre) BlackBerry Enterprise Server (BES). All data is encrypted on the mobile device (using the AES encryption standard) and only decrypted on the BES server. Every BlackBerry device has an ID called BlackBerry PIN, which is used to identify the device to the BES.

6.4 Database server

At the study centre (IZVW), a dedicated server was set up for the reception and storage of the questionnaire data. The server is used as a Blackberry Enterprise Server (BES) and is thus connected to the MDS network. Additionally, the Microsoft Internet Information Server (IIS) has been installed to host ASP.NET 2.0 web services, and the MySQL 5.0 database server for data storage. For pre-processing, an ASP.NET web service receives the questionnaires sent by the BlackBerry devices (which are transmitted in a XML/SOAP based format) and inserts the contained data into the database using relational database (SQL) queries. The data can then be accessed from workstations of the IZVW researchers working on the project. When it is sent over the university network, data is encrypted using a VPN tunnel (OpenVPN 2.0.9). Daily backups of the database are performed and archived on external hard-disks.

6.5 Data access and subject management

During each subject's study period, additional tasks had to be performed (e.g. assignment of a smartphone to the subject, entering basic subject information in the database, sending messages to the smartphone, etc). These tasks were performed from the IZVW workstations using Web applications (implemented in ASP.NET 2.0) running on the database server. The applications perform SQL queries on the database or execute relevant BlackBerry helper programmes.

Not all possible data inconsistencies were detectable by the system. In Chapter 8.4.2 data inconsistencies are listed that were only traceable through a detailed examination of the whole context of a particular report. All data sent were checked for consistencies by

IZVW study assistants. For this purpose a control form was designed in Microsoft Access, which operates the data storage on the server using SQL queries (Figure 6).

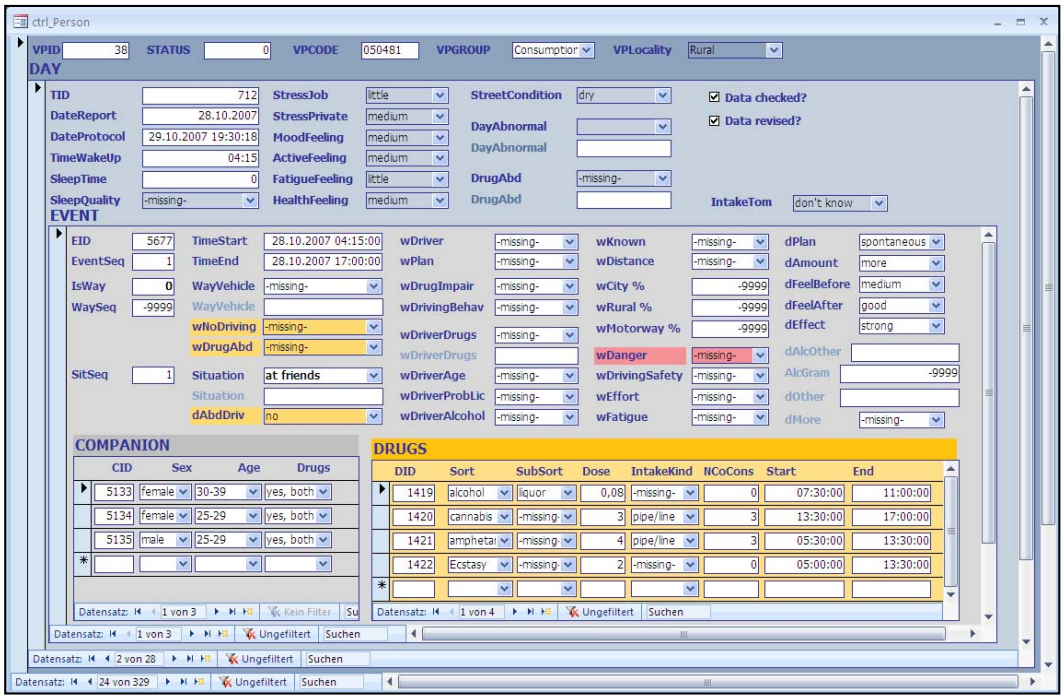


Figure 6: Microsoft Access form for person-controlled data consistency check.

6.6 Performance reliability of the system

The technical setup was very reliable. The database server's internet connection (and thus connection to the BlackBerry devices) was rarely lost. The server's main board broke once during the study. A copy of the server's hard disk (which was undamaged) was created and the system was migrated to a similar PC. No data was lost.

7. Data pools

7.1 Smartphone data collection

7.1.1 Questionnaire structure

Each subject was logged in the database with an individual ID, subject code and the respective parameter values concerning study group and residence. All other person variables were gathered in paper and pencil questionnaires and are described in Chapter 7.2.

The daily questionnaire contained three different levels (an overview will be given in Chapter 7.1.3). General questions concerning the circumstances of the whole day (Level 1) were placed in the beginning and in the end of the questionnaire. The main task when producing the daily report was the listing of all daily episodes in chronological order with alternating situations (locations or activities) and intermediate trips (Level 2) (Figure 7).

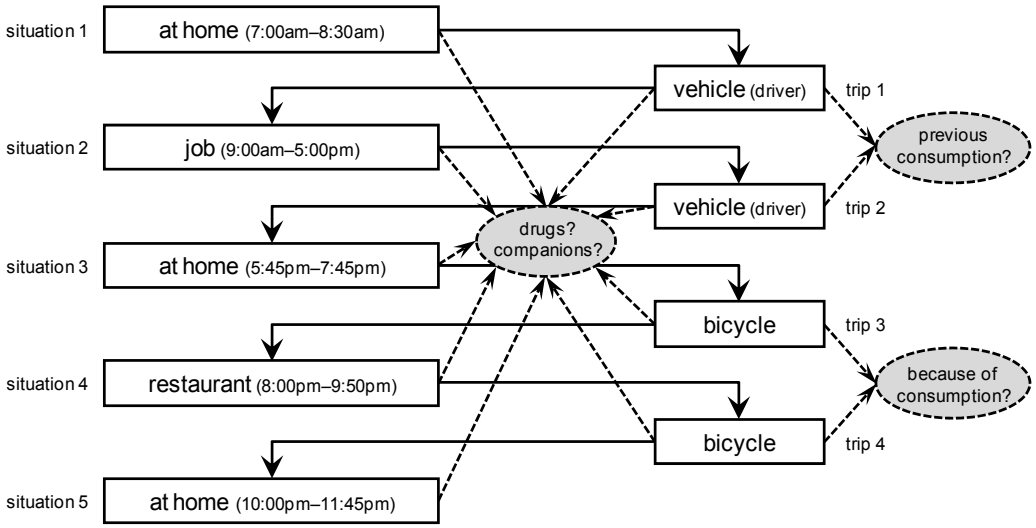


Figure 7: Illustration of an exemplary listing of a fictitious day.

The number of episodes per day depended on the actual daily structure. Each episode had to be described in its main characteristics (i.e. location and time for each situation, or mode of transport, distance, etc. for each trip). Two questions were asked for both situations and trips. The subjects had to indicate for each episode if they consumed drugs[8] or medicines (Level 3a) and if they had companions (Level 3b). If so, the main characteristics of these occurrences were inquired (i.e. amount, time of consumption for each drug, or age, gender and consumption behaviour for each companion).

[8] In the present report the term “drug” comprised of illegal drugs and alcohol.

7.1.2 Drug use and driving interaction

Through the linkage between data about drug consumption and traffic participation and through the additional daily information, drug driving incidences could be detected and described with respect to their situational circumstances. Furthermore, circumstances that promote decisions against drug driving or towards risk limitation, i.e. the mutual interference of drug use and driving, are of special interest.

To find out if someone separates drug consumption and driving, the following behavioural intentions were surveyed: If the subjects stated **drug use before driving a vehicle**, they had to indicate if they **reduced the amount of drugs** due to driving. If the subjects stated **no drug use before driving a vehicle**, they were asked if they **abandoned drug use** due to driving or if they did not use drugs because of other reasons. If the subjects stated **they were not driving a vehicle**, they were asked if this was due to **previous** or **subsequent drug consumption** or because of other reasons. This query was realized through the following questions:

Question "*Did you take drugs before or during this trip?*" (if trip was travelled **as a driver** of a vehicle).

Response options:

(1) yes, I consumed drugs beforehand without restricting it,
*(2) no, I **abandoned drug consumption** due to driving,*
*(3) yes, but I **restricted drug consumption** due to driving,*
*(4) no, I didn't use drugs due to **other causes**.*

In the case of abandonment (2) or reduction (3), the subjects had to **specify the episode in which they abandoned/restricted drug consumption**.

Question "*Why didn't you travel as a driver of a vehicle?*" (if trip was **not travelled as a driver** of a vehicle).

Response options:

(1) *because of **previous drug consumption**,*
(2) *because of **subsequent drug consumption**,*
(3) *because of **other reasons**.*

7.1.3 Variables and adaptive layout

In Table 6 all information gathered by the daily questionnaire is listed for each data level. The exact wording of the questions and response options of the daily questionnaire can be seen in the Annex (Annex 14.3). Adaptive questions are labelled as optional. The exact adaptive order of the questions in the questionnaire is diagrammed in Figure 8 on the next page.

Table 6: Content of the daily questionnaire.

LEVEL 1: DAY	
	- Date - Time wake up/bedtime - Length of sleeping time - Sleeping quality - Abnormalities in daily routine - Stress level (private and job-related) - Mood - Activity level - Fatigue - Health state - Street condition - Reason for drug abstinence – same day (optional) - Intention to consume drugs – next day
LEVEL 2: EPISODE	
Situation:	- Location/activity - Time start - Time end - Abandoned/restricted drug use in this situation (optional)
Trip	- Time start - Time end - Mode of transport - Planned or spontaneous trip - Distance - Abstain from driving because of previous/subsequent consumption or other reason (optional) - Abandoned/restricted drug use on this trip (optional)
Driving details (optional)	- Driver/passenger - Percentage of motorway/rural/urban road - Abandoned/restricted drug use because of driving (optional) - Familiar road - Dangerous situation - Driving safety (optional) - Driving effort (optional) - Driving fatigue (optional)
Drug driving details (optional)	- Impairment - Changed driving behaviour
LEVEL 3a: DRUGS (optional)	
	- Kind of drug - Intake kind - Dose - Number co-consumer - Time of consumption - Planned amount of drug - Planned or spontaneous consumption - Drug effect - Feeling before and after consumption
LEVEL 3b: COMPANIONS (optional)	
	- Age - Gender - Current drug consumption

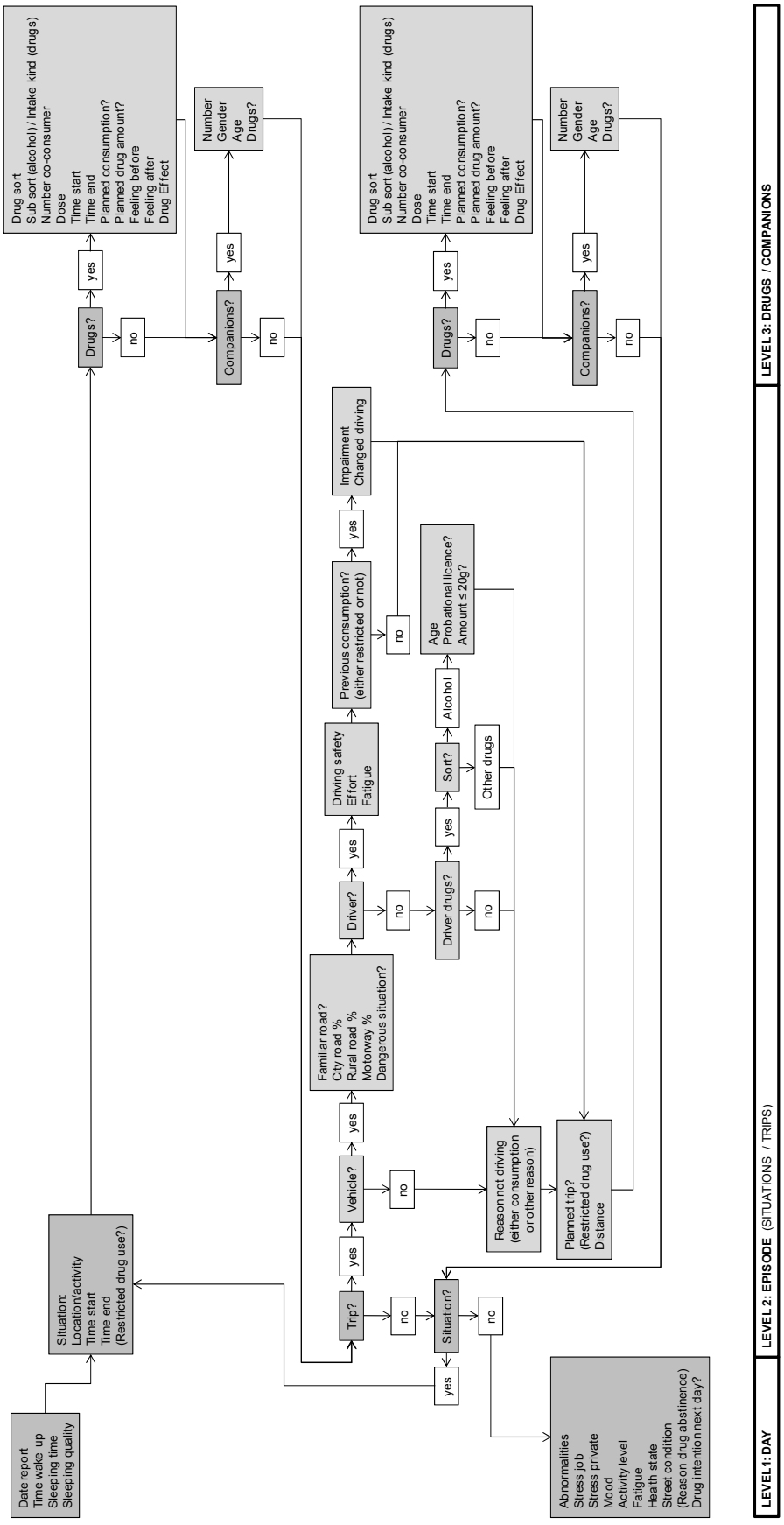
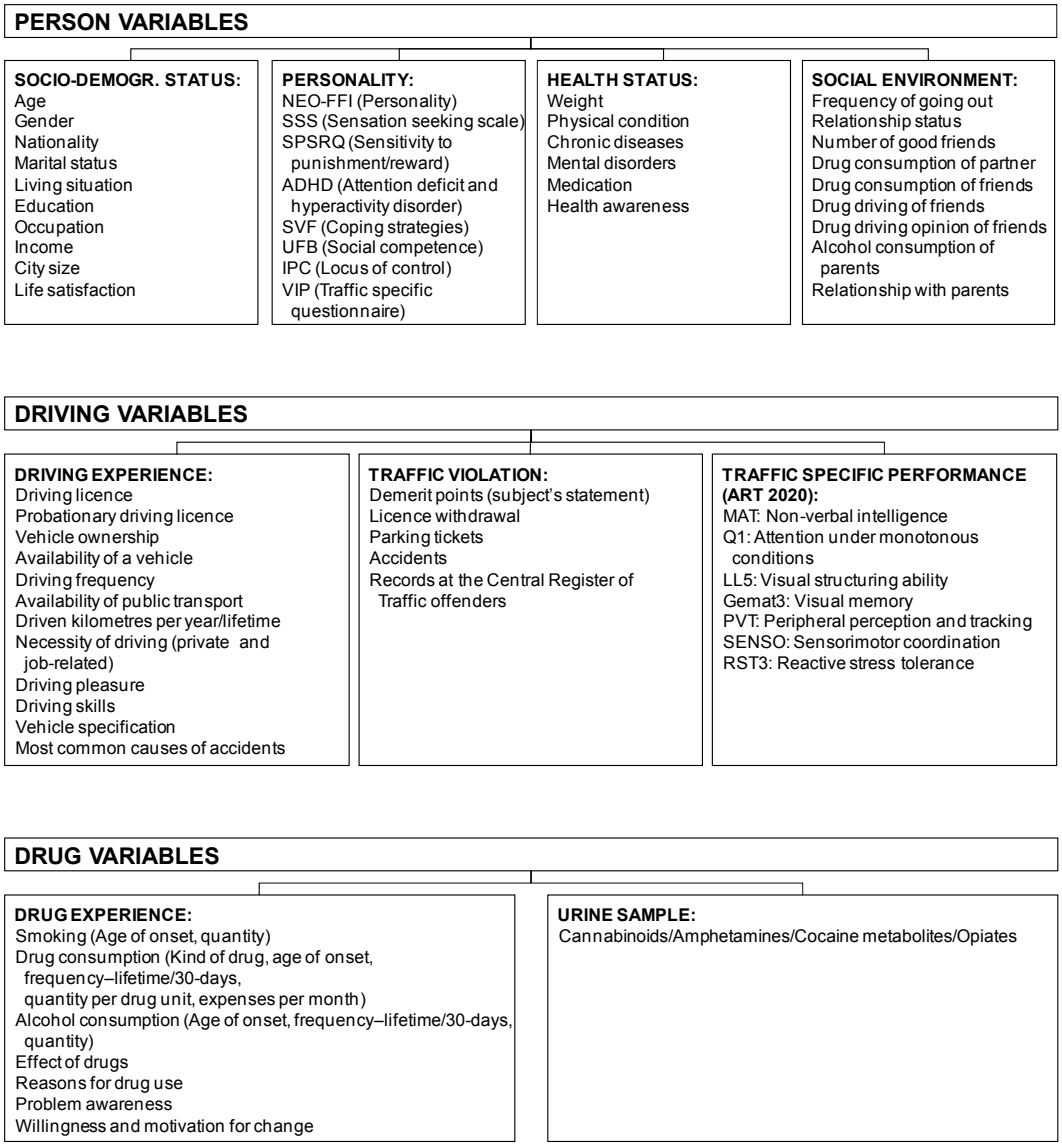


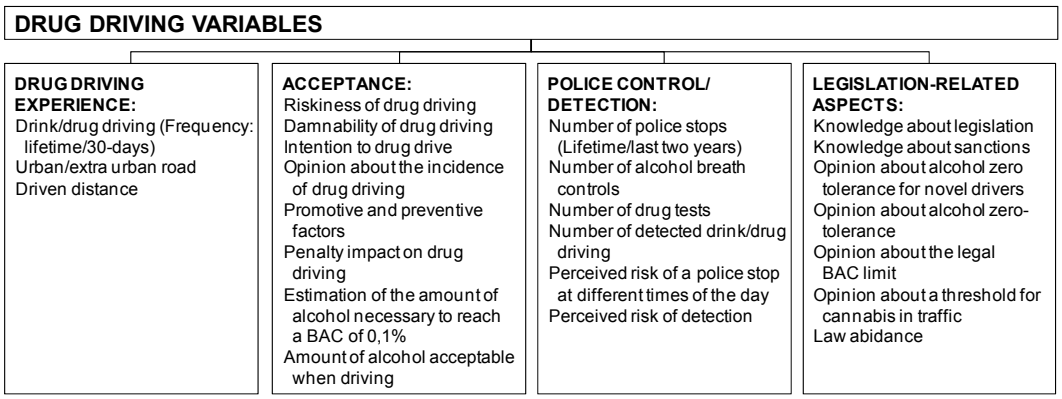
Figure 8: Daily questionnaire and containing variables reflecting the dependencies between the variables.

7.2 Overview of person-related data

Included in the study was also an extended diagnostic part to assess relevant socio-demographic information, relevant previous experiences, personality variables, and attitudes. As described in Chapter 4.2, this information was gathered through paper and pencil questionnaires. Moreover, the SCID-I was conducted and a urine sample was collected. Additionally, the traffic-specific performance was tested with the computer-based Act & React Test System (ART) 2020 Standard test battery and the subjects' records saved at the Central Register of Traffic Offenders were requested. All person-related information is summarized in Figure 9 in thematic order.

Figure 9: Person-related data.





7.3 Personality questionnaires

The literature was reviewed for psycho-social factors to predict drug driving. Few findings report direct associations of psycho-social factors to drink or drug driving. Instead factors are found that are associated with risky behaviour in general (risky driving, substance use, crash rates, driving while impaired (DWI) arrests, etc.).

Jonah (1997) did a review and synthesis of the literature on sensation seeking and risky driving. Of 18 studies, all but five found a positive relationship. Few studies compared the subscales of the sensation seeking scales (SSS). The Disinhibition subscale correlates most strongly with drinking and driving whereas the Thrill and Adventure Seeking Scale (TAS) has the strongest relationship to risky driving.

Caspi et al. (1997) found that undercontrolled (i.e. irritable, impulsive, impersistent) three year old children are low on the Constraint scale (i.e. disposed to act on impulse, take risks, and ignore conventional restrictions) and high on the Negative Emotionality scale (i.e. proneness to experience anxiety, anger, and related emotional and behavioural negative engagement) of the Multidimensional Personality Questionnaire (MPQ) by Tellegen (1982) at age 18, and are more likely to be involved in more health-risk behaviours (including drinking and driving) at age 21. Ryb, Dischinger, Kufera and Read (2006) also found that, in addition to low risk perception, high impulsivity is associated with risky behaviours (including drinking and driving). Moeller, Barratt, Dougherty, Schmitz and Swann (2001) as well as Swann, Bjork, Moeller and Dougherty (2002) stated that impulsivity is also a symptom of psychiatric disorders, including attention deficit/hyperactivity disorder (AD(H)D), borderline personality disorder, and bipolar disorders. The authors state that impulsive individuals are prone to substance abuse and dependence. A relationship between drug use and AD(H)D is often referred to in the literature. Miller and Blum (1996) found that AD(H)D in childhood often leads to drug-abuse or dependence in adolescence and adulthood. Besides impulsivity, the relieving effects of some drugs on AD(H)D might be the reason. Zeberlein and Küfner (2003) stated common drug use as self-medication of AD(H)D. Adriani, Caprioli, Granstrem, Carli and Laviola (2003) found that acute administration of a cannabinoid agonist normalized the impulsive behavioural profile in hypertensive rats without any effect on rats within a control group. Furthermore, amphetamine is commonly used as prescribed medication for AD(H)D.

Armstrong, Wills and Watson (2005) found that those who perceived more social and non-social rewards than punishments associated with drug driving, were more likely to engage in the behaviour. Referring to this, the sensitivity to punishment and to reward could have a moderating effect. Gray (1972, 1981) described two motivational systems, the Behavioural Inhibition system (BIS) and the Behavioural Activation system (BAS) that control aversive and appetitive behaviour, respectively. The BIS is related to the trait-anxiety dimension and is highly associated with high sensitivity to non-reward, to punishment, and to novelty whereas the BAS is related to the impulsivity dimension of personality and highly associated with high sensitivity to reward and to non-punishment. Castellà and Pérez (2004) studied the relationship between traffic offences and sensitivity to reward and punishment. Those people with high scores in sensitivity to punishment and low ones in sensitivity to reward drove lawfully, while those with low sensitivity to punishment and high sensitivity to reward broke the law more often.

Kaplan's self-derogation theory of delinquency (Kaplan, 1975) is based on the assumption that all persons have a basic need to think well of themselves and to avoid negative self-evaluations. Kaplan stated that adolescents with low self-esteems and low social competence are motivated to take action to restore positive self-regard by unlawful behaviour. When low self-esteem and rejection by conventional reference groups is experienced, individuals are likely to join unconventional, delinquent peers and involve in unlawful behaviour.

Locus of control can be defined as a personality trait reflecting the degree to which a person generally perceives events to be under their own control (internal locus of control) or under the control of powerful others or other outside forces (external locus of control) (Rotter, 1966). Several researchers (e.g. Hoyt, 1973) supposed that an external locus of control is related to a lack of caution and failure to take precautionary steps to avoid the occurrence of unfavourable outcomes. Hence, it has been hypothesized that external locus of control might be related to less responsible driving and accidents.

In a literature review by Donovan, Marlatt and Salzberg (1983) social stresses have been found to be related to drinking episodes that eventuate in DWI arrests. Even if the frequency of stressful events was not higher, the arrestees reported a significantly higher level of subjective distress associated with the occurrence of the events (Selzer and Barton, 1977; Selzer, Vinokur and Wilson, 1977; cited by Donovan et al., 1983).

Based on this literature review it was decided to apply the following series of eight personality questionnaires:

- **NEO-FFI** – Personality[9] (Borkenau & Ostendorf, 1993)[10]: 'Neuroticism', 'Extraversion', 'Openness to experience', 'Agreeableness', 'Conscientiousness'
- **SSS** – Sensation-Seeking (Beauducel, Strobel & Brocke, 2003)[11]: 'Thrill and Adventure Seeking', 'Disinhibition', 'Experience Seeking', 'Boredom Susceptibility'

[9] Even if there are no findings that indicate an association between drink and drug driving and the "Big Five" factors of personality, the corresponding questionnaire was applied to get information about broader personality dimensions.
[10] According to Costa & McCrae, 1995
[11] According to Zuckerman, 1978.

- **ADHDQ** – Attention Deficit and Hyperactivity Disorder in childhood (Zeberlein & Küfner, 2003): 'Distractibility', 'Inattention', 'Hyperactivity/Impulsivity', 'Psycho-social consequences', 'Drug effect on inattention and hyperactivity'
- **SPSRQ** – Sensitivity to punishment and Sensitivity to reward (Torrubia, Ávila, Moltó & Caseras, 2001): 'Sensitivity to Punishment', 'Sensitivity to Reward'
- **UFB** – Social competence (Ullrich & Ullrich, 1998): 'Fear of blame and criticism', 'Fear of contact to those of the opposite sex, fear of responsibility', 'Inability to set plans and set plans into motion' (originally positive scale, reversed polarity), 'Inability to say no', 'Feeling of self-blame in relation to their own actions as they relate to and affect others', 'Inappropriately exaggerated feelings of embarrassment'
- **IPC** – Control beliefs (Krampen, 1981): 'Internal control orientation', 'Powerful others control orientation', 'Chance control orientation'
- **SVF** – Stress-coping strategies (Erdmann & Janke, 2008): 'Compare with others', 'Guilt defence', 'Distraction from situation', 'Substitutional satisfaction', 'Situational control', 'Reaction control', 'Positive self-instruction', 'Need for social support', 'Avoidance', 'Flight tendency', 'Rumination', 'Resignation', 'Self-accusation', 'Self-medication/alcohol use'
- **VIP** – Traffic-specific item pool[12] (Schmidt & Piringer, 1986): 'Orientation at social expectations', 'Uncritical self-perception', 'Aggressive interaction', 'Emotional relationship to car and driving'.

7.4 Structured Clinical Interview for DSM Disorders (SCID)

Darke, Kelly and Ross (2004) found that recent drug drivers had significantly higher levels of dependence, higher frequency of drug use and more extensive polydrug use. Lapham et al. (2001) stated that an examined DWI offender population has high rates of alcohol/drug-use disorders.

The Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I) by Wittchen et al. (1997) was administered to determine DSM-IV Axis I Disorders (major mental disorders) – especially alcohol/drug-use disorders. The 300 interviews were conducted by two research assistants, who had had experience with clinical populations and had been trained to conduct the SCID-I.

The following disorders were queried:

- **Dependence/Abuse**: Alcohol, other substances
- **Mood Disorders**: Major Depressive Disorder, Mania, Dysthymic Disorder, Hypomania, Bipolar Disorders
- **Anxiety Disorders**: Panic Disorder, Agoraphobia, Social Phobia, Specific Phobia, Obsessive-Compulsive Disorder, General Anxiety Disorder, Post Traumatic Stress Disorder
- **Eating Disorders**: Bulimia, Anorexia
- **Psychotic Disorders**: Schizophrenia, Schizophreniform Disorder, Schizoaffective Disorder, Delusional Disorder, Brief Psychotic Disorder
- Any **Somatoform Disorder**

[12] As a measurement of traffic-specific personality dimensions.

Besides, it was inquired if the subjects were in outpatient or inpatient treatment or if any diagnoses were made in the past concerning major mental disorders (including AD(H)D and Borderline).

The interview took between ½ hour and 2 hours depending on the complexity of the past psychiatric history and the subject's ability to clearly describe episodes of current and past symptoms.

7.5 Traffic-specific performance tests (ART 2020)

To test the psychometric performance of driver aptitude in accord with the German Driver's Licence Ordinance ("Fahrerlaubnis-Verordnung", FeV), Annex 5 (Janker, 2009), and the "Guidelines for Expertise on Driver Aptitude" Chapter 2.5 ("Begutachtungs-Leitlinien zur Kraftfahrereignung"; Lewrenz, 2000) the applied test procedure has to fulfil several requirements:

(1) The applied test procedures have to be standardized, objective, and scientifically validated.
(2) In order to assess the traffic-specific performance, the following cognitive measures that are closely associated with driving abilities have to be assessed: Coordination, concentration, attention, reaction capacity, and stress resistance.

The computer-based Act & React Test System (ART) 2020 Standard test battery, developed by the Austrian Road Safety Board (ARSB), fulfils these requirements. It has been designed to assess cognitive measures closely associated with driving abilities and is certified for this purpose in Germany and Austria.

A series of seven ART2020 tests was applied:

- **MAT** (Non-verbal intelligence test; Bukasa & Wenninger, 2001a): The test is a screening of logical reasoning, understanding of rules, and causal relations.
- **Q1** (Test for attention under monotonous conditions; Bukasa & Wenninger, 2001b): This test measures continuity of attention regarding quantitative and qualitative aspects.
- **LL5** (Test for visual structuring ability; Bukasa & Wenninger, 2001c): The test examines dynamic perception functions in a complex visual environment under time pressure.
- **GEMAT3** (Visual memory test; Bukasa & Wenninger, 2001d): The test examines non-verbal short term recall functions.
- **PVT** (Test for sensorimotor coordination and peripheral perception ability; Bukasa, Piringer & Wenninger, 2004): The test examines eye-hand-foot coordination and peripheral perception in a dual task condition
- **SENSO** (Test for sensorimotor coordination; Bukasa, Piringer & Wenninger, 2003): The test records traffic-specific eye-hand-foot coordination under free choice and pre-given speed.
- **RST3** (Test for reactive stress tolerance; Bukasa & Wenninger, 2001e): The test measures resistance to work load determined by different speed levels and information processing complexity.

The applied tests can be assigned to the performance dimensions listed in the FeV (Table 7):

Table 7: Applied ART2020 tests and associated performance dimensions.

ART2020 tests and associated performance dimensions
- Coordination capacity: LL5, PVT, SENSO - Concentration and attention capacity: Q1 - Reaction capacity: RST3 - Stress resistance: RST3

The GEMAT3 and the MAT measure memory capacities and intelligence, respectively. These dimensions are not listed in the FeV. However, in Austria these tests are applied as standard test procedures. In the framework of the present study they are relevant to detect potential cognitive deficits of long term drug users.

7.6 Data integration

The smartphone data collection provided data of three different data levels (Figure 10): Day, Episode (i.e. situation or trip) and Drugs/Companions. Through the additional inquiry of relevant data about the subjects' socio-demographic background, previous experiences concerning driving, drug consumption, road traffic offences, corresponding attitudes, personality traits and driving performance, a fourth level was implemented containing personal data.

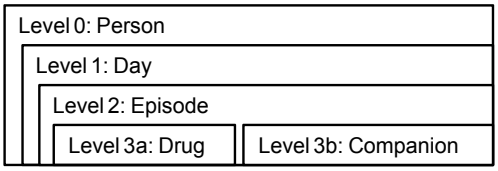


Figure 10: Data levels.

Levels 1 to 3 specify the **situational characteristics of drug driving** (e.g. weekday, daytime, route, distance, companions, etc.). Besides, a prediction can be made regarding the **extent to which drug driving occurs**. All personal data (Level 0) specify the **characteristics of drug driving individuals**. From all this information, rehabilitation and prevention strategies for targeting those most at risk can be deduced.

8. Additional requirements

8.1 Ethical approval and data privacy

The study did not require approval from the medical ethics committee. This was affirmed by the responsible committee of the medical faculty at the University of Würzburg with the argument that the study was designed as an epidemiological study, in which drug use and driving were observed, but no drugs administered.

Assuring the protection of data privacy was a very important issue. In this context, the following provisions were arranged and maintained:

- Consultation of the data protection agency at the University of Würzburg: The data protection agency was consulted on all judicial questions concerning data privacy and the legal protection of the participating subjects.
- Professional discretion: All persons working in the project were bound to observe professional secrecy. They were not allowed to give information about personal data of the participating subjects to third parties.
- Support from the public prosecution in charge: The public prosecution in charge guaranteed that the data of the subjects would neither be inspected during the study participation nor after unless a participating subject was suspected of having committed a notifiable, serious offence that requires disclosure.
- Anonymous data recording: Each subject was equipped with an anonymous code that was used for data storage and analysis. As far as personal or individual data were collected, they were kept strictly confidential so they could not be matched to any individual. After termination of the project, all individual data was destroyed.

The voluntary participation of the subjects was ensured by an informed consent that was signed by each subject before starting the survey. Therein, they declared to be elaborately informed about the study and to participate voluntarily.

8.2 Instructions / Training

The briefing sessions included a one-to-one instruction on how to structure the daily routine. The investigator guided the subject through the questionnaire by reporting a predefined day. This exemplary day contained all situations relevant to process exhaustively the possible branches of the questionnaire. Additionally, help texts were placed next to crucial questions in the questionnaire. If the respondent felt unsure about answering a question, the help text provided information about its meaning.

The subjects were instructed to list all daily episodes in chronological order with alternating situations and intermediate trips. It was emphasized that episodes with drug consumption and driving should be focused when compiling the report. These occurrences should be reported as accurately as possible. Before including someone in the study, it was clarified whether the person had planned any travels lasting more than three days. If

so, the study participation was postponed to the time after the absence. In doing so, it was assured that most reports refer to the residence the person was chosen for. Trips for up to three days did not lead to a postponement. If a subject spontaneously went on vacation while participating, the reporting was only interrupted for the time of the journey if reporting was impossible while travelling. In these cases, the subjects added the number of such days to the end of the study. Hence, in total, reports of at least 28 regular days were received. The same procedure was applied for days of illness.

Day-related instruction

A report runs from wake up to bedtime and is not defined by date. For instance, the report covers a 26 hour period of time if the subject gets up at 5am and goes to bed at 7am the next day.

However, two reports should be provided in the case that someone has an all-night party and skips one sleeping period completely. The break should be placed at a reasonable point in time, e.g. when the subject leaves one location. In this case, the first day would end with a trip (from one location to another) and the second day would start at the other location stating zero sleeping time.

The sleeping time should reflect the actual hours of sleep. Thus, it is quite possible that the reported sleeping time differs from the time span between reported bedtime and getting up the next day, e.g. when the sleep quality was bad and the person was awake all night long.

When a person is travelling and is staying a night over, the day has to be marked as abnormal (namely as domestic or international journey).

Situation-related instruction

Not all subsequent situations need to be separated by a trip. A new situation might start without a change of location. For example, when a subject is working at home, the situation “job” follows the situation “at home” without an intermediate trip. Likewise one situation becomes two contiguous situations at the same location when the number of companions changes (e.g. receiving a visit in the evening and being alone at home the rest of the day). Not every change of the number of companions at the same location has to be recorded as a separate situation. The respondents were instructed to record prominent situational changes, e.g. alone at home until 6pm (situation 1) and with friends at home afterwards (situation 2), without listing the arrival of each friend separately (Figure 11).

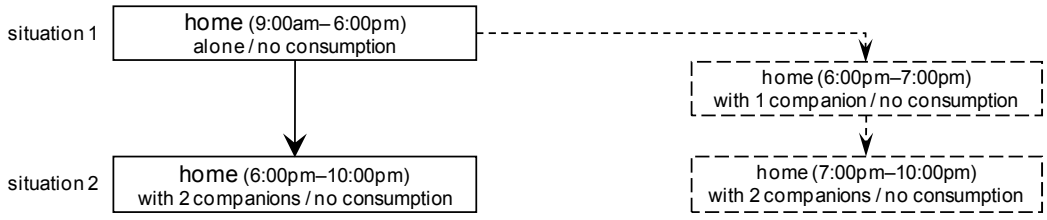


Figure 11: Example of situations that can be conflated.

However, situations containing drug consumption had to be described as accurately as possible in view of location, time, and number of companions in the situation, e.g. alone at home until 6pm (situation 1), afterwards with parents at home until 8pm (situation 2), followed by a situation with friends at home until 11pm consuming cannabis (situation 3) (Figure 12).

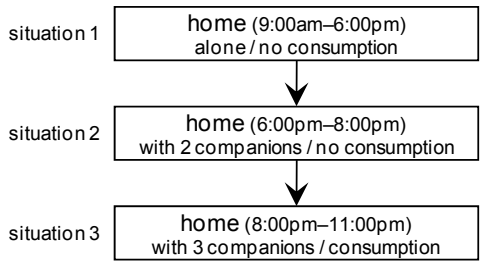


Figure 12: Example of situations that cannot be conflated.

If someone took a nap of more than one hour during the daytime, this is listed as a separate situation using the response option “other”.

Trip-related instruction

A trip is defined as every distance covered on foot or by another mode of transport outside home that separates two contiguous situations. A break within the trip is not listed as a separate situation if the break constitutes a short errand and the errand is not the target destination (Figure 13).

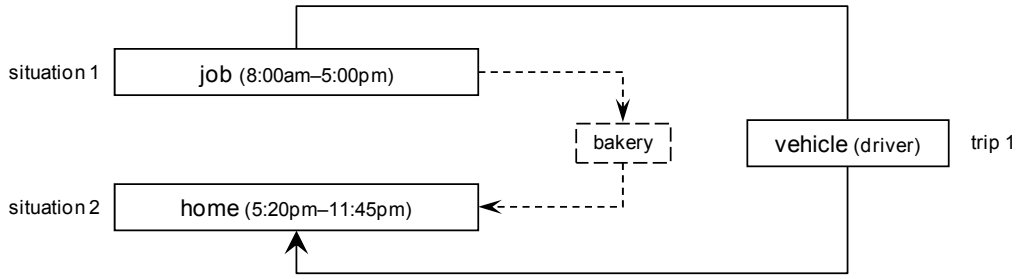


Figure 13: Example for waypoints that do not have to be listed.

As a rule, it was determined that situations that last no longer than 15 minutes do not have to be listed unless drugs were consumed therein. The ratio between the duration of the trip and the distance should remain plausible depending on the mode of transport that is stated for the trip.

Furthermore, a situation can be skipped when it only serves for changing the mode of transport. If, for example, someone travels from one location to another by walking, tram or train, this trip is cited as one trip covered by different modes of transportation (Figure 14). Again, this rule is suspended if someone takes drugs at one waypoint. Apart from this, an intermediate stop has to be mentioned if one changes from driver to passenger of a vehicle. When stating a trip taken by a vehicle, the respondent can only specify if he/she is travelling it either as a driver or as passenger and not both. By inserting an intermediate situation, the trips can be regarded separately from one another.

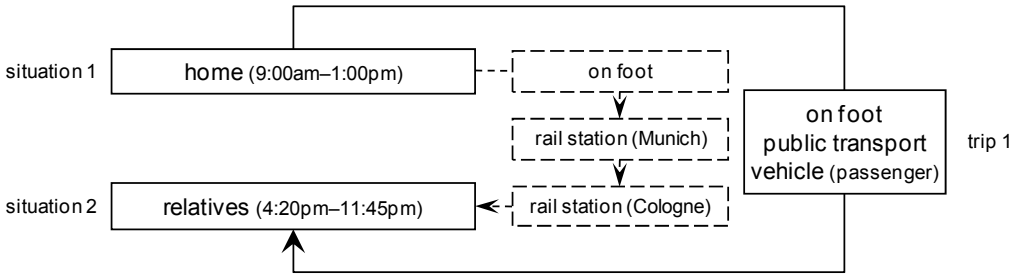


Figure 14: Example for trips that can be conflated.

If a trip is covered by different modes of transportation and one of them is driving a car, the information about the distance refers to the car drive only.

The subjects had to state if a trip is planned or spontaneous. This question does not refer to the mode of transport or route, but to the destination. A trip is spontaneous if someone decides it in the situation immediately before. Planned trips are periodical trips, e.g. the weekly trip to a sport facility or the daily trip to work/school. The way back home in the evening is generally planned unless the person planned to stay overnight and spontaneously changes this plan.

If the respondent has to give reasons for not driving a car, he/she can only state previous or subsequent drug consumption if a car is actually available. If a person rides the bicycle when going out because of a planned consumption afterwards, he/she can state drug consumption as a reason for not driving only for the way there, but not for the way back, because the person has no car available on the way back (Figure 15).

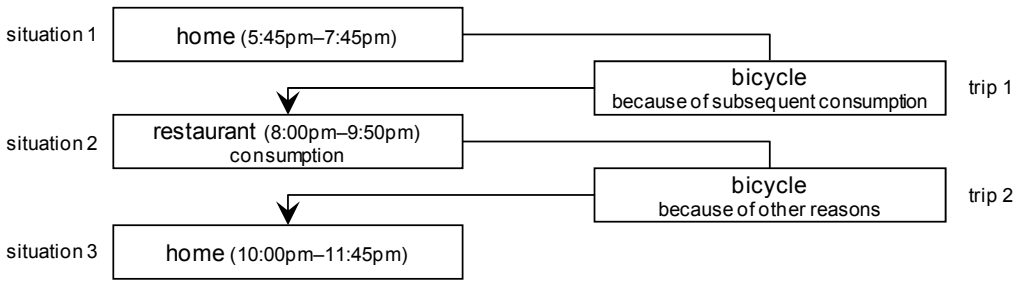


Figure 15: Example for trips for which consumption can be specified as reason for not driving.

If a person travels a trip as driver of a vehicle and had consumed drugs beforehand, he has to state the previous drug consumption only when it took place immediately before the trip. If the consumption dates back some time, the person has to state it only if he/she thinks that the drug consumption still has an effect on driving, i.e. when the person is still noticing an effect (Figure 16).

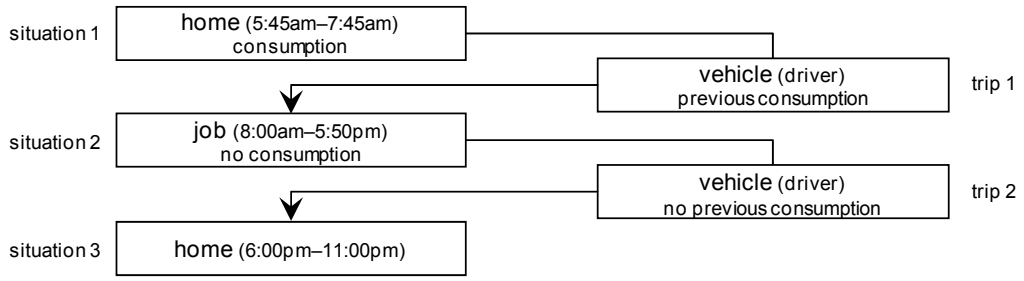


Figure 16: Example for conditions under which consumption had to be stated or not when describing a drive.

If the person restricted drug consumption because of driving, this always has to be mentioned when describing the drive, no matter if the drug effect is still noticeable or not (Figure 17).

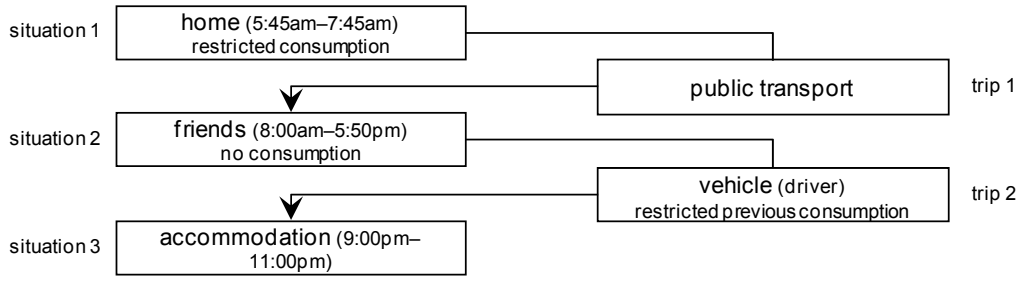


Figure 17: Example for stating restricted consumption previous to driving.

If a person has a business trip (excluded are trips to/from work), it has to be marked by additionally selecting the “other” response option and writing “job” in the corresponding text field.

Drug-related instruction

On days with drug consumption the exact timeframe of the consumption has to be reported. In the case of short consumption periods (e.g. one joint in ten minutes), the timeframe can be reduced to a point of time (e.g. one joint at 5pm).

To facilitate the reporting of the drug amount, the subjects have the opportunity to report the number of consumers with which they consume drugs and the drug amount that is consumed altogether, e.g. one joint with two co-consumers. The individual drug amount is calculated afterwards by the investigators. The highest response option for specifying the drug amount is the category “above 5 units”, which is treated as 6 units in the evaluation.

Medicines that are regularly used do not have to be reported in the daily report. This data is asked for in a paper and pencil questionnaire at the beginning of the study (Q-Start, Annex 14.2).

The subjects have to state if the drug consumption is planned or spontaneous. The consumption should be reported as spontaneous if it was decided to consume in the preceding situation. Planned consumption refers to situations in which drug use is very common,

e.g. at the weekend when meeting drug using friends. Whenever multiple drugs are used in a situation, the questions on planned or spontaneous drug use always refer to the drug use in total. If a person consumes multiple drugs, and the consumption of at least one of the drugs is spontaneous, the consumption in total is spontaneous.

Companion-related instruction

Companions are friends, family members, and other persons with whom one consciously spends time with. Colleagues at work, school or university do not have to be listed unless one attendee uses drugs at work or at school. At a maximum, five companions can be listed. If the actual number of companions is larger, the subjects were instructed to list those five which best represent the group.

Only the companions' current behaviour should be regarded when stating the companions' drug use. It was not relevant if the companions used drugs before the situation in question.

8.3 Financial incentive

To make sure that the subjects continue to answer the daily questionnaire for four weeks until the end of the study period, a reward system was devised. It compensates every single effort carried out by the subjects over the whole study period. The raw structure of the reward system was derived from a study from Searles, Perrine, Mundt & Helzer (1995).

The main values in Figure 18 refer to the credits achievable by the users. The values in brackets refer to the controls' credits. Two considerations justify a higher total credit for the users. First of all, the study was more time consuming for the users than for the control group. The questionnaire's focus lays on driving and drug consumption. In the user group, most subjects consumed at least every second day. For each consumption episode, this group had to answer the corresponding questions. On the other side, the drug users had to reveal much more confidential information. They were asked to report illegal behaviour – their drug consumption. The hesitations to take part were much higher than for controls. Therefore, the incentives had to be great enough for this group to take part.

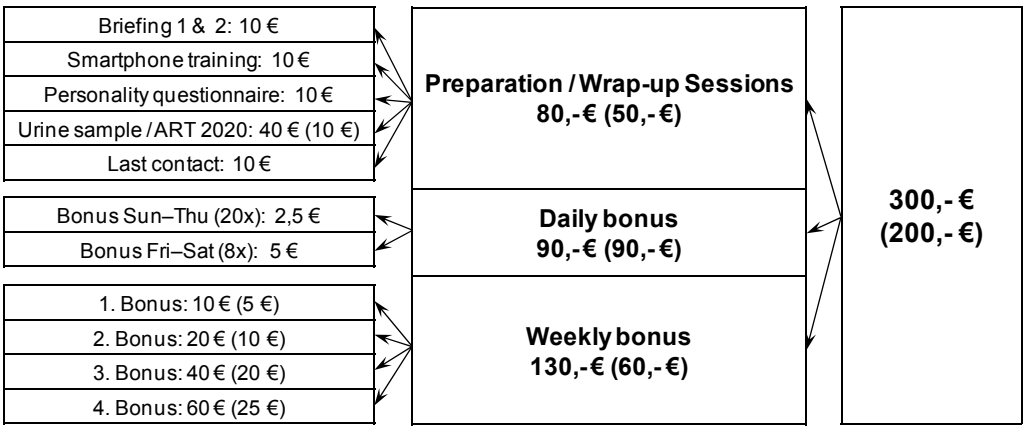


Figure 18: Credit sources for users and controls (in brackets).

The time delay between the daily occurrences and their reporting has an influence on memory performance and therefore on the quality of the data. Thus, the subjects had to send the protocols no later than two days after the date of the day they intended to report. If they sent it directly the next day, they got the complete daily bonus. If they sent it the day after, the daily bonus was halved. More money was paid for Fridays and Saturdays because it was assumed that consumption is higher at weekends. The time effort for reporting is higher then and the achieved data is more relevant for the detection of drug driving incidences and their circumstances.

Additionally, a weekly bonus was paid that made allowances for each successfully recorded week. If within one week, one protocol was missing, the weekly bonus was halved. If two or more protocols were missing, no weekly bonus was paid and the bonus for the next week was not increased.

For motivational issues the daily bonus was reported on the display of the smartphone after sending the questionnaire. Once a week the subjects got a PIN message on their smartphone sent by the investigator containing information about the complete credits achieved. Figure 19 shows the maximum credits over the study period for the users ("good compliance (user)") and the control group ("good compliance (control)"). The dotted lines refer to exemplary user subjects who omitted one ("moderate compliance (user)") and four ("bad compliance (user)") reports to show the impact of omissions on the total sum of credits.

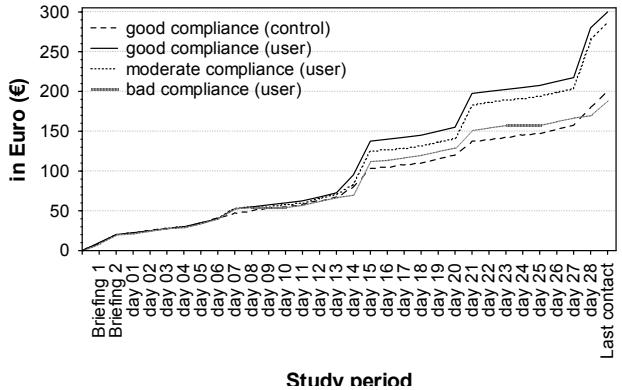


Figure 19: Maximum credits achievable for user and control group over the study period.

8.4 Data consistency check

8.4.1 System-controlled consistency check

Logical data inconsistencies were immediately announced by the system when the respondent answered all questions of one level and switched to the next level. Errors had to be corrected before continuation. Some feedback did not indicate an error but a warning. Warnings were triggered by data that were not essentially wrong but rather unlikely (Table 8).

Table 8: System-controlled consistency check.

Variable	Condition	E*	W*	F*
All levels				
All	Missing data	X		
Day level				
Date	Feedback signal about weekday of reported date			X
Time wake up	No change of preset value (12am)		X	
Date	Date lies in future or more than two days in the past	X		
	Report already exists in database	X		
	Day lasts more than 48 hours	X		
Episode level				
	No episode has been reported	X		
	No trip has been reported between two situations		X	
	Last episode represents a trip		X	
Time	Time start of first episode differs from time wake up	X		
	Trip between two situations lasts longer than five hours		X	
	Episode overlap	X		
	Situations separated by a trip but no delay in time between situations	X		
	Situation lasts longer than 18 hours (determined by the system)	X		
Companion level				
	Passenger on trip but no companion listed	X		
Drug level				
Time	Consumption time lays outside of episode time	X		

*E=Error, W=Warning, F=Feedback

8.4.2 Person-controlled consistency check

8.4.2.1 Inspection focus

Not all data inconsistencies were detectable by system-controlled consistency checks. Several inconsistencies became apparent only through screening the entire context. Immediately after receiving the data at the study centre, each report was checked for inconsistencies by a study assistant (Table 9).

Table 9: Person-controlled consistency check.

Variable	Condition
Day level	
Sleeping time	Sleeping time=Time Wake up minus Time End last situation of previous day? (less sleeping time acceptable in the case of bad sleep quality)
Episode level (situation)	
	Do situations make sense in the course of the day? (e.g. job situation at unusual time)
	Last situation of previous day=first situation of next day?
Episode level (trip)	
	Do trips make sense in the course of the day concerning distance, %motorway/rural/city road? (e.g. long distance trips should occur twice – outward and return trip)
Time	Does time of a trip makes sense concerning distance and mode of transport?
Previous consumption	Previous consumption (restricted or not) reported for drive ↔ consumption in former situations of same day?
	No/abandoned previous consumption reported for trip ↔ no consumption/abdication specified in former situations of same day?
Reason for not driving	Previous consumption as reason → consumption in former situations of same day or high consumption on previous day?
	Subsequent consumption as reason → consumption in later situation of same day?
	No car available? (e.g. when outward trip was already travelled with another mode of transport) → "other reason"

Variable	Condition
Drug	
	Subject uses drug in a situation, but not the companions or vice versa?
	Subject uses drugs at job/school/university → companions?
	Consumption on trip possibly false statement?
Time	Time reported for drug consumption appropriate for consumed drug amount?
Companion	
	No companions listed in particular situations in which companions are very likely? (e.g. at friends', at relatives', etc.)
	Companions in last situation of previous day=companions in first situation of same day?
	Comparing number of co-consumers with number of companions/drug consumption of companions (e.g. number of companions cannot be lower than number of co-consumers)
Drugs	Drug consumption of companions refers to consumption in current situation/trip?
Driver	Drug consumption of driver refers to previous consumption?

8.4.2.2 Data correction volume

The single data values collected via the smartphones add up to approximately 1.3 million values. In Table 10 the numbers of variables and the number of cases per data level are listed (the actual number of values per data level range in each individual case because of the adaptive nature of the questionnaire):

Table 10: Data volume.

Level	Number of variables	Number of cases
Person-Level (VPID)	4	300
Day-Level (TID)	17	8,633
Episode-Level (EID)	35	68,635
Companion-Level (CID)	3	60,526
Drug-Level (DID)	7	11,969

The subjects were called to discuss data inconsistencies approximately five to six times within the study period. The users had to be called more often (Mean=5.8) than the controls (Mean=4.8). Approximately 20,000 data values (~1.5% of all data values) had to be changed by correcting single values or inserting/deleting whole levels.

9. Data quality

9.1 Comparison with existing data (representativity)

9.1.1 Driving

The Germany-wide survey "Mobility in Germany 2008" (MiD 2008) was carried out in the tradition of the MiD 2002 and the western German KONTIV-surveys from 1976, 1982 and 1989. The survey provides representative data about the mobility of the German population. In 2008 60,713 persons were randomly surveyed regarding their mobility behaviour on a predefined day over a one-year period.

In order to get information about the representativeness of the driving behaviour that was reported within the present (DYDD) survey ("*do**you**DRUG**DRIVE?*"), the data was compared with the data from the corresponding sub-population within the MiD 2008 survey[13]. By applying the DYDD in- and exclusion criteria, the total MiD Sample of 60,713 subjects is reduced to 6,274 (German) or 808 (Bavarian) valid subjects with which the DYDD data were compared (Figure 20). The MiD data were weighted to compensate for the presence of biases due to the sample selection whereas the DYDD data were not weighted. For the DYDD data the mean values were first calculated for each person. Then the average of all persons was calculated in order to reach highest data comparability.

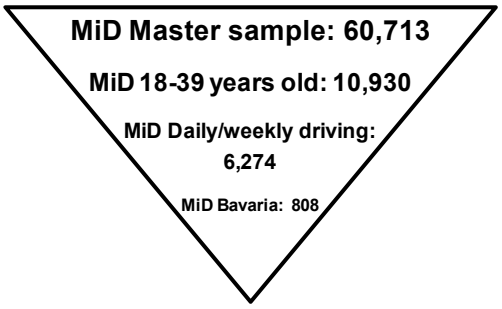


Figure 20: MiD sample.

Table 11: Descriptive data concerning the number of drives per day of the MiD/DYDD sample.

			$N_{Subject}$	N_{Days}	M	Min	Max	SD
Drives	**MiD**	**Germany**	6,274		2.03	0	12	2.07
		Bavaria	808		1.96	0	12	1.87
	DYDD	**All**	300	8,633	1.79	0	4.8	0.86
		User	200	5,730	1.71	0	4.8	0.85
		Control	100	2,903	1.94	0.62	4.43	0.87

The mean number of drives adds up to 2.03 drives a day for the German population and 1.96 for the Bavarian population according to the MiD data (Table 11)[14]. So, the mean number of drives for the Bavarian population is lower than the one of the German population in total. For the DYDD data the mean number of drives per day is 1.79 (User: 1.71; control: 1.94). The mean number of drives of the controls within the DYDD sample corre-

[13] The data was purchased from the "Clearingstelle für Verkehrsdaten und Verkehrsmodelle" in order to use them for own analysis.

[14] Business trips except trips to and from work are not included because the MiD data delivered no information about how business trips were travelled. Neither are those trips included that were additionally reported but not further specified (N_{MiD}=47). The minimum of zero drives within the DYDD sample is due to one user who only had drives at work that were excluded.

sponds very well to the values of the Bavarian sample whereas the users drove slightly less often than the Bavarian population.

When comparing the occurrence of drives in the course of the day, the MiD sample was not limited to Bavarian subjects nor to the sub-population, who drives regularly. Three assumptions were adopted:

- Regional differences in the relative occurrence of drives in the course of the day between Bavaria and the rest of Germany are not expected
- The drives over the course of the day are equally distributed. This does not differ between persons who drive daily/weekly and those who drive monthly. If so, the difference is of no consequence since the fraction of the latter sub-group's drives is rather low.

The DYDD data was compared to all drives of the 18-39-year-old German-wide population. The MiD data consists of single days for each subject of the sample whereas the DYDD data obtains several days for each subject. Because the number of days is approximately equal for all subjects, biases resulting from the different structure of the data pools are not expected.

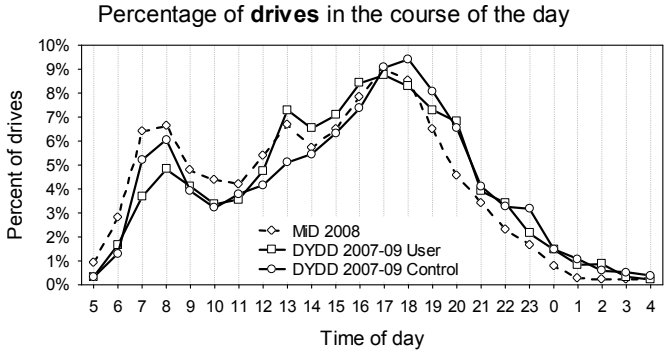


Figure 21: Percent of drives in the course of the day for the MiD 2008 and the DYDD user and control sample (the single values of all hours of the day sum up to 100% for each group).

The persons who participated in the study drove less frequently in the morning hours and more often in the evening and at night compared to the representative data (Figure 21). Here again, the controls' distribution of drives in the course of the day resembles the representative data better than the users'. The users drive less often in the morning hours.

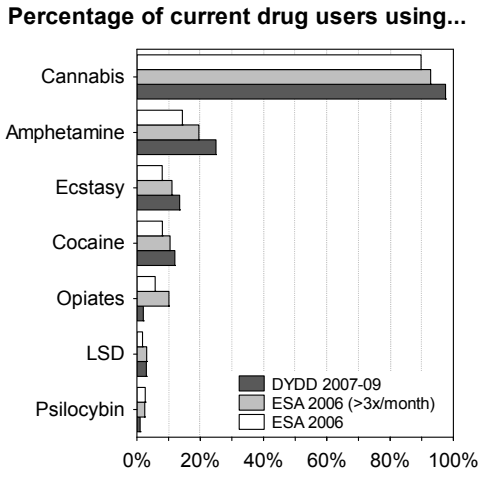
All in all, the number of drives and the distribution of drives in the course of the day of the sample are comparable to the representative data. However, slight differences between the users of the DYDD sample and the representative sample were found that might indicate a different driving behaviour of drug users. The subjects' affinity for drug use could be related to a decreased total amount of drives per day, an increased amount of drives at night and a decreased driving frequency in the morning.

9.1.2 Drug use

To find out if the drug using behaviour recorded in the DYDD survey equals the representative data of the German population (ESA 2006), the percentages of subjects using can-

nabis, amphetamine, ecstasy, cocaine, opiates, psilocybin, and LSD while participating in the study were compared to the 30-day prevalence of each drug measured in the Epidemiological Survey on Substance Abuse in Germany (ESA). Because the occurrence of less prevalent drugs could especially be higher when someone uses drugs more frequently (and one inclusion criteria for the DYDD study was regular drug use), the prevalence rates of the ESA 2006 data were also calculated for the comparable sub-group of regular users (>3x/month).

Figure 22 illustrates the percentage of the user group using the different drugs while participating in the DYDD study (dark bar) compared to the drug prevalence values according to the ESA 2006 survey for the 18-39-year-old general German population (white bar) and those who regularly used drugs within the last month (grey bar). For all drugs except opiates the agreement between the data pools is very good. The agreement is higher for the regularly using sub-population. Consuming at least once a week, was one inclusion criteria to take part in the DYDD study. The difference regarding the current consumption of opiates may be based on two reasons. Firstly, opiate consumers often do not have a driver licence. Secondly, the focus of the study was on the “common” drug user who usually does not use opiates.



	DYDD	ESA 2006 (>3x/month)	ESA 2006
Cannabis	97.5%	92.84%	89.79%
Amphetamine	25%	19.59%	14.38%
Ecstasy	13.5%	11.11%	8.01%
Cocaine	12%	10.46%	8.07%
Opiates	2%	10.1%	5.75%
LSD	3%	3.1%	1.77%
Psilocybin	1%	2.48%	2.63%

Figure 22: Drug prevalence for different substances within the DYDD survey (dark bar) and for the 18-39-year-old German population that currently uses drugs (white bar) and uses drugs regularly (grey bar), respectively.

9.2 Previous consumption

9.2.1 Description

The main analyses conducted in this report are planned to be based on information about the current drug use behaviour received from the daily questionnaires. Nonetheless, if drug use is regarded as an important variable for predicting drug driving and if not only the behaviour itself but also the motives behind are seen as important predictors, previous drug use should also be considered in this context. After all, a person who consumed hard drugs in the past but does not any more might think, for example, that it is not that dangerous or reprehensible to drive after consuming soft drugs, especially cannabis.

For this purpose, the drug use history reported by the participants is outlined in this chapter. Moreover, the information about previous drug use behaviour is compared to the current behaviour to be able to decide if the latter sufficiently represents the subjects' drug use experience.

The following questions were asked in a questionnaire at the beginning of the study (Q-Start; Annex 14.2) to gain information about the subjects' previous experience with drugs (Table 12).

Table 12: Q-Start questions concerning previous drug use.

Question
Have you ever taken any of the following drugs (cannabis, amphetamine, ecstasy, LSD, psilocybin, cocaine, crack, heroin and sniffing agents)? If yes, when was the first time? How many years ago?
From the first time to this day, how often have you taken the following drugs? (never, 1x, 2x, 3-5x, 6-9x, 10-39x, ≥40x)[15]
How long has it been since you have taken the following drugs for the last time? (<1 month, 1-5 months, 6-11 months, ≥1 year, ≥2 years, ≥5 years, never used)

The questions were asked for the drugs cannabis, amphetamine, ecstasy, LSD, psilocybin, cocaine, crack, heroin, and sniffing agents. Additionally, a miscellaneous field was given for specifying other, not listed drugs. In this category the following drugs were mentioned: other psychoactive plants[16], non-prescribed methylphenidate, ephedrine, phencyclidine, ketamine, GHB, spice, chrystal, tilidine, barbiturates, and benzodiazepines. Four subjects had experience with synthetic opioids as maintenance anti-addictive. One subject used methadone in the past whereas the remaining three subjects are still in treatment with methadone and buprenorphine, respectively, and additionally use other drugs (cannabis, cannabis and heroin, heroin).

Almost all drug users (N_{User}=200) within the sample have used cannabis more than forty times in their lifetime. The drug users' experiences with other drugs varied (Figure 23).

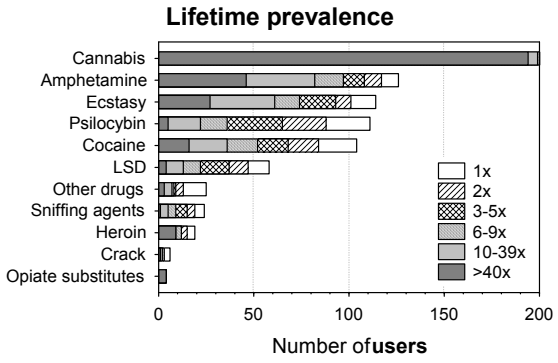


Figure 23: Lifetime drug use frequency per drug for the user sample (N_{User}=200).

Figure 24 and Figure 25 show the age of onset of drug use (left figure) and the number of subjects within the user group (N_{User}=200) that used each drug at least once in a lifetime (right figure). The earliest mean onset at the age of 15.6 was found for cannabis, followed by sniffing agents at age 17.1. Amphetamine (18.6), ecstasy (18.6), psilocybin (18.7) and LSD (18.9) were used for the first time at the age of 18 to 19. For all other drugs (Heroin:

[15] "x" means times of use.

[16] Hawaiian baby woodrose, mescalin, tryptamine, salvia divinorum, brugmansia

19.9; cocaine: 20.0; crack: 20.7; all other drugs: 20.1) the users were around 20 years old when they used it for the first time.

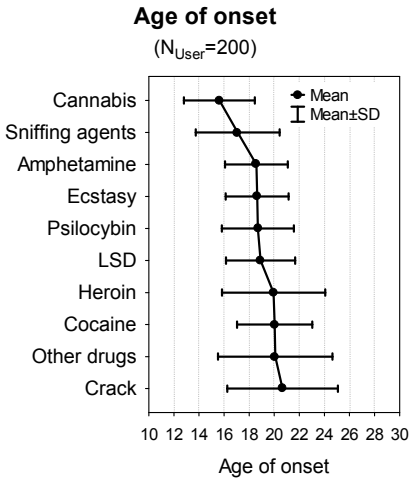


Figure 24: Mean age of onset per drug for the users (N_{User}=200).

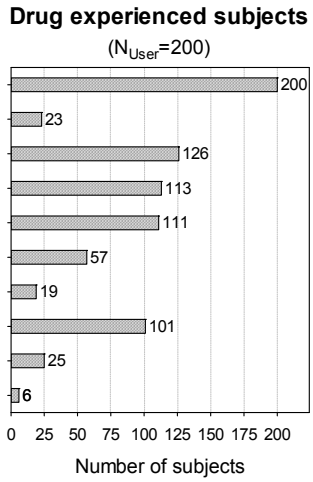


Figure 25: Number of drug experienced subjects per drug for the users (N_{User}=200).

Figure 26 shows the time when the subjects used the different drugs for the last time. All users are currently using drugs. Five persons did not use cannabis within the last month. Other drugs were used instead within the previous month. One person was regularly using ephedrine, one amphetamine, one amphetamine, ecstasy and sniffing agents and another two heroin, one of which additionally used buprenorphine.

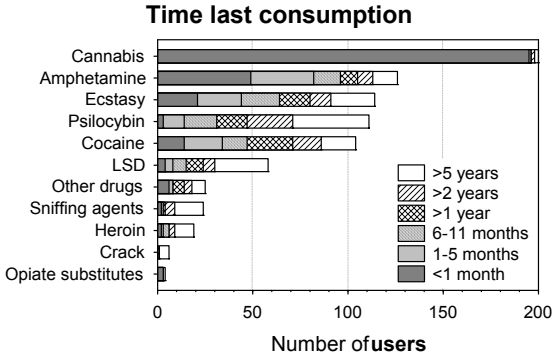


Figure 26: Time of last consumption per drug for users (N_{User}=200).

On the basis of the data about the frequency of previous drug use, different user classes were categorized by exploratory data analysis based on a face validity approach and not a formal analytic procedure like a cluster analysis (Table 13). In the first step, the mean values of the frequency of using stimulants (*Stim*), hallucinogens (*Hallu*), "high potential" drugs (*Her*) and other drugs (*Oth*) were calculated. Amphetamine, ecstasy and cocaine were subsumed in the *stimulants* category, psilocybin and LSD in the *hallucinogens* category. The *high potential drug* category contained the drugs heroin and crack because of their high potential for abuse. Moreover, opiate substitutes were subsumed in this category. The remaining drugs were summarized within the *other drugs* category. The mean value of each category was calculated with the following values of the lifetime frequency of each drug: "1x"=1x, "2x"=2x, "3-5x"=4x, "6-9x"=7x, "10-39x"=24x, ">40x"=40x. If the

mean value was above 10 the drug use concerning this category was classified as crucial. Table 13 shows the different user classes drawn from this categorization.

Table 13: User classes based on frequency of previous drug consumption and number of users.

		Lifetime drug consumption			N_{User}=200
User class	**Class description**	**Cann**	**Stim/Hallu/Oth**	**Her**	
CanOnly	Cannabis only	**>0x**	0x	0x	40
CanOthLow	Cannabis and sometimes stimulants and/or sometimes hallucinogens and/or sometimes other drugs and/or sometimes high potential drugs	**>0x**	<10x	<10x	75
CanOthHigh	Cannabis and oftentimes stimulants and/or oftentimes hallucinogens and/or oftentimes other drugs and/or sometimes high potential drugs	**>0x**	**>10x**	<10x	76
CanHer	Cannabis and oftentimes high potential drugs	**>0x**	not specified	**>10x**	9

All users used cannabis quite often. 40 users have only used cannabis in their lifetime (*CanOnly*). 75 subjects also used amphetamine, ecstasy, cocaine, and psilocybin sometimes and very rarely LSD, sniffing agents, and other drugs except opiates and crack (*CanOthLow*). 76 users used stimulants and hallucinogens quite often and sometimes sniffing agents and other drugs including heroin (*CanOthHigh*). The remaining nine users are classified as one group because of their experience in heroin (*CanHer*). This user class also used all other substances quite often.

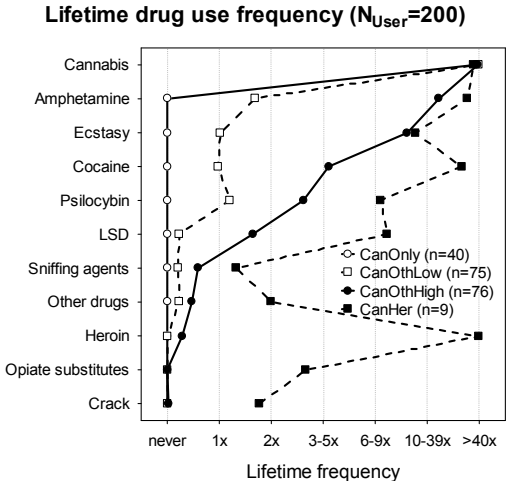


Figure 27: Lifetime drug use frequency in user group for the user classes "CanOnly" (cannabis only), "CanOthLow" (cannabis and sometimes other drugs), "CanOthHigh" (cannabis and oftentimes other drugs) and "CanHer" (cannabis and oftentimes high potential drugs).

Figure 27 shows the users' profile concerning the frequency of drug use in lifetime for the different user classes. The classification separates the users quite well into different user types. The cannabis lifetime frequency does not differ between the four classes - *CanOnly* (cannabis only), *CanOthLow* (cannabis and sometimes other drugs), *CanOthHigh* (cannabis and oftentimes other drugs) and *CanHer* (cannabis and oftentimes high potential drugs).

9.2.2 Comparison of former and current consumption

In a next step it was examined whether the data of the lifetime experience with drugs suits the current consumption behaviour reported within the 4-week study period. Almost all subjects used cannabis while participating in the study (for detailed information see Chapter 11.5). All other substances were currently used rather seldom, so they were summarized as *other substances* in this context. Five subjects did not use cannabis within the study period. Instead one used amphetamine (on 4.3 days)[17] and ecstasy (on 1.1 days), one ephedrine (on 28.9 days), one buprenorphine (on 30 days) without concomitant drug use, one amphetamine (on 13.1 days) and cocaine (on 3.7 days), and one heroin (on 16.1 days) and zopiclone (on 10.7 days). Those were excluded from all further analyses.

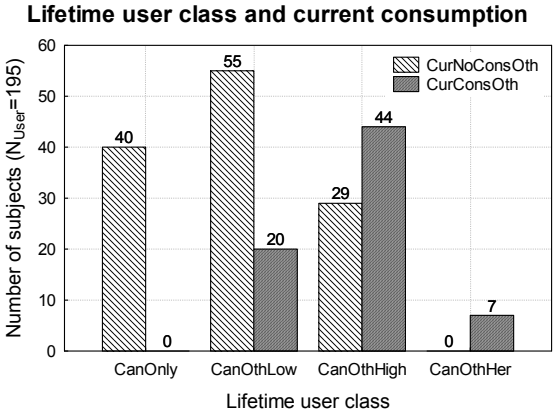


Figure 28: Lifetime user classes depending on current consumption of other drugs than cannabis (lifetime user class: CanOnly=Cannabis only, CanOthLow=Cannabis and sometimes other drugs, CanOthHigh=Cannabis and oftentimes other drugs, CanOthHer=Cannabis and oftentimes high potential drugs; current use of other drugs than cannabis: CurConsOth=Yes, CurNoConsOth=No; N_{User}=195).

The users who reported that they had never used other drugs than cannabis in their lifetime (*CanOnly,* N_{User}=40), only used cannabis while participating in the study (Figure 28). Of those who reported that they have sometimes used other drugs in their lifetime (*CanOthLow*), 27% (N_{User}=20) reported usage of other drugs while participating. Of those who oftentimes used other drugs before participating in the study (*CanOthHigh*), 60% (N_{User}=44) reported current consumption of other drugs. All users who have used heroin, crack, and opiate substitutes (*CanOthHer,* N_{User}=7) used other drugs than cannabis within the survey period.

The higher percentage of users who use other drugs than cannabis in those user classes that reported higher use of other drugs in the past, indicates a good consistency of the queried information and shows that the current drug consumption behaviour is a good parameter for describing the drug use experience in general.

At the end of the study the subjects were also asked if their drug use and driving behaviour within the study period was comparable to their usual behavioural habits. 19 subjects (6.4%) said that they changed their drug use behaviour – 15 reduced it, 4 consumed

[17] Because of the varying number of available reports per person, the days were extrapolated to 30 days (number of days with drug use divided by number of reported days and multiplied by 30).

more – and 54 subjects (18.3%) said that they had become more aware of their drug use but did not change it (driving behaviour: 1% were more mobile; 2.7% drove with more care).

9.3 Urine sample – toxicological analysis

9.3.1 Method

All subjects were required to randomly submit to a urine drug test once within the study period. The urine samples were analysed at the Institute of Legal Medicine in Würzburg and Munich, respectively. In Table 14 the applied immunoassay technologies, the analysed substances and the corresponding cut-off values are listed.

Table 14: Immunoassay technologies applied for the toxicological analysis of the urine samples and corresponding cut-off values.

Institute of Legal Medicine	Würzburg	Munich
Assay	AxSym-Assay (Abbott)	CEDIA-Assay (Microgenics/Thermo Fisher)
	Cut-off values	
Cannabinoids	25 ng/mL	25 ng/mL
Amphetamines	600 ng/mL	200 ng/mL
Cocaine-Metabolites	300 ng/mL	100 ng/mL
Opiates	200 ng/mL	200 ng/mL

Because the amount of substrates in the urine cannot be interpreted quantitatively, the sample outcome was categorised dichotomously as either “positive” or “negative”. The degree of correspondence between the urine screening and the recorded drug use was assessed by examining and relating the following data:

- Screening result
- Time difference between urine sample collection and last drug use
- Drug amount consumed at last drug use

For the latter, a timeframe of 96 hours back from the last drug use episode was considered to avoid biases arising if the consumed drug amount in the last drug situation was considerably smaller than the one consumed – perhaps almost shortly before – in the drug situation before the last.

9.3.2 Agreement between urine and recording

295 urine samples were collected and tested for four different drugs or classes of drugs of abuse[18]. All urine analysis of the controls’ samples resulted in a negative outcome. The following criteria were applied to decide on which samples were included to the further analyses of the users’ samples. First of all, it was determined which user could potentially have or actually has a positive result on the different substances. Four information sources were used:

[18] Two subjects (two users) refused to give a urine sample because they feared that this could have a negative impact on data privacy. Three subjects (two users and one control) suddenly cancelled the study after approximately two weeks. In these cases the urine sample was not collected.

- Positive urine sample
- Report on current drug use behaviour while participating in the study (Q-Daily)
- Statement about standard drug use behaviour (first contact)
- Statement about drug use behaviour within the previous 30 days (Q-Start)

All urine samples with a lower creatinine value than 20 dl/ml and a negative drug screening were excluded from analysis because a lowered creatinine level could implicate that the sample is diluted and a false negative outcome is likely to occur (N_{User}=12, 6.1%; compared to $N_{Control}$=13, 13.1%). Samples were also excluded from the analysis when relevant reports previous to the urine collection were missing and the relation between the reported drug use in the available reports and the urine screening could thus be not interpreted.

Five samples were positive for cannabinoids and amphetamines, respectively, even though no drug use was reported within the 5-25 available previous days before the urine was collected (false positive). It was tried to collect the urine sample after approximately two weeks to make sure that enough information would be available about all relevant previous drug use. When the data collection started in Munich the investigators were not constantly on site yet. So, the study procedure had to be adjusted to the time the investigators were present in Munich. That is why some subjects had only reported a few days before they had to deliver the urine sample. In this case false positive samples could result from the fact that not all relevant previous consumption was reported. All other false positive samples might indicate that the subjects forgot to report the drug use in question. Nevertheless, since in the previous survey an underreporting leads to conservative results, the false positive results were ignored.

Of the remaining samples of the subjects who used the analysed substance classes within the study period previous to the urine sample collection, 80% were positive for cannabinoids, 28% were positive for amphetamines, 21% were positive for cocaine-metabolites and 100% were positive for opiates (absolute numbers in Table 15). The three opiate-positive samples were ascribed to one subject who was using an opioid medicine and two subjects who were using heroin.

Table 15: Urine sample description and outcome depending on days since last drug use.

	Cannabis		Amphetamines		Cocaine		Opiates	
Regular/previous/current drug use	192		76		44		6	
Low creatinine & negative sample	7		4		–		–	
Relevant reports missing	2		1		–		–	
	pos.	**neg.**	**pos.**	**neg.**	**pos.**	**neg.**	**pos.**	**neg.**
No previous drug use reported	1	–	4	28	–	25	–	3
Number of analysed samples	182		39		19		3	
	pos.	**neg.**	**pos.**	**neg.**	**pos.**	**neg.**	**pos.**	**neg.**
Samples with previous drug use	145	37	11	28	4	15	3	–
Days since drug use: max. 1 day	117	10	5	–	2	–	1	–
2-4 days	22	14	6	10	2	6	2	–
5-7 days	6	7	–	5	–	3	–	–
>7 days	–	6	–	13	–	6	–	–

The absolute numbers of the screening results for different time lags between urine sample collection and last drug use (i.e. max. 1 day, 2-4 days, 5-7 days, >7 days) show that the higher the time delay, the more likely a negative screening outcome is (Figure 29).

Figure 30 to Figure 32 show the relation between the time difference and the consumed drug dose and the outcome of the drug screening for the different substance classes: cannabinoids, amphetamines and cocaine-metabolites. Opiates were not considered here because the results are clear concerning opiates. For the other substances though, a sample in most cases is positive when the subjects consumed a larger amount of drugs or the drug consumption took place not far in the past.

Nonetheless, there are no definite criteria for determining the agreement between the screening outcome and the drug amount/time difference between drug use and sample collection. Besides, there is no exact information about the dose that was actually consumed by the subjects. The dose was reported as number of units (e.g. joint/pipe/cookie/tea for cannabis, line/inhalation for cocaine, line/pill for amphetamine, etc.) and not as mg. The subjects were asked in the beginning of the survey how many mg they use when they consume a regular unit. It turned out that very few had an idea about the exact dose.

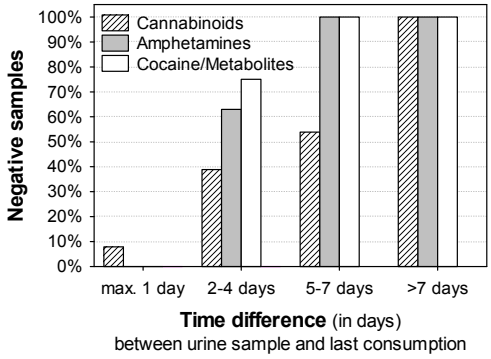


Figure 29: Percent negative urine samples dependent on the time difference between urine sample and last drug consumption.

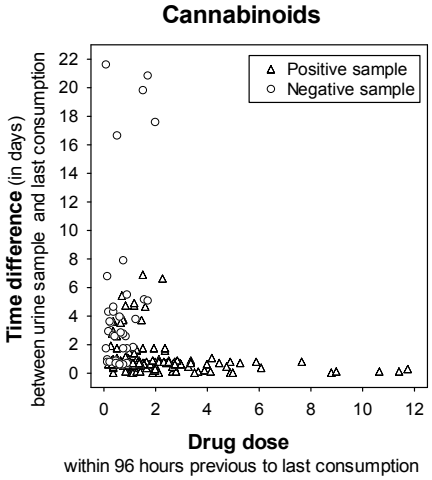


Figure 30: Relation between outcome of urine analysis and time difference to previous consumption and consumed units of cannabis (e.g. joint/pipe/cookie/tea).

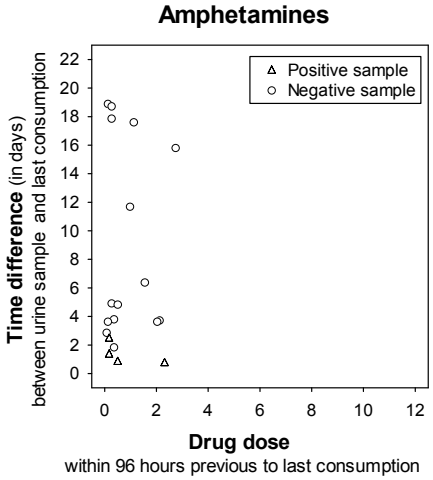


Figure 31: Relation between outcome of urine analysis and time difference to previous consumption and consumed units of amphetamines (e.g. line/pill).

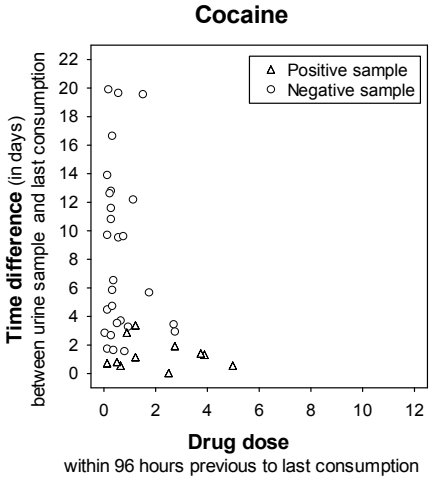


Figure 32: Relation between outcome of urine analysis and time difference to previous consumption as well as consumed units of cocaine (e.g. line/inhalation).

All in all, the subjects' statements about their drug using behaviour seem to be reliable because most screening results can be explained by the previous drug use that was reported. The differing statements slightly implicate both an underrating (false positive outcomes) and an overrating effect (negative outcome with previous consumption within the last day).

10. Data pre-processing

In order to estimate the proportion of DUI as accurately as possible, BACs and THC concentrations were calculated from the information about the consumed doses of the subjects[19].

10.1 Alcohol – Calculation of blood alcohol concentration

10.1.1 Rationale of calculation

For alcohol, the following steps of calculation were applied:

(1) Conversion of the amount of the different kind of drinks in gram alcohol
- 1 litre beer (5% alcohol by volume)=40g
- 1 litre wine (10% alcohol by volume)=80g
- 2cl=0.02 litre liquor (40% alcohol by volume)=6.4g

(2) Due to the fact that the periods of consumption vary from 15min to several hours, it was decided to assume a constant consumption over the whole consumption period. Therefore, the amount of consumed alcohol (in g) was equally divided into as many 15min intervals as the period of consumption comprises.
- 40g alcohol from 7:00pm-7:45pm
- 3x15min consumption intervals=40g/3=13.3g per consumption interval

(3) Calculation of the BAC using the Widmark Formula (Widmark, 1932) for each interval[20]. The BAC of a 15min interval is calculated as the BAC of the currently consumed amount of alcohol plus the remaining BAC level from the intervals before.

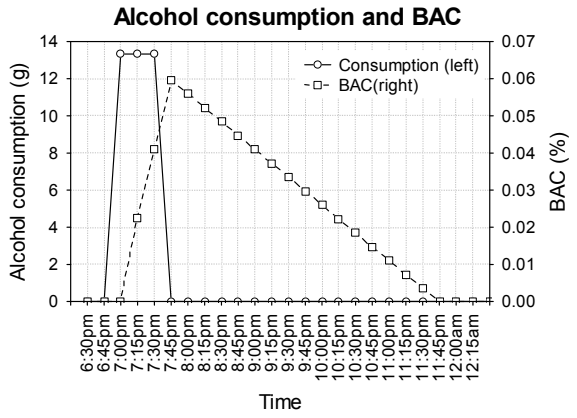


Figure 33: Calculated BAC for a male person (85kg) who consumes 40g alcohol from 7:00-7:45pm.

[19] For the other substances no valid estimation of substance concentrations is possible.

[20] For the calculation, the following assumptions were made: body weight or mean body weight for missing values (males=77 kg; females=64 kg), reduction factor: males=0.7, females=0.6; catabolic degration rate=0.015% BAC per hour (Madea & Dettmeyer, 2007).

(4) Matching the resulting 15min intervals with the basic time-structure of episodes (situations and trips, Figure 34), so that for each episode the BAC is provided for the beginning and the end of the episode.

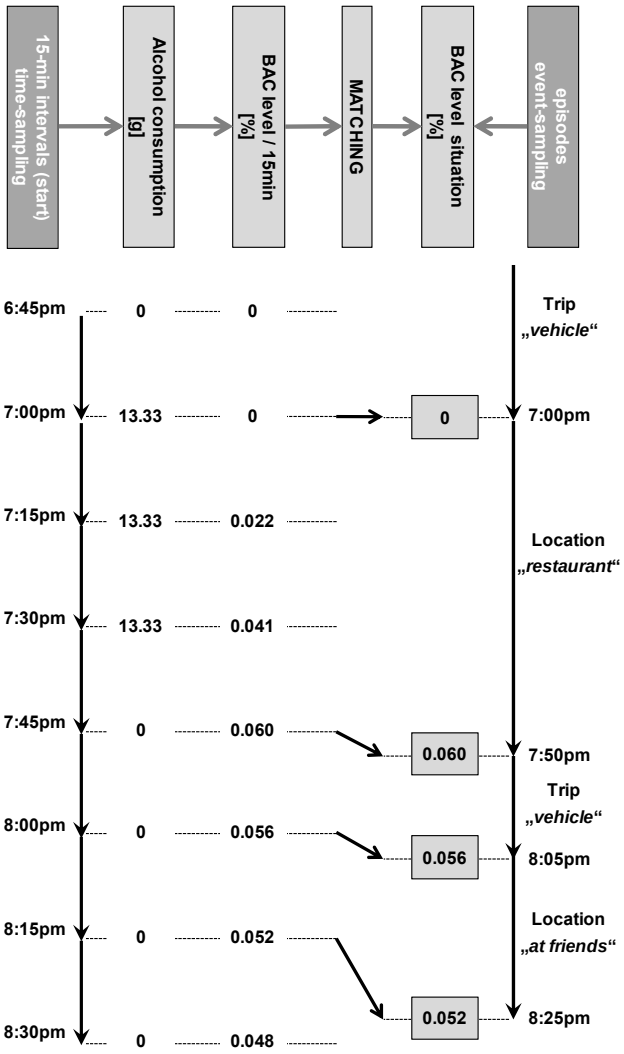


Figure 34: Illustration of transferring the BAC values from time-sampling to the time-points of the event-sampling of real episodes.

10.1.2 Constraints

(1) The amount of 154 drinks (out of 5,804=2.6%) could not be calculated automatically because the drinks were mix drinks (e.g. gin tonic). For them the amount of alcohol was calculated manually according to their standard ingredients.

(2) A consumption of any alcohol dose in the middle of a 15min interval (e.g. 7:05pm or 7:10pm) will result in a BAC value of zero at the beginning (7:00pm) and a BAC value of a 15min elimination period at the end of the interval (7:15pm).

(3) If a positive BAC remains after the sleep period of a subject, the BAC is calculated using a linear approximation of the Widmark Formula starting with the BAC level when waking up until the BAC converges to zero. If further alcohol is consumed before the BAC level from the day before reaches zero, the BACs are added.

10.2 Cannabis: Calculation of THC blood plasma concentration

10.2.1 Rationale of calculation

For THC, the following steps of calculation were applied:

(1) Calculation of the total amount of consumed THC (in mg) regarding the number of co-consumers. For this procedure a mean amount of 15mg per joint was assumed, which is a usual dose according to Madea and Dettmeyer (2007).
   - Consumption of 3 joints with 4 co-consumers: 3*15mg/(4+1)=9mg per person

(2) Due to the fact that the periods of consumption vary from 15min to several hours, we decided to assume a constant consumption over the whole consumption period. Therefore the amount of consumed cannabis (in mg) was equally divided into as many 15min intervals as the period of consumption comprises.
   - 3 joints with 4 co-consumers from 7:00pm-7:45pm
   - Consumed mg: 3*15mg/(4+1)=9mg
   - 3x15min consumption intervals=9mg/3=3mg per consumption interval

(3) Calculation of the THC blood plasma level using the data of Sticht (G. Sticht, personal communication, December 2009), which describe the nonlinear elimination curve of THC in 15min intervals (Annex 14.4). The THC blood plasma level of the last 15min interval in a 45min period of consumption (e.g. 7:45pm in our example) is calculated as follows:
   - THC level of the currently consumed amount of THC (7:30pm-7:45pm) eliminated for 15min plus
   - THC level of the previous interval (7:15pm-7:30pm), eliminated for 30min plus
   - THC level of the interval 30min ago (7:00pm-7:15pm), eliminated for 45min

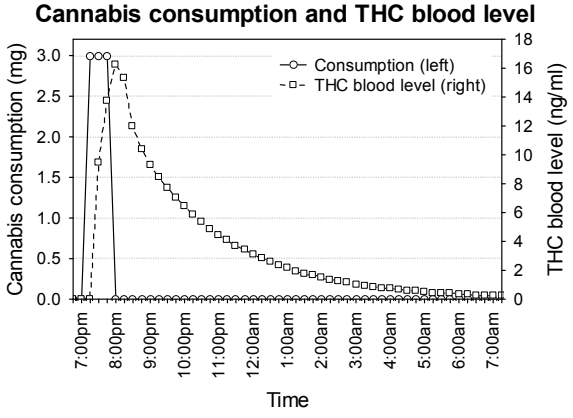


Figure 35: Calculated THC blood plasma level for a person who smoked 3 joints (3x15mg) from 7:00-7:45pm with 4 co-consumers.

(4) Matching the resulting 15min intervals with the basic time-structure of episodes (situations and trips, Figure 34), so that for each episode the THC blood plasma level is provided for the beginning and the end of the episode.

10.2.2 Constraints

(1) Out of 5,680 THC consumption units in the database, 4,116 (72.5%) were smoked as joints and 1,548 (27.3%) where inhaled as pipes. 16 consumption units (0.28%) were consumed as cookies or tea. For all kinds of drug intake, the procedure for the calculation of the THC blood plasma level described in Chapter 10.2.1 is applied. Because of different absorption and elimination processes depending on the consumption method, this is not correct but was considered as an acceptable falsification, primarily because the number of cookies or tea intakes was so low.

(2) A consumption in the middle of a 15min interval (e.g. 7:05pm or 7:10pm) will result in a THC value of zero in the beginning (7:00pm) and a THC value of a 15min elimination period at the end of the interval (7:15pm).

(3) If a positive THC level remains after the sleep period of a subject, the THC level is transferred to the subjects' protocol of the next day. In the case of further consumption before the THC level from the day before reaches zero, the THC values are added.

11. Results

11.1 Glossary

The following chapter summarizes and defines main terms that are used within the report to facilitate an easy understanding and orientation within the following results section.

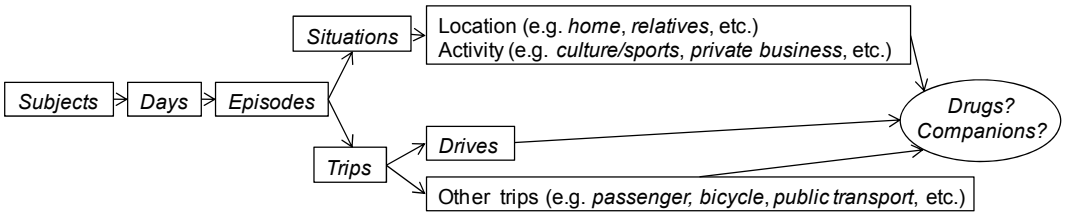


Figure 36: Terminology of daily data points.

The daily data consist of different *days* of each subject, which are divided into as many daily *episodes* as each subject had on each day (Figure 36). An *episode* can be a *situation* or a *trip*. *Situations* in turn are locations (e.g. *home,* etc.) and activities (e.g. *culture/sports,* etc.). *Trips* on the other hand are divided into *drives* that were travelled as driver of a motor vehicle or any other trip (e.g. *passenger*, *bicycle*, *public transport*, etc.). Data about the consumed *drugs* and the accompanying *companions* are available for each situation and trip. In Table 16 all main terms are described as they are used within the results section of this report.

Table 16: Definition of main terms used in results section.

Term	Definition
User	Drug using subjects who used cannabis at least once while participating in the study
Episodes	Situations and trips
Situations	Locations and activities
Trips	Motorised private transport as driver (moped, motorcycle, vehicle, transporter, truck) and all other trips (passenger, bicycle, etc.)
MPT	Motorised private transport (either as driver or as passenger)
Drives	Motorised private transport as driver of a motor vehicle (motorised private transport as passenger is not included)
Drug	Any impairing substance (illegal drugs, alcohol, and not legally prescribed medicines)
Stimulants	Amphetamine, cocaine, ecstasy
Residence	Rural: < 50,000 residents, urban: < 500,000 residents, city: > 500,000 residents
City drives	Drives that were travelled on city roads to 70%
NoCity drives	Drives that were travelled on city roads to less than 70%
DUI	Drives under the influence of cannabis (THC≥1ng/ml) and/or alcohol (BAC≥0,01%) and/or any other substance (according to the calculation described in Chapter 10)
Conflicts	Trips associated with drug driving: drives that were consciously travelled under influence (*consumption as usual*), drives that were travelled after reduced consumption (*restricted consumption*) and trips for which the subjects stated having abdicated driving under influence by either abstaining from drug use (*consumption abdication*) or abstaining from driving (*drive abdication*) (for a detailed description of the different conditions see Chapter 11.7.12.1)
Weekday	All hours after 9pm on Sundays until 9pm on Fridays
Weekend	All hours after 9pm on Fridays until 9pm on Sundays
Hour	Lasts from 29 min before until 30 min after the full hour (e.g. 5=4:31am-5:30am)

11.2 Data overview

This section gives an overview of the magnitude of all reported daily data points. In the following tables the absolute numbers of the listed reference parameters are shown (Table 17, Table 18, and Table 19).

Table 17: Available data (absolute numbers and percent): overview (N_{User}=195; $N_{Control}$=100).

	User (N_{User}=195)		Control ($N_{Control}$=100)		Total (N_{Total}=295)	
	N	%	N	%	N	%
Days	5,586		2,903		8,489	
...with drug use (% of days)	4,373	78.3%	839	28.9%	5,212	61.4%
...with drives (% of days)	3,605	64.5%	2,046	70.5%	5,651	66.6%
Episodes	43,967		23,571		67,538	
...Situations (% of episodes)	25,360	57.7%	13,487	57.2%	38,847	57.5%
...Trips (% of episodes)	18,607	42.3%	10,084	42.8%	28,691	42.5%
...Drives (% of trips)	9,553	51.3%	5,646	56%	15,199	53%

Table 18: Consumption episodes (absolute numbers and percent): overview of the users' data (N_{User}=195; for alcohol additionally for controls – $N_{Control}$=100).

		Situations		Trips			
				No drives		Drives	
		N	%	N	%	N	%
Any drug		7,479	29.5%	315	3.5%	46	0.5%
Alcohol	**User**	3,042	12%	209	2.3%	14	0,1%
	Control	1,040	7.7%	25	0.6%	4	0.04%
Cannabis		5,528	21.8%	120	1.3%	32	0.3%
Amphetamine		254	1%				
Ecstasy		69	0.3%	3	0.03%		
Methadone/buprenorphine		58	0.2%				
Cocaine		50	0.2%				
LSD		8	0.03%	2	0.02%		
Sedatives		8	0.03%				
Heroin		5	0.02%				
Psilocybin		2	0.01%				
GHB		2	0.01%				
Spice		2	0.01%				
Methylphenidate[21]		3	0.01%				
Salvia Divinorum		1	0.004%				

Table 19: Trips separated for modes of transportation (absolute numbers and percent): overview (N_{User}=195; $N_{Control}$=100).

Mode of transport	Number (and percent) of trips		
	User (N_{User}=195)	Control ($N_{Control}$=100)	Total (N_{Total}=295)
Foot/bicycle/other	4,267 (22.9%)	2,197 (21.8%)	6,464 (22.5%)
Taxi	292 (1.6%)	59 (0.6%)	351 (1.2%)
Public transport	2,207 (11.9%)	1,055 (10.5%)	3,262 (11.4%)
MPT passenger	2,288 (12.3%)	1,127 (11.2%)	3,415 (11.9%)
MPT driver alone	6,793 (36.5%)	4,062 (40.3%)	10,855 (37.8%)
MPT driver companion	2,760 (14.8%)	1,584 (15.7%)	4,344 (15.1%)

[21] Non-prescribed methylphenidate

11.3 Main points of data analysis

As pointed out in the introduction, the study collected a broad range of data from different sources (Chapter 7). This report concentrates on very basic information about...

- How do people spend an average day?
- When and what kind of substances do people use?
- When do people drive a vehicle and when do they use other modes of transportation?
- How often does driving under impairing substances occur within the study sample?
- How high is the proportion of DUI in the general population (estimated by the survey results)?
- When does drug driving occur?
- What are the situational characteristics of DUI?
- Does everybody who uses drugs and drives regularly commit DUI?
- Do heavy users or people who drive a lot commit more DUI than others?
- Do subjects who were conspicuous in road traffic before (measured by the records in the Central Register of Traffic Offenders) commit more drives under influence compared to those who had no entry in the register?
- Do subjects who reported dangerous traffic situations while participating commit more drives under influence compared to those who had no dangerous traffic situation?
- Does the legal BAC limit have an effect on alcohol-positive drives?
- How often do people decide not to drive under influence by either refraining from driving or refraining from drug use?
- Is there a correlation between the degree of impairment and the decision against drug driving?
- Do moderate users or people who drive a motor vehicle less regular refrain from drug driving more often?
- What are the situational circumstances like in which people decide against DUI?
- Does the perceived risk of being stopped by the police or the perceived risk of being detected when stopped by the police while driving under influence have an effect on DUI?

11.4 Structure of days

11.4.1 Sleep-wake ratio

To compare the sleep-wake ratio of weekdays and weekends, all reported hours after 9pm on Fridays until 9pm on Sundays were summarized as weekend hours. All remaining hours were classified as weekday hours. Obviously, the subjects generally went to bed later at night and got up later in the morning on weekends than on weekdays (Figure 37). Between 4am and 6am they were awake on up to 30% of the reported hours (i.e. days). On weekdays they were awake at this time in less than 10% of the days. Compared to controls the users were more awake at night-time and more asleep between 7am and noon on both weekends and weekdays.

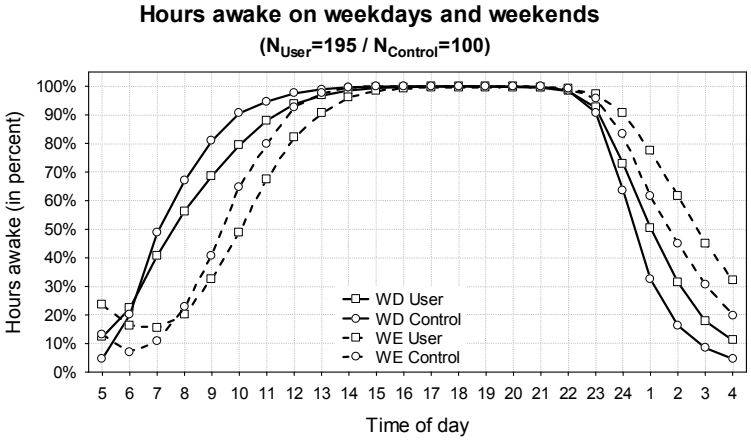


Figure 37: Hours awake on weekdays and weekends for users (N_{User}=195) and controls ($N_{Control}$=100) in percent - naps during the day are not included.

So, both weekends and being a drug user shifts back the sleeping period to later at night until later in the morning.

11.4.2 Structure of locations/daily activities

The structuring of each daily report was described in Chapter 7.1.1. The subjects listed all situations and trips in chronological order. For each situation they specified the location or the activity they carried out using the predetermined categories "*at home*", "*friends*", "*relatives*", "*job*", "*school*", "*private business*", "*culture, sports*", "*restaurant, bar*", "*club*", "*event*", "*outside*" or "*excursion*". Moreover, a "miscellaneous" response was provided to express locations/activities that could not be expressed by the given response alternatives. For a clear presentation of the locations and daily activities all specifications that were mentioned through the miscellaneous category were subsumed to the predetermined categories (e.g. "*cinema*" to "*culture, sports*", "*garden shed*" to "*at home*", etc.). Besides, the categories "*job*" and "*school*" were placed together and the category "*excursion*" was subsumed to the category "*outside*". The situations were assigned to the 24-hour timeline of a day according to their length (e.g. the situation "*at home* from 5:00pm-7:20pm" was assigned to the hours 17, 18, and 19). Because more than one situation could take place within one hour, the number of situations per time category exceeds the number of days and varies according to the frequency rate of situations per time category. Therefore, no absolute numbers but percentage values per time of day are shown in the following sections.

As one would expect, weekends and weekdays especially differ concerning work/school and going out in the evening (Figure 38). On weekends the users spent time at friends' all day long whereas on weekdays the situations at friends' mostly occurred in the evening and at night. Furthermore, the users spent more time outside and at relatives' on weekends compared to weekdays and had more private business situations on weekdays compared to weekends (e.g. shopping, hair dresser, etc.).

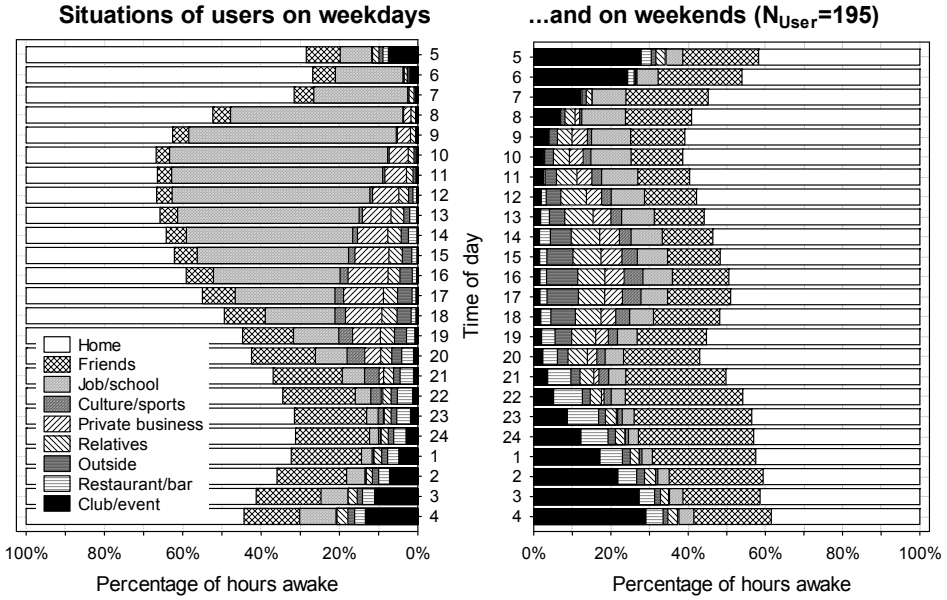


Figure 38: Proportion of time spent on different activities/at different localities for weekdays and weekends of users (N_{User}=195).

The distribution of situations throughout the day of the controls looks fairly similar to that of the users (Figure 39). Nevertheless, in contrast to the users the controls were more often out at public places on weekends ("*restaurant/bar*", "*club/event*") whereas the users spent more time at friends' – on weekends the whole day, on weekdays especially at night. The only time when users were out more when awake as compared to controls was between 6am and 8am on weekends. Additionally, the controls seem to do more sports and cultural activities and had some more situations at relatives'.

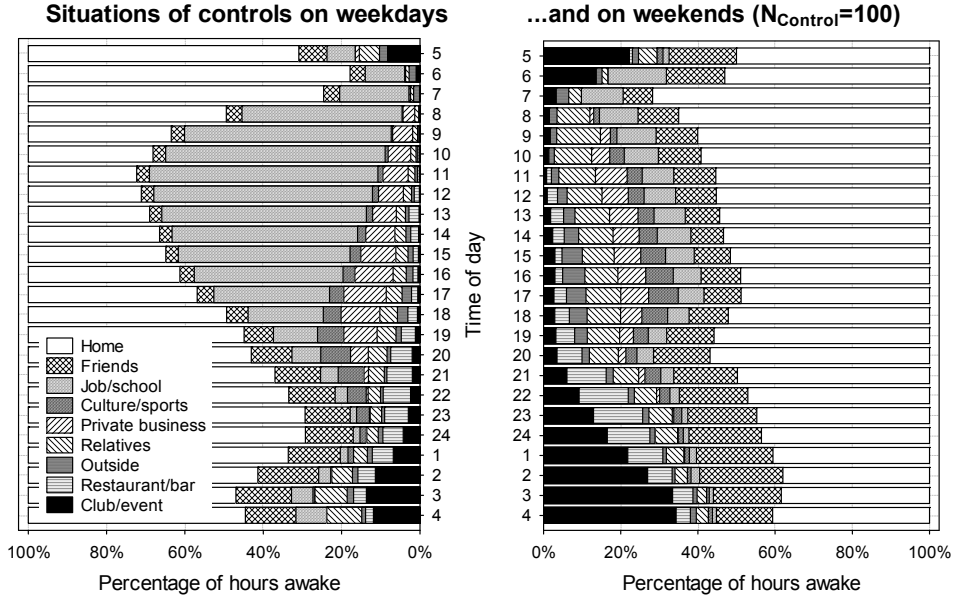


Figure 39: Proportion of time spent on different activities/at different localities for weekdays and weekends of controls ($N_{Control}$=100).

11.5 Structure of consumption: drug incidences

11.5.1 Drug use as a function of time

Between 9pm and midnight, the users consumed impairing substances in almost fifty percent of all hours (Figure 40). Later at night – until approximately 5am, the proportion of hours when the subjects were asleep increases. On days the subjects were still awake at that time, substance consumption again took place at around fifty percent of the time. Between 6am until noon, substance use occurred rather seldom.

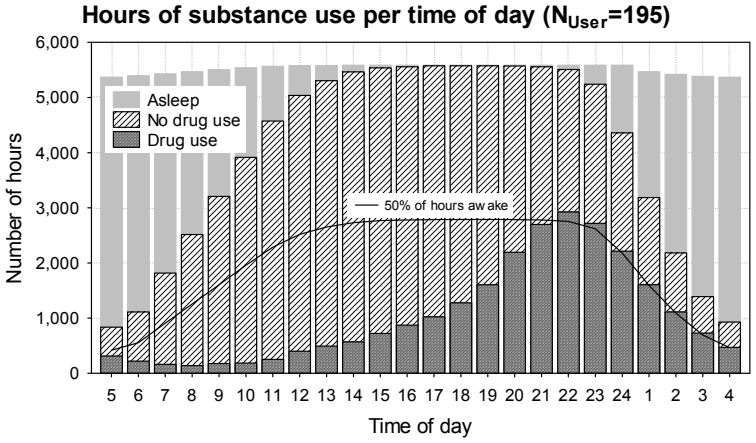


Figure 40: Hours of substance use per time of day (N_{User}=195).

The users spent much more time on consumption on weekends than on weekdays (Figure 41). On weekends, consumption continually increased from noon onwards with a peak between 9pm and midnight. From that time on until 4am, they spent up to 70% of the time they were awake on substance consumption whereas this was only true for approximately 40-50% of the time they were awake on weekdays. Additionally, consumption was still increased until around 6am on weekends whereas consumption rather infrequently occurred in the early morning hours on weekdays. On weekends, they were less awake in the morning. So, the proportion of hours with substance consumption of all hours they were awake was rather high until 9am.

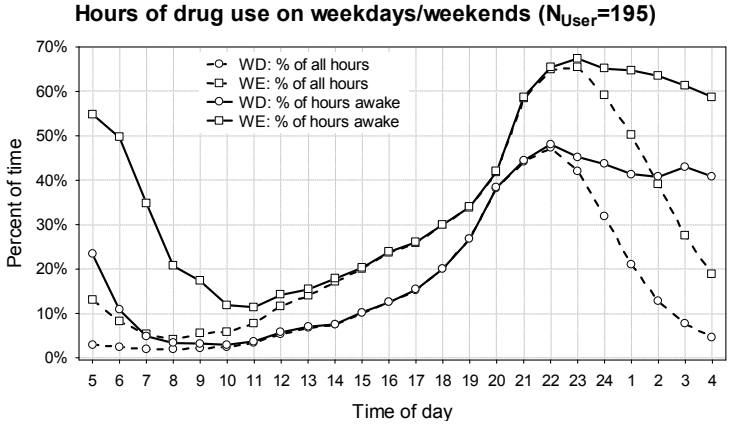


Figure 41: Hours of substance use (in % of all hours and % of hours awake) on weekdays and weekends (N_{User}=195).

When considering only those hours when alcohol was consumed, it becomes obvious that the users spent more time on drinking than the controls, started drinking earlier in the day and drank more until the early-morning, especially on weekends (Figure 42). The same increase in consumption on weekends compared to weekdays is observable for the controls.

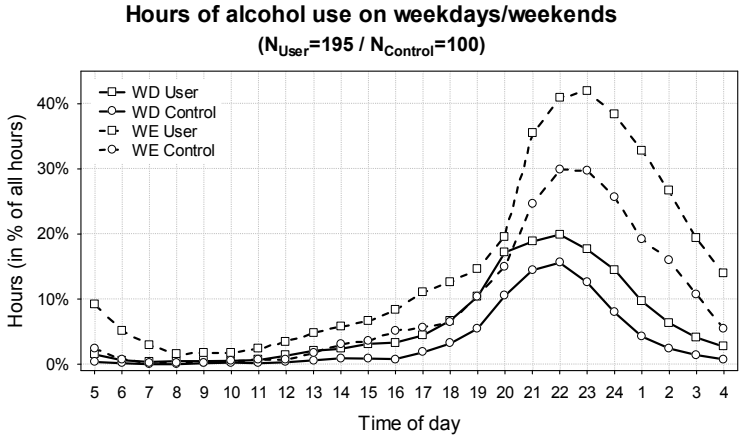


Figure 42: Hours of alcohol use (in % of all hours) on weekdays and weekends for users (N_{User}=195) and controls ($N_{Control}$=100).

In the following, all episodes with substance consumption were summarized into the categories "*alcohol*", "*cannabis*", "*alcohol and cannabis*", and "*other drugs*" (all stimulants, other drugs, and drug combinations). The proportion of time spent on using the different drugs is shown. Other drugs/drug combinations than cannabis and alcohol are more often used on weekends, namely from early afternoon on until early-morning (Figure 43). On weekends, the users also drank more alcohol than on weekdays. The proportion of alcohol consumption alone and alcohol consumption in combination with cannabis was higher throughout the day, except for the hours before and around noon. Consequently, the proportion of using cannabis alone is decreased on weekends compared to weekdays.

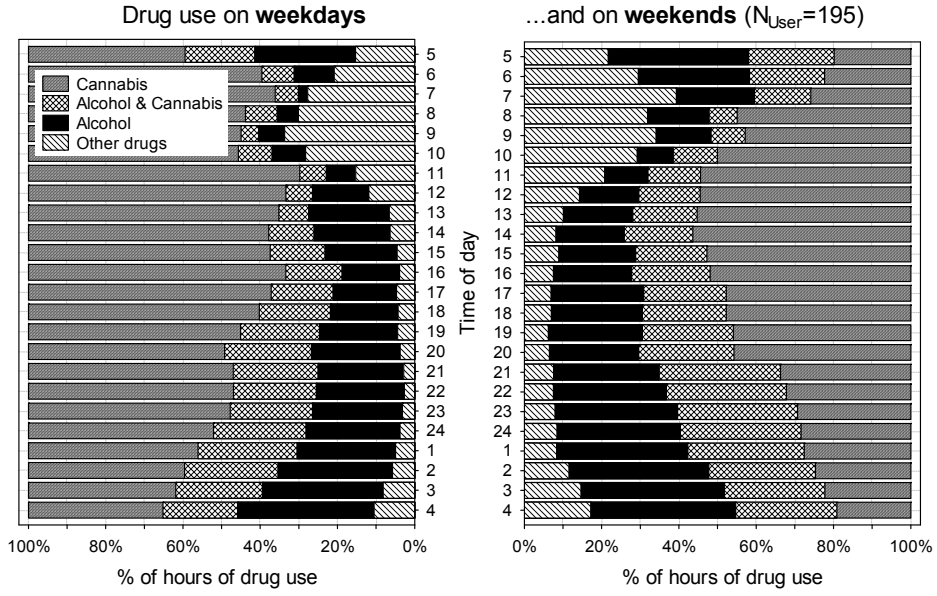


Figure 43: Proportion of time spent on the usage of different drugs on weekdays and weekends (N_{User}=195).

11.5.2 Frequency and amount of drug consumption

For all frequently used substances three substance-specific parameters were calculated for each subject:

- **Drug days**: Number of days the subject was using the substance (extrapolated to 30 days[22])
- **Drug episode**: Mean number of drug using episodes per drug using day
- **Drug dose**: Mean drug dose per drug using episode[23]

Due to low prevalence rates within the sample, no specific parameters were calculated for the following substances (the number of subjects who used the drug at least once and the number of days they used it are specified in brackets):

- **Psilocybin** (2 subjects on 1 day)
- **GHB** (2 subjects on 1 day)
- **Spice** (2 subjects on 1 day)
- **Heroin** (1 subject on 3 days)
- **Methadone/buprenorphine** (2 subjects on almost each day)
- **Salvia divinorum** (1 subject on 1 day)
- **Non-prescribed methylphenidate** (1 subject on 3 days)

94.9% of all users drank alcohol within the study period on about every third day (on 11.79 out of 30 days) (Table 20). In regards to the median, the users used cannabis on twice as many days as alcohol. Amphetamine was used by 24.6%, ecstasy and cocaine by 12-13%, and LSD and sedatives by approximately 3% of all users. The number of consumption days ranges between one and three days out of 30 for these substances.

Table 20: Method of consumption, number of users (N_{User}=195) and controls ($N_{Control}$=100) who were using each drug at least once and number of days drug using subjects were using each drug (for all frequently used substances).

				Drug days (per person)					
Substance		**Method of consumption (% Units)**	**$N_{subject}$**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**MAX**
Alcohol	**User**	Beer (52%), wine (25%), liquor (23%)	**185 (94.9%)**	**11.79**	2.14	6.43	17.59	24.55	30
	Control	Beer (48%), wine (32%), liquor (20%)	**90 (90%)**	**8.13**	1.07	4.29	13.45	22.5	28.93
Cannabis		Joint (72%), pipe (27%), cookie/tea (,25%)	**195 (100%)**	**21**	5	13.45	27	30	
Amphetamine		Line (98%), pill (2%)	**48 (24.6%)**	**2.95**	1.03	1.62	5.69	11.61	19.29
Ecstasy		Pill (100%)	**26 (13.3%)**	**2**	1	1.07	2.73	5.81	6.43
Cocaine		Line (98%), inhalation (2%)	**23 (11.8%)**	**1.07**	.97	1.03	2.07	3.33	5.17
LSD		Blotter (100%)	**6 (3.1%)**	**1.05**	.91	.97	1.11	4.29	
Sedatives		Pill (100%)	**5 (2.6%)**	**1.94**	1	1.03	2.07	2.14	

Table 21 shows the number of episodes per day with substance consumption and the dose that has been consumed per drug episode. If users drank alcohol while participating in the study, they did it in about 1.35 episodes per day with a median dose of 41.07 gram

[22] Because of the varying number of available reports per person, the days were extrapolated to 30 days (number of days with drug use divided by number of reported days and multiplied by 30).
[23] For alcohol, the dose per episode was reported in litres of beer, wine or liquor; for all other substances, the subjects reported the dose in the substance-typical unit, i.e. joint, pipe, line, etc.

alcohol (~2 beers). Around the same daily frequency accounts for cannabis (MD=1.32) with a dose of 1.03 joints (or pipes/cookies/teas) per drug episode. All other substances were used – if having been used at all – only once a day.

Table 21: Number of drug using episodes per drug using day and dose per drug using episode for users (N_{User}=195) and controls ($N_{Control}$=100).

			Drug episodes (per day)						**Drug dose** (grams/units per episode[24])					
Substance		**$N_{subject}$**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**
Alcohol	**User**	**185 (94.9%)**	**1.35**	1	1.17	1.67	2.17	2.75	**41.07**	18.93	29.26	55.21	82,74	149.33
	Control	**90 (90%)**	**1.17**	1	1	1.4	1.82	2.33	**31.07**	14	22	45.13	76.27	131.85
Cannabis		**195 (100%)**	**1.32**	1	1.13	1.6	2.38	3.28	**1.03**	.51	.73	1.53	2.58	4.49
Amphetamine		**48 (24.6%)**	**1.17**	1	1	1.5	2.2	2.5	**1.01**	.29	.50	1.65	2.75	3.04
Ecstasy		**26 (13.3%)**	**1**	1	1	1.17	2		**1**	.5	.67	1.5	2.06	3
Cocaine		**23 (11.8%)**	**1**	1	1	1.33	2		**1.17**	.2	.5	1.5	2.3	3
LSD		**6 (3.1%)**	**1**	1	1	1	1.25		**1**	.5	.5	1	1	
Sedatives		**5 (2.6%)**	**1**	1	1	1	1		**.75**	.5	.5	.75	1.5	

The alcohol-specific parameters were also analyzed for differences between the users and the controls. Because the data distribution was not normal, rank order testing was applied (Mann-Whitney U-test). To analyse the number of days, all subjects who did not use alcohol were included in the analysis with a value of zero. All parameters were significantly different between users and controls. The users drank alcohol on more days (MWU: Z(1;295)=3.70; p=0.000), on more episodes per day (MWU: Z(1;275)=4.75; p=0.000) and in larger quantities (MWU: Z(1;275)=3.53; p=0.000).

The substance-specific parameters concerning alcohol (N_{User}=185), cannabis (N_{User}=195), and stimulants (N_{User}=65) were further analyzed for differences between the different levels of the stratifying variables gender, age, and residence. Again, rank order tests were applied (Kruskal Wallis H-Test and Mann-Whitney U-test). In the case that the independent variable had more than two levels, Kruskal Wallis H-Test were applied to test all levels. If the global result was significant or marginally significant, Mann-Whitney U-tests were applied afterwards to find out which levels differed significantly. To find out if interactions existed, a testing procedure was applied that was described by Conover and Iman (1981) and that was further developed by Thomas, Nelson and Thomas (1999). According to Conover and Iman (1981), non-parametric tests can be replaced by transforming the data into ranks. Then, the usual t-test or analysis of variance procedures can be applied. Thomas et al. (1999) suggest using the L-Statistic in this case, especially when more advanced parametric procedures are applied (i.e. factorial analysis of variance, multiple regressions)[25]. Whenever interactions are mentioned in the further course of this report, they were calculated according to this procedure. Table 22 shows all significant differences found for gender, age, and residence concerning the use of alcohol, cannabis, and stimulants. Here, only the users were analyzed.

[24] Grams for alcohol; units for all other substances (joint/pipe/cookie/tea for cannabis, line/pill for amphetamine; pill for ecstasy; line/inhalation for cocaine; plotter for LSD; pill for sedatives)

[25] L-Statistic – calculation:
L=(N-1) * r^2 (N=number of participants, r^2=proportion of true variance ($SS_{Between}/SS_{Total}$))
The L statistic is compared to a X^2 with pq degrees of freedom (df)
p=k-1 (k=number of groups)
q=number of dependent variables

Table 22: Significant effects for gender, age, and residence on substance-specific parameters for alcohol, cannabis, and stimulants (N_{User}=195).

		Gender	Age	Residence
Alcohol	**Day**	male > female Z(1;195)=2.45; p=0.013		urban > rural Z(1;149)=2.59; p=0.010 city > rural Z(1;127)=2.26; p=0.024
	Episode		18-24 > 30-39 Z(1;135)=3.10; p=0.002	urban > rural Z(1;140)=2.24; p=0.025 urban > city Z(1;113)=2.36; p=0.019
	Dose	male > female Z(1;185)=5.66; p=0.000	18-24 > 25-29 Z(1;160)=4.04; p=0.000 18-24 > 30-39 Z(1;135)=3.44; p=0.001[1]	[1]
Cannabis	**Day**			
	Episode		18-24 > 30-39 Z(1;145)=2.83; p=0.005 25-29 > 30-39 Z(1;78)=1.99; p=0.047	(rural > urban Z(1;149)=1.99; p=0.047)
	Dose	male > female Z(1;195)=2.20; p=0.028		rural > urban Z(1;149)=2.47; p=0.013
Stimulants	**Day**	(female > male Z(1;195)=1.86; p=0.063)		
	Episode			
	Dose			rural > urban Z(1;51)=2.32; p=0.020 city > urban Z(1;39)=2.26; p=0.024

[1] sign. interaction age*residence (only sign. for subjects from rural/city areas): L(4;185)=9.74; p=0.045.

Males drank alcohol on more days and in a higher dose than females. They also used cannabis in higher doses whereas the consumption frequency of cannabis (whether days or episodes per day are considered) does not differ between males and females. Females tend to use stimulants on more days than males. But this difference did not reach significance.

Age significant effects were found for alcohol episodes, alcohol dose, and cannabis episodes. When 18-24-year-olds drank alcohol, if at all, they drank alcohol more frequently per day compared to 30-39-year-olds. 18-24-year-olds also drank higher doses of alcohol compared to 25-29-year-olds and 30-39-year-olds. (Note that for the alcohol dose the interaction age*residence turned out to be positive; this is explained beneath Table 22). Both 18-24-year-olds and 25-29-year-olds used cannabis more frequently per day than 30-39-year-olds.

Significant effects for residence were found for days of alcohol consumption, alcohol episodes, cannabis dose, and stimulants dose. A significant trend was found for cannabis episodes (KW-H(2;195)=5.41; p=0.067). Subjects from urban and city areas drank alcohol on more days than subjects from rural areas. Subjects from urban areas drank on more episodes per day compared to subjects from city and rural areas. In contrast, subjects from rural areas consumed cannabis in higher doses and tend to consume cannabis more frequently per day than subjects from urban areas. Subjects from rural and city areas also used higher doses of stimulants compared to subjects from urban areas.

11.5.3 Consumption groups

11.5.3.1 Classification

For substances that were regularly used by the subjects while participating in the study, consumption classes were defined. According to Burger, Bronstrup and Pietrzik (2004), alcohol use can be differentiated into three classes depending on how much alcohol a person consumes per day. The suggested classification was used to classify the subjects of the present study into *moderate*, *heavy,* and *excessive alcohol users* (Table 23).

Table 23: Classification of alcohol use into moderate, heavy, and excessive alcohol use.

	Amount of alcohol used per day (grams)	
Classification	Male	Female
Moderate alcohol use	≤24 g/day	≤12 g/day
Heavy alcohol use	>24-60 g/day	>12-40 g/day
Excessive alcohol use	>60 g/day	>40 g/day

In the same way, it was attempted to find a mode for classifying cannabis use into different categories according to the amount of cannabis consumed. The Federal Highway Research Institute (Bundesanstalt für Straßenwesen - BASt) suggests classifying cannabis consumption of up to four times a week as occasional consumption, and more than four times a week as heavy consumption (Müller et al., 2006). Because in the current survey a situation is always flanked by a previous and a subsequent trip, a consumption situation could be divided into two situations just because of a short trip in-between. Moreover, the persons surveyed in the present study were all regular users and consumed cannabis quite often. Most users would have been classified as heavy users according to the suggested classification. It was decided to classify cannabis consumption into *moderate*, *heavy,* and *excessive use* analogous to alcohol according to the mean daily dose quantified by the mean number of units consumed per day[26] (Table 24).

Table 24: Classification of cannabis use into moderate, heavy and excessive cannabis use.

Classification	**Amount of cannabis used per day (unit=joint, pipe, etc)**
Moderate cannabis use	<1 unit
Heavy cannabis use	1-<2 units
Excessive cannabis use	≥2 units

Stimulants (i.e. amphetamine, ecstasy, cocaine) were used by 65 subjects on one to 19 days within 30 days. Because of the low number of stimulant using subjects and the more infrequent stimulants use compared to alcohol and cannabis, it seemed reasonable to use the number of episodes a person used stimulants within the study period as classification criterion instead of units per day. If a person used stimulants up to once every two weeks, the person was classified as *moderate stimulants user*. If a person used stimulants on up to 1-2 occasions per week, the person was classified as *heavy stimulants user*. If the consumption frequency was higher than 1-2 times per week, the person's stimulants use was classified as *excessive* (Table 25).

[26] A unit is either a joint, a pipe, a cookie or cannabis consumed as tea.

Table 25: Classification of stimulants use into moderate, heavy, and excessive stimulants use.

Classification	Number of episodes within four weeks
Moderate stimulants use	≤2 episodes
Heavy stimulants use	≤6 episodes
Excessive stimulants use	>6 episodes

Table 26 shows the number of subjects within each category. 10 users (5.1%) and 10 controls (10%) did not use alcohol while participating. 41% of the users were moderate, another 41% heavy, and the remaining 12.8% excessive alcohol users. Within the control group, the distribution of moderate, heavy, and excessive users was 67%, 20%, and 3%. In other words: there are 10% more excessive and 20% more heavy drinkers at the cost of 30% less moderate drinkers in the user group. Cannabis was consumed by all users. 53.8% were moderate, 23.1% heavy, and another 23.1% excessive users. 13.3% of the users were moderate, 10.3% heavy, and 9.7% excessive stimulant users.

Table 26: Number of subjects in each consumption category.

Classification		No consumption	Moderate	Heavy	Excessive
Alcohol use	**User**	10 (5,1%)	80 (41%)	80 (41%)	25 (12.8%)
	Control	10 (10%)	67 (67%)	20 (20%)	3 (3%)
Cannabis use		0	105 (53.8%)	45 (23.1%)	45 (23.1%)
Stimulants use		130 (66.7%)	26 (13.3%)	20 (10.3%)	19 (9.7%)

11.5.3.2 Comparison of daily alcohol dose with representative data

For the general German population aged 18 to 64, data about the percentage of persons who drink more than 12g alcohol per day (female) and more than 24g (male) alcohol per day, respectively, are available (Pabst, 2008). 17.4% of the German population aged 18-64 belong to this category of risky alcohol consumption. Figure 44 shows the percentage of the German population aged 18-64 and the percentage of the user and control study sample aged 18-39 that was classified either as heavy or as excessive alcohol user. The controls percentage resembles the one of the general population (Control: 23%) whereas the percentage of the users is much higher (User: 53.8%).

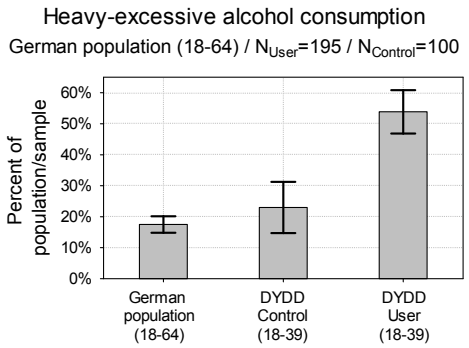


Figure 44: Percentage of heavy and excessive (females>12 g per day; males>24g per day) alcohol users within the German population aged 18-64, and the user (N_{User}=195) and control ($N_{Control}$=100) study sample aged 18-39 (±0.95 CI).

11.5.3.3 Problem awareness

To measure problem awareness concerning consumption, the subjects were asked how problematic they find their consumption behaviour for all substances they were currently using (Table 27).

Table 27: Q-Start question concerning problem awareness of own consumption habits.

Question
How problematic is your consumption in your opinion (concerning alcohol, cannabis, amphetamine, ecstasy, LSD, psilocybin, cocaine, crack, heroin, sniffing agents, other substances)? 0=not at all, 1=very little, 2=little, 3=medium, 4=much, 5=very much

In general, the subjects never evaluated their consumption habits as highly problematic (Figure 45). The most evaluations ranged from *not at all* problematic to *medium* problematic. But the higher the consumption was (*moderate*, *heavy*, *excessive*), the more problematic the subjects evaluated it. This was especially true for alcohol. Moderate users of stimulants and cannabis classified their consumption pattern as more problematic than moderate alcohol users did.

The subjects' problem awareness rises as higher daily substance doses are consumed, but is relatively low when considering that excessive users who consume more than 60g alcohol (males) or 40g alcohol (females) per day, two or more joints per day or stimulants on more than 6 occasions per month think their consumption is only little to medium problematic.

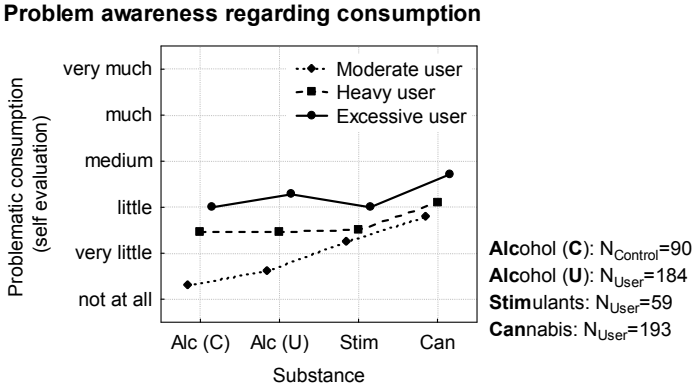


Figure 45: Problem awareness of own consumption habits (not at all, very little, little, medium, much, very much problematic) dependent on consumption group (moderate, heavy, excessive user) and substance (alcohol, cannabis, stimulants)[27].

11.6 Trips

11.6.1 Mobility as a function of time

For the illustration of trips and drives in the course of the day and for comparing weekdays and weekends, the absolute number of trips/drives per hour and weekday/weekend day was divided by the absolute number of weekdays and weekend days, respectively,

[27] Because of missing data, the information about the subjective evaluation was not available for all users.

and distributed along the 24-hour timeline. So, for each hour the mean number of trips/drives is shown. The mean numbers of trips/drives for all 24 hours of a day add up to the mean number of trips/drives per day.

On weekdays, the users had 3.43 trips per day on average, and 3.08 on weekends (Figure 46). On weekdays, 1.86 (54.2%) of the trips were drives. On weekends, 1.33 (43.2%) of the trips were drives. On weekdays, mobility culminated at 7-9am, at noon, and at 4-6pm – at times when the subjects had to go to and from work and school, respectively (left). In contrast, trips on weekends are distributed throughout the day. Compared to weekdays, weekend mobility was lower until 9pm. At night, the subjects were more mobile on weekends. The distribution of drives in the course of the day is very similar to the distribution of trips, except from the weekend night hours (right). Even if the subjects were out more on weekends, they did not drive more. Instead, they must have used other modes of transportation.

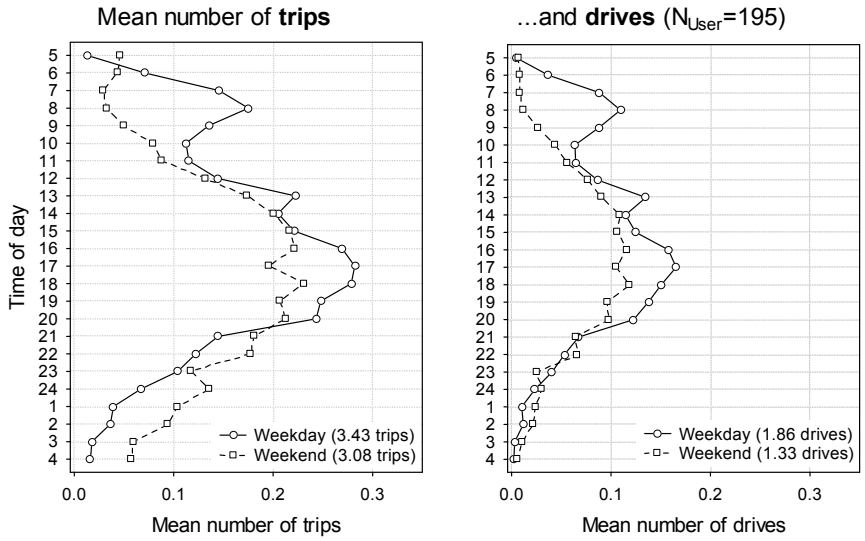


Figure 46: Mean number of trips and drives per time of day of the users (N_{User}=195).

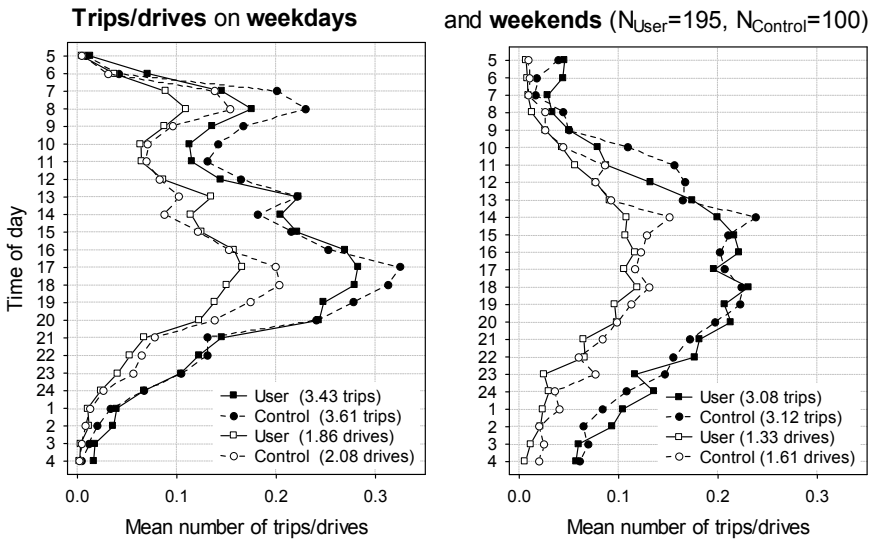


Figure 47: Mean number of trips/drives on weekdays and weekends for users (N_{User}=195) and controls ($N_{Control}$=100).

Both on weekdays and weekends, the controls were more mobile in the morning before and around noon compared to the users, on weekdays also in the late afternoon (Figure 47). The users were more mobile at night and in the early-morning and on weekends also in the afternoon. On weekdays, controls drove more in the morning and in the evening – at usual rush-hour times. The users drove more at noon and had a less distinct peak in the morning and in the evening. On weekends, the controls drove a little more throughout the day, even at night when the users were generally more mobile. Considering the weekday driving behaviour, controls seem to have a day structure that is more influenced by a usual daily working routine.

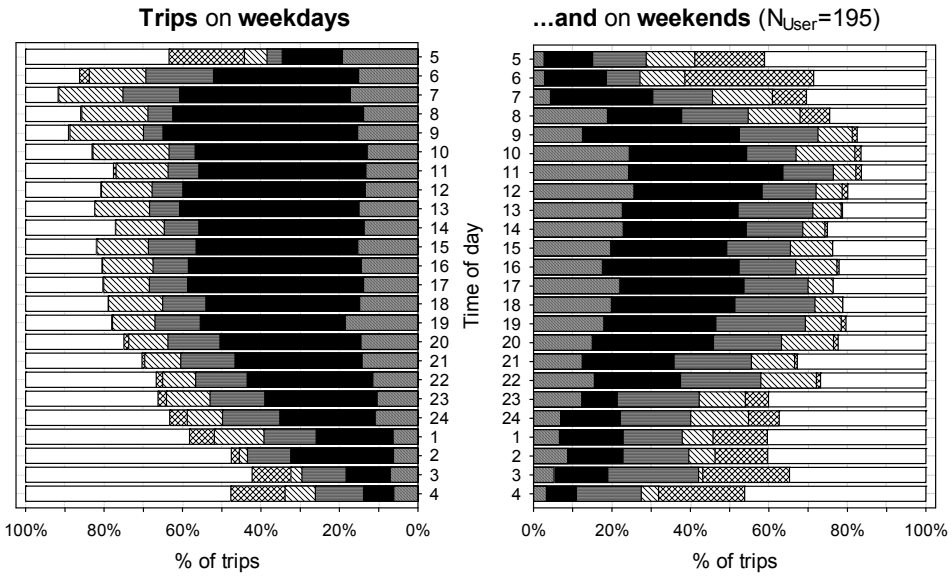


Figure 48: Proportion of transport modes of users on weekdays and weekends (N_{User}=195).

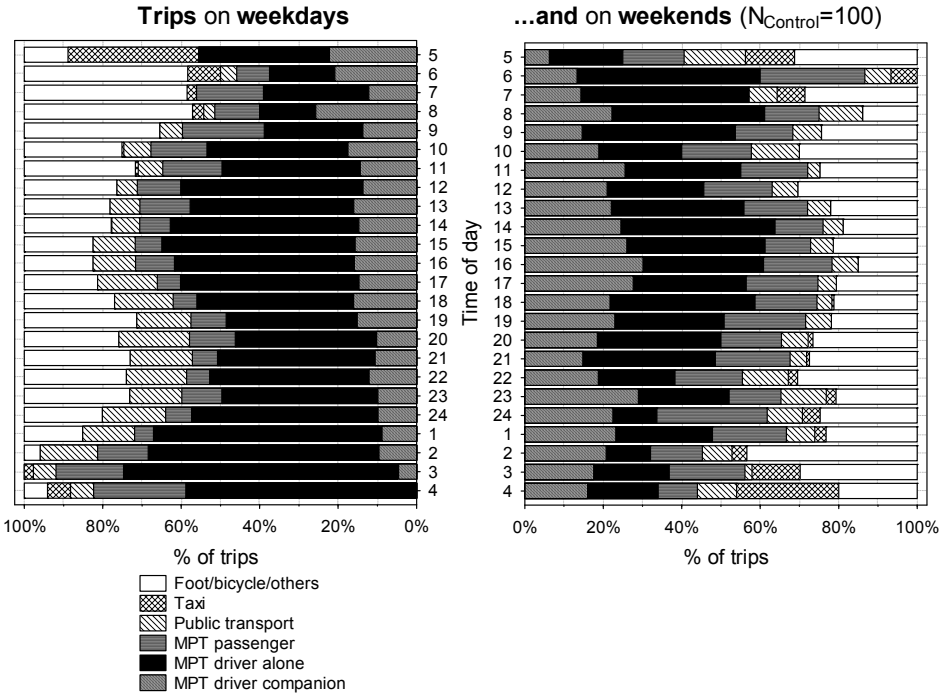


Figure 49: Proportion of transport modes of controls on weekdays and weekends ($N_{Control}$=100).

Figure 48 distributes the percentage of trips per time, travelled by the different transport modes and separated for weekdays and weekends (N_{User}=195). On weekdays the subjects drove a vehicle and used public transportation more often in the morning hours compared to weekends. The percentage of driving a vehicle alone was higher on weekdays. On weekends the subjects were more often accompanied by others while driving or were passengers themselves. The rate of trips on foot or by bike is higher on weekday nights compared to weekends when the subjects took a taxi more often. In the early-morning they travelled especially often by taxi on both weekdays and weekends.

Figure 49 shows the different modes of transport of controls. Users walked or used a bicycle more often at night compared to controls. Moreover, they travelled more often by taxi except for around 4-5am when the controls used a taxi in around 20% of their trips. On weekdays in the morning the users used public transportation more often than the controls. On weekends the users travelled more by public transportation than controls independent of time of day. Obviously there is a higher need or willingness among users to use taxis, public transport and/or walk or ride a bicycle. There is a clear difference concerning driving at night and on weekends also in the early morning hours. The controls often travelled as driver either alone or with companions whereas the users drove a vehicle less often at that time.

11.6.2 Frequency and amount of mobility

To better assess quantitative differences concerning the mobility of the subjects for all modes of transport, three trip-specific parameters were calculated for each subject:

- **Trip days**: Number of days the subject used the mode of transport (extrapolated to 30 days[28])
- **Trip**: Mean number of trips per trip day
- **Kilometres**: Mean kilometres per trip

The data had to be prepared beforehand concerning the following issues:

1) If multiple transport modes were named (e.g. on foot and public transport) the one that usually covers the farthest distance was declared as the main transport mode (i.e. public transport in our example). The others were ignored. The adopted order was as follows:

foot
bicycle
taxi
public transport
moped
motorcycle
vehicle
transporter
truck

[28] Because of the varying number of available reports per person (number of mobile days divided by number of reported days and multiplied with 30).

In the second step the categories were further summarized to the categories "***foot/bicycle/other***"[29], "***taxi***", "***public transport***", motorised private transport as passenger ("***MPT passenger***") and motorised private transport as driver ("***MPT driver***")

2) Because the subjects indicated the kilometres of a trip through the categories *"<1 km*", "*1-5 km*", "*5-10 km*", "*10-25 km*", "*25-100 km*", and *"> 100 km*", the categories had to be transformed into interval-scaled data for further analyses. The representative data from the survey "Mobility in Germany 2008" (MiD 2008) was used to calculate the median of kilometres within each category (for the 18-39-year-old population). This resulted in the following values:

"***<1 km***" → MD 0.95 km
"***1-5 km***" → MD 2,85 km
"***5-10 km***" → MD 7,6 km
"***10-25 km***" → MD 15,2 km
"***25-100 km***" → MD 37,05 km
"***>100 km***" → MD 162,45 km

Table 28: Mode of transport, number of users (N_{User}=195) who chose each mode at least once and number of days those subjects used each mode.

		Trip days (per person)					
Mode of transport	**$N_{subject}$**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**MAX**
Foot/bicycle/other	**190 (97.4%)**	**9.84**	1.07	4.29	16.55	24.64	30
Taxi	**99 (50.8%)**	**1.3**	1	1.07	3.1	5.36	8.28
Public transport	**153 (78.5%)**	**5.36**	1	2.14	11.79	23	27.93
MPT passenger	**181 (92.8%)**	**6**	1.07	3.21	9.64	18.21	26.79
MPT driver	**195 (100%)**	**20**	9	14.48	24.64	28.06	30

All users drove a vehicle as a driver (MPT driver) at regular intervals (MD 20 out of 30 days) (Table 28). Travelling by foot or by bike was done by 97.4% of the users on every third day. 92.8% of the users were passenger at least once while participating in the study and 78.5% used public transportation. Only around half of the users took a taxi within the 4-week study period.

Table 29: Number of trips per trip day and number of kilometres per trip of users (N_{User}=195).

		Trips (per day)						**Kilometres** (per trip)					
Transportation	**$N_{subject}$**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**
Foot/bicycle/other	**190 (97.4%)**	**1.91**	1	1.5	2.26	2.79	3.73	**2.07**	.95	1.33	2.82	4.65	15.2
Taxi	**99 (50.8%)**	**1**	1	1	2	2	30	**6.18**	2.85	2.85	7.6	15.2	37.05
Public transport	**153 (78.5%)**	**1.67**	1	1.25	2	2.5	3.21	**7.6**	2.85	3.8	15.2	61.75	162.45
MPT passenger	**181 (92.8%)**	**1.71**	1	1.4	2	2.45	3.11	**11.46**	2.85	6.75	19.95	57.54	162.45
MPT driver	**195 (100%)**	**2.43**	1.74	2.12	2.94	3.81	4.80	**11.53**	3.73	7.93	18.12	30.95	65.78

Table 29 shows the number of trips per day for each particular mode of transport chosen, and the kilometres per trip. If someone used a taxi for transport, this was only done for one direction in most cases. All other modes of transport were used approximately twice

[29] Other: boat, ambulance, and tractor – N=3.

a day. The farthest distances were travelled by vehicles followed by public transport and taxis. The shortest distances were covered by foot or bike.

The trip-specific parameters were analyzed for differences between users (N_{User}=195) and controls ($N_{Controls}$=100) (Table 30 and Table 31). The data were analyzed by rank order testing (Mann-Whitney U-test). For the analysis of the number of days, all subjects who did not use the mode of transport in question were included in the analysis with a value of zero. Users took a taxi more often than controls. They used it on more days (MWU: Z(1;295)=4.47; p=0.000) as well as on more occasions a day (MWU: Z(1;123)=2.08; p=0.038). On the other hand, controls drove a vehicle on more days compared to users (MWU: Z(1;295)=2.35; p=0.019).

Table 30: Mode of transport, number of controls ($N_{Controls}$=100) that chose each mode at least once, and number of days those subjects used each mode.

		Trip days (per trip person)					
Transportation	**$N_{subject}$**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**MAX**
Foot/bicycle/other	**93 (93%)**	**9.73**	1.07	3.21	15.52	24.64	26.9
Taxi	**24 (24%)**	**1.07**	1	1.03	2.14	7.5	8.57
Public transport	**72 (72%)**	**5.78**	1.03	2.62	12.38	19.66	23.79
MPT passenger	**89 (89%)**	**6.21**	1.07	3.21	9.23	16.55	22.94
MPT driver	**100 (100%)**	**22.36**	9.99	17.5	25.71	28.56	30

Table 31: Number of trips per trip day and number of kilometres per trip for controls ($N_{Controls}$=100).

		Trips (per day)						**Kilometres** (per trip)					
Transportation	**$N_{subject}$**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**
Foot/bicycle/other	**93 (93%)**	**1.86**	1	1.5	2.25	3.52	4.36	**1.96**	0.95	1.33	2.85	6.36	17.48
Taxi	**24 (24%)**	**1**	1	1	1.31	1.63	2	**2.85**	2.85	2.85	8.08	29.77	37.05
Public transport	**72 (72%)**	**1.82**	1	1.5	2.06	2.5	3	**7.6**	2.85	2.85	15.2	82.41	162.45
MPT passenger	**89 (89%)**	**1.8**	1	1.5	2	2.4	3	**10.68**	2.85	6.65	21.82	56.19	162.45
MPT driver	**100 (100%)**	**2.55**	1.82	2.25	2.96	4.02	4.43	**12.66**	4.58	9.37	17.16	32.34	63.11

Furthermore, the different levels of the stratifying variables were analysed for differences in the trip-specific parameters. To be able to indentify interactions between the main factors gender, age, and residence, the same procedure as described in Chapter 11.5.2 was applied. Males travelled longer distances on foot/by bike than females (Table 32). Females were more often passengers than males. The latter is also true for 18-24-year-olds compared to 25-29- and 30-39-year-olds. The younger subjects also travelled more by public transportation whereas the 30-39-year-olds drove a vehicle more often than the 18-24-year-olds did. As one would expect, the main differences were found between rural, urban, and city areas. Subjects from urban areas travelled on foot/by bike on more days and more often a day than subjects from city areas. Travelling by taxi was more prevalent in city/urban areas, but the distances covered were farther in rural and city areas compared to urban areas. Public transportation was mostly used in city and – in relation to the number of days – in urban areas, but here again the farthest distances were covered in rural and city areas compared to urban areas. Passengers were more found in rural and urban areas compared to city areas. Subjects from rural areas were most often drivers of a vehicle and had to cover, together with subjects from city areas, the farthest distances when driving a vehicle. Significant interactions are explained beneath the table.

Table 32: Significant effects for gender, age and residence on trip-specific parameters (N_{User}=195).

		Gender	Age	Residence
Foot/bicycle/other	**Day**			urban > city Z(1;114)=3.83; p=0.000
	Situation			urban > city Z(1;112)=3.91; p=0.000
	Km	male > female Z(1;190)=3.21; p=0.001	[1]	[1]
Taxi	**Day**			urban > rural Z(1;149)=2.30; p=0.022 city > rural Z(1;127)=2.81; p=0.005
	Situation			
	Km			rural > urban Z(1;71)=3.14; p=0.002 city > urban Z(1;67)=2.54; p=0.011
Public transport	**Day**		18-24 > 25-29 Z(1;167)=2.85; p=0.004 18-24 > 30-39 Z(1;145)=3.72; p=0.000	city > rural Z(1;127)=5.94; p=0.000 urban > rural Z(1;149)=2.96; p=0.003
	Situation			city > rural Z(1;99)=3.37; p=0.000 city > urban Z(1;98)=2.73; p=0.006
	Km			rural > urban Z(1;109)=6.31; p=0.000 city > urban Z(1;98)=5.15; p=0.000
MPT passenger	**Day**	female > male Z(1;195)=2.21; p=0.027[2]	18-24 > 25-29 Z(1;167)=3.51; p=0.000 18-24 > 30-39 Z(1;145)=3.94; p=0.000[2]	rural > city Z(1;127)=3.46; p=0.000 urban > city Z(1;114)=2.94; p=0.003[2]
	Situation	female > male Z(1;181)=2.66; p=0.008[3]	[3] [4]	rural > city Z(1;117)=3.25; p=0.001 urban > city Z(1;107)=2.80; p=0.005[4]
	Km			
MPT driver	**Day**		30-39 > 18-24 Z(1;145)=2.59; p=0.010	rural > urban Z(1;149)=1.99; p=0.047 rural > city Z(1;127)=2.24; p=0.025
	Situation			rural > city Z(1;127)=2.78; p=0.005
	Km	[5]	[5]	rural > urban Z(1;149)=2.02; p=0.043 city > urban Z(1;114)=2.44; p=0.015

[1]sign. interaction age*residence (18-24-year-olds in urban/city areas farther distances than in rural areas; in rural areas 30-39-year-olds farther distances than 18-24-year-olds): L(4;190)=11.04; p=0.026.
[2]sign. interaction gender*age*residence: L(4;195)=11.54; p=0.021.
[3]sign. interaction gender*age (only for 18-24- and 30-39-year-olds sign): L(2;181)=7.94; p=0.019.
[4]sign. interaction age*residence (only for 18-24-year-olds sign): L(4;181)=13.09; p=0.011.
[5]sign. interaction gender*age (males farther distances at age 25-39 than at age 18-24): L(4;195)=7.73; p=0.021.

11.6.3 Driving groups

As for consumption (Chapter 11.5.3), the subjects were categorised according to their driving frequency to be able to analyze the impact of driving on the occurrence of driving under influence. To classify the driving frequency, the well-established categories from the survey "Mobility in Germany 2008" were resorted to ("Mobilität in Deutschland" – MID 2008): "*daily or almost daily*", "*on 1-3 days a week*", "*on 1-3 days a month*", "*less than monthly*" and "*never or almost never*". In the present study, only regular drivers were admitted. So, only the first two categories were applied ("*daily driving*", "*weekly driving*") (Table 33).

Within the user group 39% drove weekly while participating in the study according to the applied categorisation and 61% drove daily. Within the control group 22% were weekly drivers and 78% daily drivers.

Table 33: Classification of driving into weekly and (almost) daily driving and number of users (N_{User}=195) and controls ($N_{Control}$=100) within each category.

Classification	Frequency of driving per week (in days)	N_{User}=195	$N_{Control}$=100
Weekly driving	1-3 days per week	76 (39%)	22 (22%)
(Almost) Daily driving	≥4 days per week	119 (61%)	78 (78%)

11.7 Drug driving

11.7.1 Definition

To decide whether a drive was conducted under the influence of illegal drugs or alcohol, different approaches for the different substances were chosen. For alcohol and cannabis the calculated BAC- and THC-level at the beginning or at the end of a drive was used depending on which one was higher (Chapter 10). When smoking a joint that contains 15 mg THC, the concentration of THC in blood converges to zero after six hours according to the elimination curve by Sticht (G. Sticht, personal communication, December 2009). Because of the cannabis-like effects of spice and because no reliable information is known about the duration of the effect of spice, a drive was classified as under influence if it occurred six hours after spice consumption. For the remaining substances the doubled half-life of each substance was applied (adjusted upward; provided by Schulz & Schmoldt, 2003; Passie, Seifert, Schneider & Emrich, 2002; Prisinzano, 2005)[30]. The rules for defining a drive as an intoxicated drive are listed in Table 34.

Table 34: Basis for the definition of driving under influence.

	Basis of decision	Calculated blood concentration
Alcohol	Widmark Formula (Widmark, 1932)	BAC≥0.01%
Cannabis	Elimination curve by Sticht (G. Sticht, personal communication, December 2009)	THC blood plasma level≥1ng/ml
	Source	**Previous drug use within**
Amphetamine	Schulz & Schmoldt (2003)	16 hours
Ecstasy	Schulz & Schmoldt (2003)	20 hours
Cocaine	Schulz & Schmoldt (2003)	2 hours
LSD	Schulz & Schmoldt (2003)	10 hours
Heroin	Schulz & Schmoldt (2003)	8 hours
Psilocybin	Passie et al. (2002)	8 hours
GHB	Schulz & Schmoldt (2003)	2 hours
Spice	deduced from elimination curve of cannabis	6 hours
Salvia Divinorum	Prisinzano (2005)	4 hours

[30] Substances that primarily serve as medicines are not considered at this point: one person misused methylphenidate (three episodes) and five persons used sedatives (eight episodes). In all but two cases the subjects did not drive within at least twelve hours after the intake.

11.7.2 Frequency

Averaged per person, 20.5% of the users' drives (N_{User}=195) were classified as drug positive independent of what drug and what concentration is considered. When considering only drives with a BAC of 0.05% and higher, a THC blood plasma level of 4ng/ml and higher[31], and/or drives positive for any other drugs, the mean percentage of drives under influence within the user sample drops by around 40% from previously 20.5% to 13.1%. The only drive positive for spice was also positive for cannabis. The psychoactive effects of both drugs are very similar. So, the drive was classified as a cannabis positive drive only. No drive positive for LSD, psilocybin, GHB, and salvia divinorum was identified.

Table 35: Number of drives and percentage of all drives under influence within the user group, mean percentage and ±0.95 CI by person (N_{User}=195)[32].

		Total sample	By person
		Number of drives (%)	Mean % of drives (±0.95 CI)
All drives		9,553 (100%)	
	Sober	7,454 (78%)	
	Under influence	2,099 (22%)	20.5% (17.4% - 23.5%)
Not separated for single-/poly-drug drives (multiple specifications possible)			
	Cannabis	1,521 (15.9%)	14.8% (11.8% - 17.7%)
	Alcohol	546 (5.7%)	5.4% (4.2% - 6.7%)
	Stimulants Amphetamine. XTC. Amphetamine and XTC. Cocaine	223 (2.3%) 186 (1.9%). 17 (0.2%). 19 (0.2%). 1 (0.01%)	2.2% (1.1% - 3.4%) 1.8% (0.8% - 2.9%). 0.2% (0.1% - 0.3%). 0.2% (-). 0.01% (-)
	Heroin	5 (0.05%)	0.05% (-)
Separated for single-/poly-drug drives			
Single drug	**Cannabis**	1,354 (14.2%)	13.1% (10.5% - 15.8%)
	Alcohol	410 (4.3%)	4.1% (3% - 5.1%)
	Stimulants	147 (1.5%)	1.5% (0.5% - 2.4%)
Multiple drugs	**Total**	188 (2%)	1.8% (1.1% - 2.5%)
	Cannabis / Alcohol	107 (1.1%)	1% (0.5% - 1.5%)
	Cannabis / Stimulants	47 (0.5%)	0.4% (0.1% - 0.8%)
	Alcohol / Stimulants	21 (0.2%)	0.2% (0.1% - 0.3%)
	Cannabis / Alcohol / Stimulants	8 (0.1%)	0.1% (-)
	Cannabis / Heroin	5 (0.05%)	0.05% (-)

The mean percentage of drives under the influence of cannabis was 14.8%. The mean percentage of alcohol-positive drives was 5.4%. On average, 2.2% of the users' drives were under the influence of stimulants (amphetamine: 1.8%, ecstasy: 0.2%, amphetamine and ecstasy: 0.2%, cocaine: 0.01%) and 0.05% under the influence of heroin (Table 35). The mean percentage of drives under the influence of cannabis alone was 13.1%. On average, 4.1% of the users' drives were under the influence of alcohol alone and 1.5% under the influence of stimulants alone. The remaining 1.8% drug-positive drives were positive for multiple drugs of which the greatest part was under the influence of alcohol and cannabis (1%). Alcohol- and cannabis-positive drives were further classified depending on the blood concentration. Figure 50 shows the mean percentage of BAC-/THC-positive drives for different BACs and THC blood plasma levels. For alcohol the

[31] According to Berghaus, Sticht and Grellner (2011) a THC blood plasma concentration of 3.8ng/ml corresponds to a BAC of 0.05% concerning the performance impairing effects of the substance.

[32] Confidence intervals for the mean percentage of DUI were only calculated for those DUI categories that were committed by a sufficient number of subjects, resulting in positive confidence intervals (for a detailed description of the calculation see Chapter 11.7.3)

controls' positive drives are also shown. The mean percentage of the controls' BAC-positive drives amounts to a total of 2.2%, i.e. less than half of the users' BAC-positive drives (5.4%).

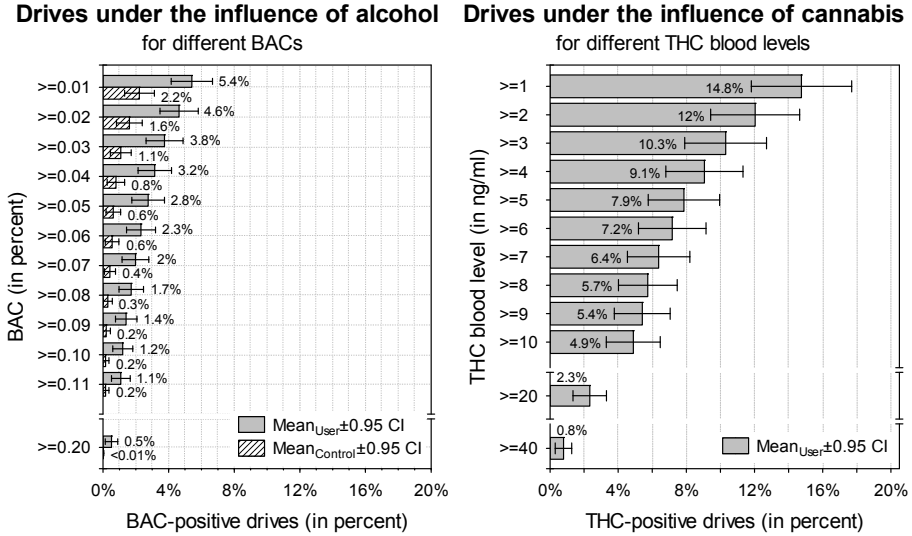


Figure 50: Mean percentage of drives (±0.95 CI) under the influence of alcohol (left) and cannabis (right) of users (N_{User}=195) and in the case of BAC-positive drives of users (N_{User}=195) and controls ($N_{Control}$=100) for different BACs and THC-levels (accumulated).

11.7.3 Calculation of confidence intervals

Before analysing the frequency of drug driving, several considerations were taken into account. The present study design was chosen to draw conclusions about the prevalence of drug driving and at the same time about the drug driver in general. Data were collected from 195 drug users (inter-individual variance), who were observed for 28 days (intra-individual variance). As a consequence, the study design poses the problem of combining intra- and inter-individual variance in a meaningful way depending on which question was answered.

For the estimation of the general prevalence of drug driving the percentage of drives under influence of all drives within the sample could be used as basic population when calculating confidence intervals (CI for percent values; Table 36). In doing so, the fact that all users' drives (N_{Drive}=9,553) were travelled by a comparatively small number of persons (N_{User}=195) would be disregarded and intra-individual variance would be treated as inter-individual variance. The huge number of drives used as basic population would result in unrealistic small confidence intervals (percentage of THC-positive drives of all users' drives within the sample: **15.9%; CI: 15.2% - 16.6%**).

For other questions the driver himself is of interest. How high is the percentage of drug users who drive after the consumption of drugs? By pursuing this person-related approach the inter-individual variance is of interest and so the use of the number of drivers as basic population is mandatory:

Percentage of drug users who drove after cannabis consumption while participating
65.6%; CI: 59% - 72.3%

To extrapolate the occurrence of drug driving into representative figures, eventually, a combination of the two approaches was used to avoid the above mentioned problem: First, the percentage of drives under influence on all drives was calculated for every person. Second, these values were averaged over all users. This calculated sample mean was then extrapolated into a prevalence rate of the general German driver population (Chapter 11.7.4). The confidence interval for the sample mean was calculated by the number of persons (N_{User}=195) as the basic population (CI for mean values; Table 36). So, the fact that the sample is relatively small was considered and influenced the size of the calculated confidence intervals:

Mean percentage of THC-positive drives of all drives per subject
14.8%; 11.8% - 17.7%

Table 36: Formulas to calculate confidence intervals (for percent values and for mean values) (Bortz, 2010).

	Percent values	Mean values
SE (standard error)	$\hat{\sigma}_{Percent\ values} = \sqrt{\frac{p\ *\ (1-\ p)}{n}}$	$\hat{\sigma}_{Mean} = \frac{\hat{\sigma}}{\sqrt{n}}$
CI (confidence interval)	$p - z_{(\frac{\alpha}{2})} * SE;\ p + z_{(\frac{\alpha}{2})} * SE$	$\bar{x} - z_{(\frac{\alpha}{2})} * SE;\ \bar{x} + z_{(\frac{\alpha}{2})} * SE$

11.7.4 Extrapolation

To estimate the proportion of BAC-/THC-positive drives in the population by the survey results, the proportion of drives of the population represented by the sample on all drives was calculated according to the following procedure[33]:

1) From existing mobility measures ("Mobility in Germany 2008" – MiD 2008) the proportion of drives travelled by 18-39-year-olds who regularly drive (i.e. (almost) daily/weekly) was calculated:

   18-39-year-old population of regular drivers – proportion of all drives:
   32.9% (18-24-year-olds: 6.3% / 25-39-year-olds: 26.6%)

2) From existing drug prevalence data ("Epidemiological Survey on Substance Abuse 2006" – ESA 2006) the prevalence for regular drug use (i.e. more than three times in four weeks) for the 18-39-year-old population was calculated:

   Prevalence for regular drug use for 18-39-year-old population:
   2.8% (18-24-year-olds: 4.8% / 25-39-year-olds: 2.1%)

3) The proportion of drives travelled by 18-39-year-olds who regularly drive and regularly use drugs (="*sample like population*") can be calculated as follows:

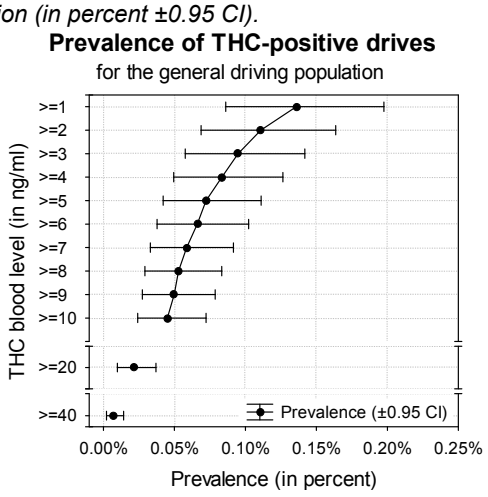
   Sample-like population's proportion of all drives:
   2.8%*32.9%/100=**0.92%**

[33] It has to be kept in mind that even if the sample was selected with caution and resembles the general population in a satisfactory manner, the extrapolated prevalence rates have to be interpreted with care. To show the uncertainty that underlies the prevalence rates calculated by the data of the study sample, confidence intervals are provided (see also Chapter 11.7.3).

Assuming the proportion of the sample-like population's drives to be 0.92% (±0.95 CI[34]: 0.73% - 1.12%) of all drives and assuming that 39-year-olds and older do not drive after cannabis consumption (because the drug prevalence rate for this age group is very low[35]) the prevalence of THC-positive drives in the German driver population can be calculated by simply multiplying the mean percentage of THC-positive drives within the sample with 0.92 and divide it by 100. This results in the following prevalence rates for THC (Table 37).

Table 37: Mean percentage of drives under the influence of cannabis within the sample and prevalence of THC-positive drives estimated for the population (in percent ±0.95 CI).

THC blood plasma level (in ng/ml)	THC-prevalence$_{Sample}$ (Mean$_{Sample}$±0.95 CI)	THC-prevalence (Prevalence±0.95 CI)
≥1	14.8% (11.8 - 17.7%)	0.14% (0.09 - 0.2%)
≥2	12% (9.4 - 14.7%)	0.11% (0.07 - 0.16%)
≥3	10.3% (7.9 - 12.7%)	0.09% (0.06 - 0.14%)
≥4	9.1% (6.8 - 11.3%)	0.08% (0.05 - 0.13%)
≥5	7.9% (5.8 - 10%)	0.07% (0.04 - 0.11%)
≥6	7.2% (5.2 - 9.2%)	0.07% (0.04 - 0.1%)
≥7	6.4% (4.5 - 8.2%)	0.06% (0.03 - 0.09%)
≥8	5.7% (4 - 7.5%)	0.05% (0.03 - 0.08%)
≥9	5.4% (3.8 - 7.1%)	0.05% (0.03 - 0.08%)
≥10	4.9% (3.3 - 6.5%)	0.05% (0.02 - 0.07%)
≥20	2.3% (1.4 - 3.3%)	0.02% (0.01 - 0.04%)
≥40	0.8% (0.3 - 1.3%)	0.01% (0 - 0.01%)



The same procedure can be applied for calculating the prevalence of stimulants-positive drives, drives under the influence of multiple drugs, and drives under the influence of alcohol in combination with an illegal drug. For drives under the influence of stimulants (cocaine in- or excluded), the prevalence turned out to be 0.02% (95% CI: 0.01% - 0.04%). For drives under the influence of multiple drugs (any drug combination, alcohol included), the prevalence is 0.02% (95% CI: 0.01% - 0.03%), and for drives under the influence of alcohol in combination with an illegal drug, the prevalence is 0.01% (95% CI: 0.006% - 0.02%).

For BAC-positive drives this calculation cannot be conducted because no information is given about the prevalence of BAC-positive drives within the population above 39-year-olds. The high proportion of all drives (MiD 2008)[36] and the high prevalence of risky alcohol consumption in this age group (ESA 2006, DHS 2008), however, led to the suspicion that the prevalence of BAC-positive drives is rather high within this age category. Thus, for BAC-positive drives the further analysis is reduced to the calculation of the prevalence rate within the 18-24- and the 25-39-year-old sub-population.

Figure 51 and Table 38 show the mean percentage of BAC- (left) and THC-positive drives (right) within the sample depending on age group (18-24- vs. 25-39-year-olds) and

[34] Calculated by multiplying the lower and upper limits of the confidence intervals of the proportion of the 18-39-year-old population of regular drivers of all drives (±0.95 CI: 32.5% - 33.3%; MiD 2008) and of the prevalence for regular drug use within the 18-39-year-old population (±0.95 CI: 2.2% - 3.4%; ESA 2006). This calculation results in asymmetric intervals.

[35] 30-days-prevalence of 40-64-year-old population: 0.7% / regular drug use (>3x in last 30 days): 0.3% (ESA 2006).

[36] Proportion of drives of 40+ population on all drives: 66.2% (MiD 2008).

study group (N_{User}=195 / $N_{Control}$=100)[37]. Within the control sample the younger subjects drove less often with low BACs. The difference between the age groups diminishes as soon as higher BACs (≥0.03%) are considered. In the user sample no difference is observable between the two age groups at low BACs. But the 18-24-year-olds exceed the percentage of BAC-positive drives of the 25-39-year-olds at higher alcohol levels. When it comes to THC, no clear age differences are observable.

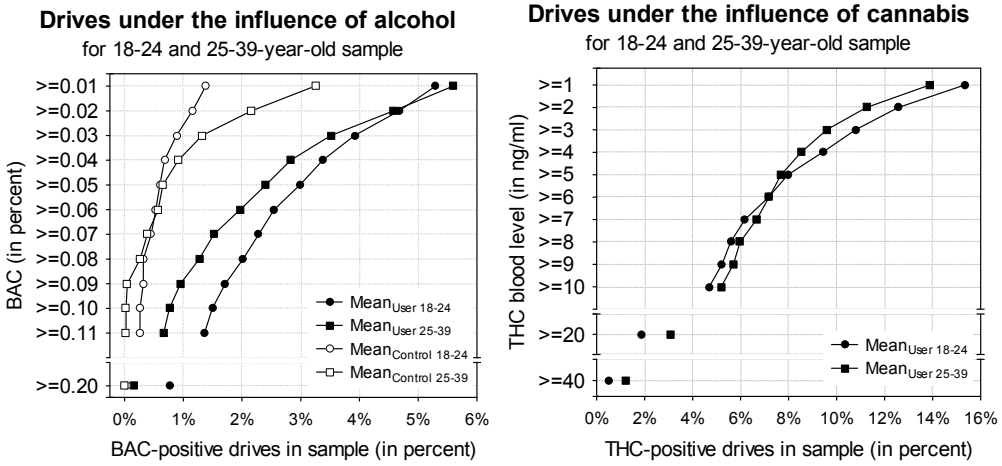


Figure 51: Mean percentage of BAC- / THC-positive drives of users (N_{User}=195) and mean percentage of BAC-positive drives of controls ($N_{Control}$=100) for 18-24-year-old and 25-39-year-old subjects.

Table 38: Mean percentage of BAC- / THC-positive drives of users (N_{User}=195) and mean percentage of BAC-positive drives of controls ($N_{Control}$=100) for 18-24-year-old and 25-39-year-old subjects.

BAC (in %)	18-24		25-39		THC blood plasma level (in ng/ml)	18-24	25-39
	Control	User	Control	User		User	
≥0.1	1.4%	5.3%	3.2%	5.6%	**≥1**	15.3%	13.9%
≥0.2	1.2%	4.7%	2.2%	4.6%	**≥2**	12.6%	11.2%
≥0.3	0.9%	3.9%	1.3%	3.5%	**≥3**	10.8%	9.6%
≥0.4	0.7%	3.4%	0.9%	2.8%	**≥4**	9.4%	8.5%
≥0.5	0.6%	3%	0.7%	2.4%	**≥5**	8%	7.7%
≥0.6	0.5%	2.5%	0.6%	2%	**≥6**	7.2%	7.2%
≥0.7	0.5%	2.3%	0.4%	1.5%	**≥7**	6.2%	6.7%
≥0.8	0.3%	2%	0.3%	1.3%	**≥8**	5.6%	6%
≥0.9	0.3%	1.7%	0%	1%	**≥9**	5.2%	5.7%
≥1.0	0.3%	1.5%	0%	0.8%	**≥10**	4.7%	5.2%
≥1.1	0.3%	1.4%	0%	0.7%	**≥20**	1.8%	3.1%
≥2.0	0%	0.8%	0%	0.1%	**≥40**	0.5%	1.2%

Considering the prevalence rate for regular drug use within the two age groups[38], the prevalence within the 18-24- and 25-39-year-old population can be calculated as follows – using the example of the prevalence of BAC-positive drives (BAC≥0.01%) in the 18-24-year-old population:

((100-4.8)*1.4 (controls' proportion) + 4.8*5.3 (users' proportion)) / 100

[37] Confidence intervals can be seen in the Annex (Annex 14.6).

[38] Prevalence for regular drug use (>3x in last 30 days): 18-24 year-old population → 4.8% (±0.95 CI: 3.4% - 6.2%); 25-39 year-old population → 2.1% (±0.95 CI: 1.5% - 2.7%).

Figure 52 and Table 39 show the calculated prevalence rates and the confidence intervals (±0.95 CI) for the two age groups. Because the general drug use prevalence is more than twice as high for the 18-24-year-old population compared to the 25-39-year-olds, the prevalence rates for driving under the influence of cannabis are much higher in this age group, even if the differences in the occurrence of THC-positive drives within the sample were relatively small. The difference in the drug prevalence rate between 18-24-year-olds and 25-39-year-olds has little influence on the calculated BAC-positive drives' prevalence rates because the main influence comes from the occurrence of BAC-positive drives within the population that does not regularly use drugs.

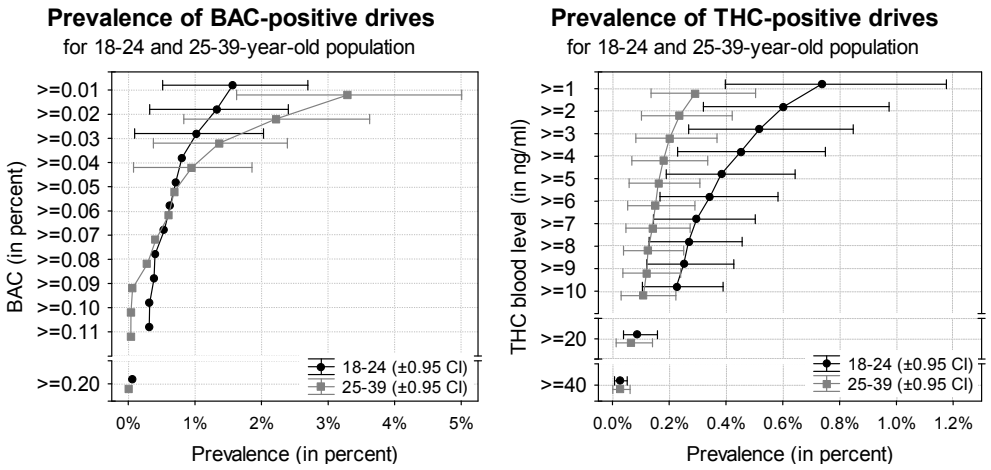


Figure 52: Prevalence of BAC- and THC-positive drives within the population of 18-24- and 25-29-year-olds calculated from the survey results (in percent ±0.95 CI).

Table 39: Prevalence of BAC- and THC-positive drives within the population of 18-24- and 25-29-year-olds calculated from the survey results (in percent ±0.95 CI).

BAC (in %)	Prevalence of BAC-pos. drives		THC blood level (in ng/ml)	Prevalence of THC-pos. drives	
	18-24	25-39		18-24	25-39
≥0.1	1.57 (0.52 - 2.7%)	3.3 (1.63 - 5%)	**≥1**	0.74% (0.4 - 1.18%)	0.29% (0.14 - 0.5%)
≥0.2	1.33 (0.32 - 2.4%)	2.21 (0.84 - 3.62%)	**≥2**	0.6% (0.32 – 0.97%)	0.24% (0.1 - 0.42%)
≥0.3	1.03 (0.09 - 2.03%)	1.37 (0.38 - 2.38%)	**≥3**	0.52% (0.27 - 0.85%)	0.2% (0.08 - 0.37%)
≥0.4	0.81 (-)	0.96 (0.08 - 1.86%)	**≥4**	0.45% (0.23 - 0.75%)	0.18% (0.07 - 0.34%)
≥0.5	0.71 (-)	0.69 (-)	**≥5**	0.38% (0.19 - 0.64%)	0.16% (0.06 - 0.31%)
≥0.6	0.63 (-)	0.6 (-)	**≥6**	0.34% (0.17 - 0.58%)	0.15% (0.05 - 0.29%)
≥0.7	0.54 (-)	0.41 (-)	**≥7**	0.3% (0.14 - 0.5%)	0.14% (0.05 - 0.27%)
≥0.8	0.4 (-)	0.28 (-)	**≥8**	0.27% (0.13 - 0.46%)	0.13% (0.04 - 0.25%)
≥0.9	0.39 (-)	0.06 (-)	**≥9**	0.25% (0.12 - 0.43%)	0.12% (0.04 - 0.24%)
≥1.0	0.32 (-)	0.04 (-)	**≥10**	0.23% (0.11 - 0.39%)	0.11% (0.03 - 0.22%)
≥1.1	0.31 (-)	0.04 (-)	**≥20**	0.09% (0.04 - 0.16%)	0.06% (0.01 - 0.14%)
≥2.0	0.06 (-)	0 (-)	**≥40**	0.03% (0.01 - 0.05%)	0.03% (0 - 0.06%)

11.7.5 Driving under influence as a function of time

In Chapter 11.6.1, the daily distribution of drives was shown compared between weekdays and weekends. For this purpose, the absolute number of drives per hour and weekday/weekend day was divided by the absolute number of weekdays and weekend days, respectively. So, the mean number of drives was shown for each hour. The mean numbers of drives for all 24 hours add up to the mean number of drives per day. This procedure is also applied to show the daily distribution of drives under influence.

On weekdays, the users drove on average 0.35 of 1.86 drives (18.8%) under the influence of alcohol, cannabis, or other substances or drug combinations (Figure 53). On weekends, this number rises to 0.43 of 1.33 drives (32.3%). On weekdays, there is a small increase around 6-9am when the subjects drive to school and job. In around 50% of these cases, the main substance effect stems from the night or day before (Annex 14.5). Both on weekdays and weekends from 11pm onward, the users drove in around 50% of the cases under the influence of illegal drugs and/or alcohol.

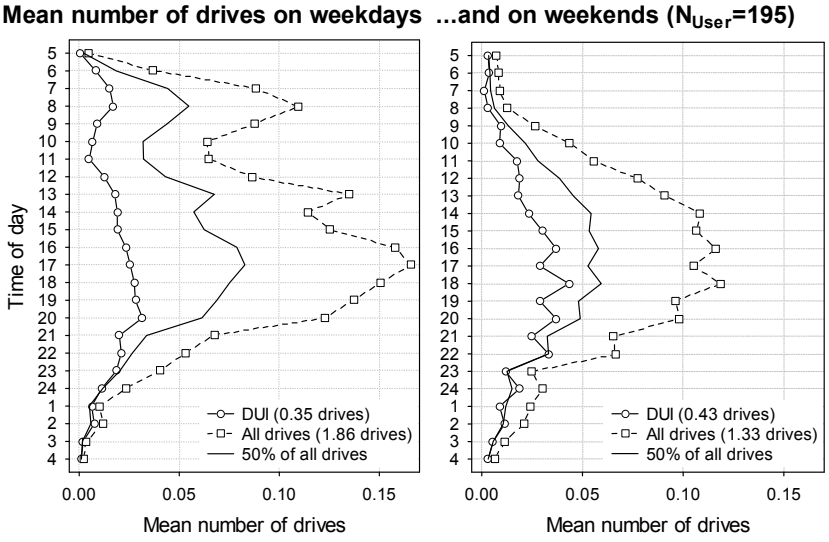


Figure 53: Number of DUI and total number of drives on weekdays/weekends for users (N_{User}=195).

On weekends, especially in the time category from 8pm until 2am, both users and controls drove most often under the influence of alcohol (BAC≥0.01%) (Figure 54).

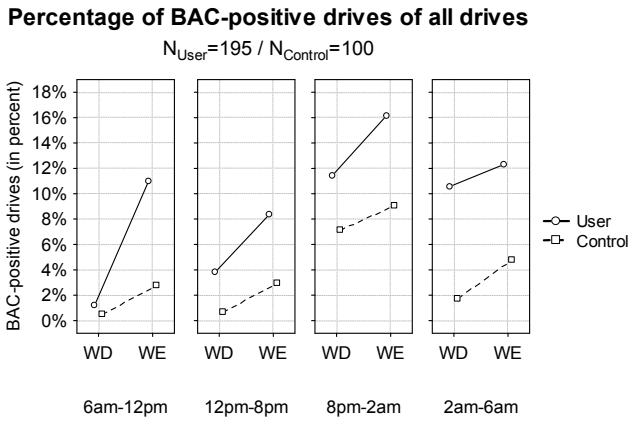


Figure 54: Percentage of BAC-positive drives (BAC≥0.01%) of all drives of users (N_{User}=195) and controls ($N_{Controls}$=100) dependent on weekday (WD=weekday, WE=weekend) and time (6am-12pm, 12pm-8pm, 8pm-2am, 2am-6am).

As already mentioned in Chapter 11.7.2, the users drove more than twice as often with a positive BAC than the controls. Whereas the controls' positive drives were basically restricted to common times for going out (8pm-2am), the users had numerous BAC-positive drives from 2am until 6am and on weekends even until 12pm. This can be explained by the fact that users stayed up longer and consumed more alcohol at night –

as lined out in Chapter 11.4.1 and 11.5.1. The fact that users drank higher doses of alcohol than controls might also result in more residual alcohol concentrations in the morning and could therefore explain the high percentage of BAC-positive drives on weekends in the category that covers the time from 6am until noon.

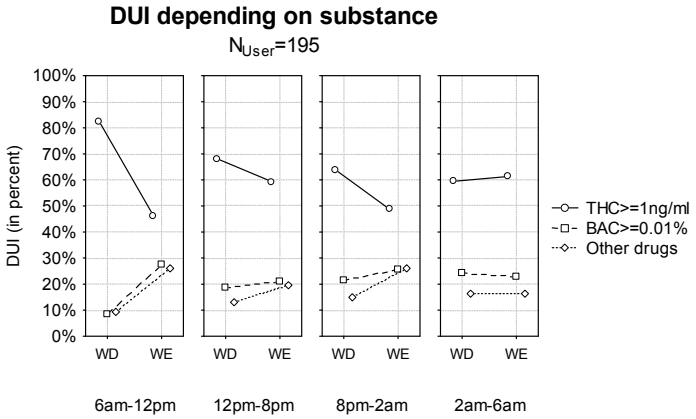


Figure 55: Percentage of DUI under different substances (THC blood plasma level≥1ng/ml, BAC≥0.01%, other substances and substance combinations) dependent on weekday (WD=weekday, WE=weekend) and time (6am-12pm, 12pm-8pm, 8pm-2am, 2am-6am) of users (N_{User}=195).

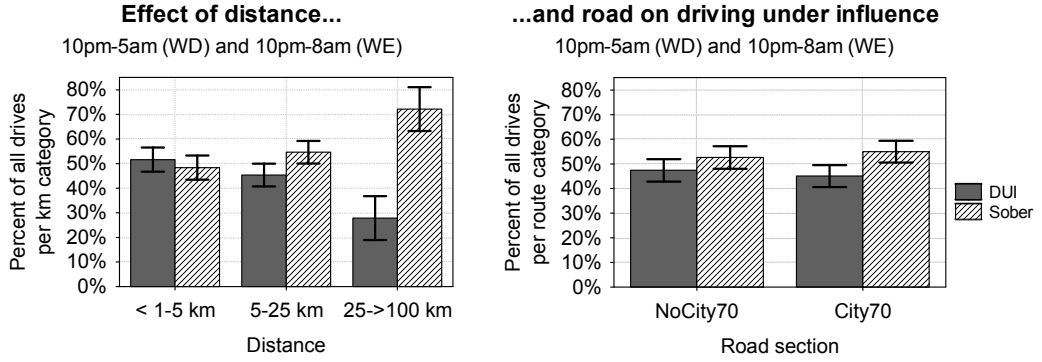
The largest amount of the users' drives under influence was under the influence of cannabis (THC blood plasma level≥1ng/ml) (Figure 55). The greatest decline of THC-positive drives between weekdays and weekends was found between 6am and noon. This could again be partly affected by residual substance concentrations from other drugs than cannabis that were consumed on weekends the night before. A decrease in drives under the sole influence of cannabis on weekends compared to weekdays and the analogous increase of BAC-positive drives and drives under the influence of other drugs or drug combinations can be found in varying degrees at any time of day.

11.7.6 Other situational characteristics

In this chapter it will be analysed if there are any route specific differences between the drives that were travelled under influence and sober drives and if companions have an influence on the occurrence of DUI. In Chapter 11.7.5 the daily distribution of drives showed that the proportion of drives under influence was highest from 10pm on until approximately 5am on weekdays and until 8am on weekends. Most of that time the subjects spent on leisure activities like going out or visiting friends (Chapter 11.4.2). To analyse further situational characteristics of drives under influence, only drives travelled in this timeframe were considered (N_{Drives}=948).

Most users' drives were either shorter than five kilometres (42.1%) or five to 25 kilometres (47.7%) at that time. Only 10.2% of all drives were farther than 25 kilometres. The distance travelled as driver of a vehicle had a clear influence on the occurrence of drugged driving (Figure 56, left). As the distance of a drive gets longer, drives under influence occurred more and more rarely. For drives with a motor vehicle the subjects stated the proportion of city roads, rural roads, and motorways. All drives that covered city roads to 70% or more were classified as city trips (*City*). Drives with less than 70% city roads were

classified as out of city drives (*NoCity*). 51.3% of the users' drives were city drives, 48.7% were out of city drives. The road section had no clear influence on the occurrence of drugged driving (Figure 56, right).



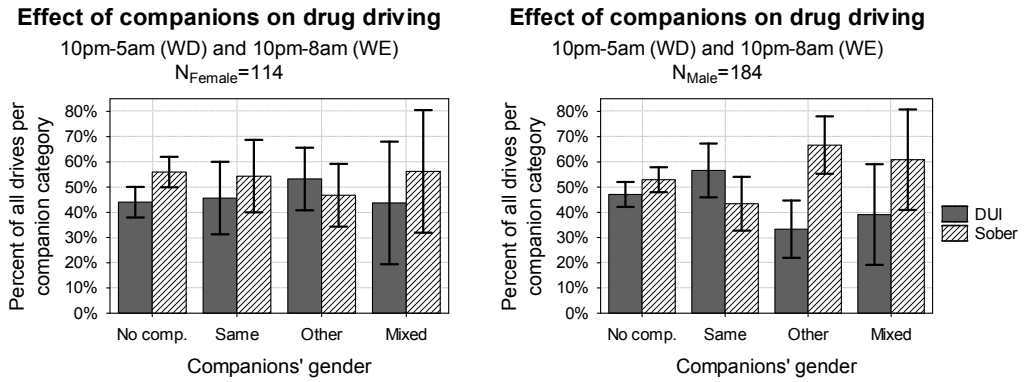
Percent (number) of drives within each km category

< 5 km	5-25 km	> 25 km
42.1% (399)	47.7% (452)	10.2% (97)

Percent (number) of drives within each road category

No city	City
48.7% (462)	51.3% (486)

Figure 56: Effect of distance (<5 km, 5-25 km, >25 km) and road section (No city, city) on driving under influence of users (N_{User}=195) – percentage of drives per category (±0.95 CI).



Percent (number) of drives within each condition (female)

No comp.	Same	Other	Mixed
67.6% (259)	12% (46)	16.2% (62)	4.2% (16)

Percent (number) of drives within each condition (male)

No comp.	Same	Other	Mixed
69.6% (393)	14.7% (83)	11.7% (66)	4.1% (23)

Figure 57: Effect of companions (no companions, same gender, other gender, mixed gender) on driving under influence of females (N_{Female}=114) and males (N_{Males}=184) – percentage of drives per category (±0.95 CI).

45.7% of the females' drives ($N_{DriveFemale}$=175) at the considered time were under influence. For male drivers the percentage of drives under influence was 46.6% ($N_{DriveMale}$=263). The presence of companions had a distinct effect on the occurrence of driving under influence (Figure 57). Whereas females drove more often under influence when male companions were accompanying, males drove less often when companions of the opposite gender or companions of both genders were present. So, female companions have a preventive effect whereas male companions increase the risk of driving under influence.

11.7.7 Descriptive characteristics

To better assess quantitative differences concerning driving after alcohol, cannabis, and stimulants consumption, three specific parameters were calculated for each subject:

- **DUI days**: Number of days the subject drove after alcohol, cannabis, and stimulants consumption (extrapolated to 30 days[39])
- **DUI**: Mean number of drives under influence per DUI day
- **Kilometres**: Mean kilometres per drive under influence[40]

Table 40: Number of users (N_{User}=195) who drove under influence of alcohol, cannabis, and stimulants and number of days they drove under the influence for each substance.

			DUI days (per DUI person)					
DUI substance		**N_{User}**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**MAX**
BAC	**≥0.01%**	**115 (59%)**	**2.14**	1	1.07	5.36	10.71	23.79
	≥0.05%	**70 (35.9%)**	**1.91**	0.91	1.07	3	8.18	17.59
THC	**≥1ng/ml**	**128 (65.6%)**	**4.29**	1	2.11	9.31	22.50	26.79
	≥4ng/ml	**100 (51.3%)**	**4.21**	1	1.91	8.28	17.59	23.57
Stimulants		**34 (17.4%)**	**1.88**	0.91	1.03	4.62	16.07	21.43

59% of the users drove with a positive BAC. Drives with BACs of 0.05% and higher were committed by 35.9% of the users. 65.6% of all users drove with a positive THC blood plasma level (51.3% with a THC blood plasma level of ≥4ng/ml). 17.4% of the users drove after consuming stimulants (Table 40). Whereas users drove on average (median) on 2 days within a 30-day period with a positive BAC, they drove on 4 days with a positive THC level. The number of days with drives under alcohol or THC seems to be hardly moderated by the substance concentration.

Table 41: Number of drives under influence per DUI day and number of kilometres per drive for users (N_{User}=195).

			DUI (per DUI day)						**Kilometres** (per DUI)					
DUI substance		**N_{User}**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**
BAC	**≥0.01%**	**115 (59%)**	1	1	1	1.5	2.29	3	9.03	2.85	4.43	15.2	37.05	162.45
	≥0.05%	**70 (35.9%)**	1.06	1	1	1.65	3	3	10	2.22	5.23	15.2	67.64	162.45
THC	**≥1ng/ml**	**128 (65.6%)**	1.5	1	1	1.86	2.5	3.18	8.91	2.47	3.80	15.2	42.75	88.83
	≥4ng/ml	**100 (51.3%)**	1.19	1	1	1.78	2.1	3	8.21	2.3	3.59	15.2	60.48	162.45
Stimulants		**34 (17.4%)**	1.38	1	1	2	3	3.7	7.6	2.85	2.85	15.2	54.96	162.45

Table 41 illustrates the number of drives under influence per DUI day and the kilometres per drive. If someone drove with a positive BAC, in most of the cases, this was only done once a day. In most of the cases, THC-positive drives occurred on one to two occasions per day. Drives after consumption of stimulants happened approximately once a day. No difference is observable for the number of kilometres between lower and higher BAC and THC blood plasma levels (see BAC≥0.01% vs. BAC≥0.05% and THC≥1ng/ml vs. THC≥4ng/ml) and between alcohol, cannabis, and stimulants.

The parameters for BAC-positive drives with BACs≥0.01% and BACs≥0.05% were analysed for differences between users (N_{User}=195) and controls ($N_{Controls}$=100, Table 42). The data were analyzed by rank order testing (Mann-Whitney U-test). For the analysis of the number of DUI days, all subjects who did not drive under influence of alcohol were included in the analysis with a value of zero.

[39] Because of the varying number of available reports per person, the days were extrapolated to 30 days (number of drug driving days divided by number of reported days and multiplied by 30).
[40] The calculation was already explained in Chapter 11.6.2.

Table 42: Number of controls ($N_{Control}$=100) who drove under influence of alcohol, number of days they drove under influence of alcohol, number of BAC-positive drives per day, and number of kilometres per BAC-positive drive.

		$N_{Control}$	MD	$Q_{.05}$	$Q_{.25}$	$Q_{.75}$	$Q_{.95}$	MAX
BAC≥0.01%	**DUI days** (per DUI person)	**39 (39%)**	1.07	0.88	1.03	4.29	7.5	11.38
	DUI (per DUI day)		1	1	1	1.33	2	2
	Kilometres (per DUI)		7.6	2.22	2.85	17.58	162.45	162.45
BAC≥0.05%	**DUI days** (per DUI person)	**15 (15%)**	1.07	0.88	1.03	2.14	9.31	9.31
	DUI (per DUI day)		1	1	1	1.33	3	3
	Kilometres (per DUI)		15.2	2.85	7.6	37.05	162.45	162.45

The users drove with a positive BAC on more days than the controls, regardless whether a BAC of 0.01% or higher or a BAC of 0.05% or higher was considered (BAC≥0.01%: MWU: Z(1;295)=3.69; p=0.000; BAC≥0.05%: MWU: Z(1;295)=3.87; p=0.000). The samples did not differ in the number of BAC-positive drives per day nor in the number of kilometres per BAC-positive drive.

Table 43: Significant effects for gender, age, and residence on occurrence of substance-positive drives in 30 days (N_{User}=195).

	Gender	Age	Residence
BAC≥0.01%			
BAC≥0.05%			
THC≥1ng/ml			rural > urban Z(1;149)=4.35; p=0.000 city > urban Z(1;114)=3.39; p=0.000
THC≥4ng/ml		18-24 > 30-39 Z(1;145)=2.32; p=0.020 25-29 > 30-39 Z(1;78)=2.18; p=0.029	rural > urban Z(1;149)=4.66; p=0.000 city > urban Z(1;114)=3.13; p=0.002
Stimulants			

The test designs for analysing the three substance-specific parameters with respect to interactions were partially not complete. So, when analysing differences between the different levels of the stratifying variables, the numbers of drives under influence (BAC≥0.01%, BAC≥0.05%, THC≥1ng/ml, THC≥4ng/ml, stimulant-positive) in 30 days were compared. The only significant differences were found for age and residence (Table 43). 18-24-year-olds and 25-29-year-olds drove more often under the influence of cannabis when it came to THC blood plasma levels of 4ng/ml or higher compared to 30-39-year-olds. Subjects from urban areas drove less often under the influence of cannabis (THC≥1ng/ml, THC≥4ng/ml) than subjects from rural or city areas. Interactions between the factors gender, age, and residence turned out to be not significant.

11.7.8 Identifying persons most at risk

Considering all drives a person travelled, 28 users (14.4%) and 61 controls (61%) didn't drive under influence while participating in the study at all. 115 users (59%) and 39 controls (39%) drove with a positive BAC (BAC≥0.01%). 29 of the users (14.9%) drove after alcohol consumption only and another 44 (22.6%) after cannabis consumption only. 59 users (30.3%) drove either with a positive BAC or with a positive THC blood plasma level or both. The remaining 35 users (17.9%) additionally or solely drove after consumption of other drugs or drug combinations. Table 44 lists all drug combinations the users were

positive for and the corresponding number of subjects. The number of BAC-positive individuals is also listed for the controls.

Table 44: Substances under which the subjects drove, number and percentage (±0.95 CI) of users (N_{User}=195) and controls ($N_{Control}$=100) who committed drives under the influence of these substances.

DUI substances	Number of users (percent ±0.95 CI) N_{User}=195	Number of controls (percent ±0.95 CI) $N_{Control}$=100
No DUI	28 (14.4%, CI: 9.5 – 19.3%)	61 (61%, CI: 51.4% - 70.6%)
BAC-positive drives	115 (59%, CI: 52.1 - 65.9%)	39 (39%, CI: 29.4% - 48.6%)
THC-positive drives	128 (65.6%, CI: 58.9 - 72.3%)	
BAC- and **THC**-positive drives	59 (30.3%, CI: 23.8 - 36.8%)	
THC-positive drives **only**	44 (22.6%, CI: 16.7 - 28.5%)	
BAC-positive drives **only**	29 (14.9%, CI: 9.9 - 19.9%)	
BAC-, **THC**- and **Stimulants**-positive drives	18 (9.2%, CI: 5.1 - 13.3%)	
BAC- and **Stimulants**-positive drives	9 (4.6%, -)	
THC- and **Stimulants**-positive drives	6 (3.1%, -)	
Stimulants-positive drives **only**	1 (0.5%, CI: -)	
THC- and **Heroin**-positive drives	1 (0.5%, CI: -)	

Figure 58 shows the percentage of all users (N_{User}=195) and controls ($N_{Control}$=100) in descending order who committed drives under influence and the proportion of drives under influence they were responsible for. In Germany, there are two BAC limits for the operation of a vehicle: zero tolerance (for novice drivers, all drivers between the ages 18 and 21 years and newly licensed drivers of any age for the first two years of having a licence) and 0.05% (for all other drivers). Therefore, the figures show either any drive under influence, independent of the BAC (*DUI*), or drives positive for THC, stimulants, heroin and/or alcohol above the legal limit (*DUI (BAC>legal limit)*).

81% (*DUI (BAC>legal limit)*) to 86% (*DUI*) of the users were responsible for all users' drives under influence (left). 28 (14%) users never drove under any substance while participating in the study. 9 users (5%) just had drives under influence with a positive BAC below the legal limit. When considering drives with a positive BAC of 0.01% or higher or drives with a positive THC blood plasma level of 1ng/ml or higher, only approximately 30% of the users were responsible for around 80% of substance-positive drives (grey lines). Considering drives with a positive THC blood plasma level of 4ng/ml or higher or drives with a positive BAC above the legal limit, the number of responsible users further decreases. In these cases up to 80% of all substance-positive drives were travelled by only 20% of the users and around 50% to 60% of the users had no drives positive at all.

The largest part of the controls did not drive with a positive BAC (right). 61 persons (61%) never drove under the influence of alcohol. Another 22 controls (22%) just had drives under influence with a positive BAC below the legal limit. 17 controls (17%) had drives with BACs above the legal limit. Because some controls had previously used drugs in their life (not illustrated in the present report), the question arises if there is a correlation between previous drug use and driving under alcohol influence while participating. When

comparing the 17 controls who committed DUI with the 87 controls who had no drive under influence with respect to their drug use history, no differences became apparent[41].

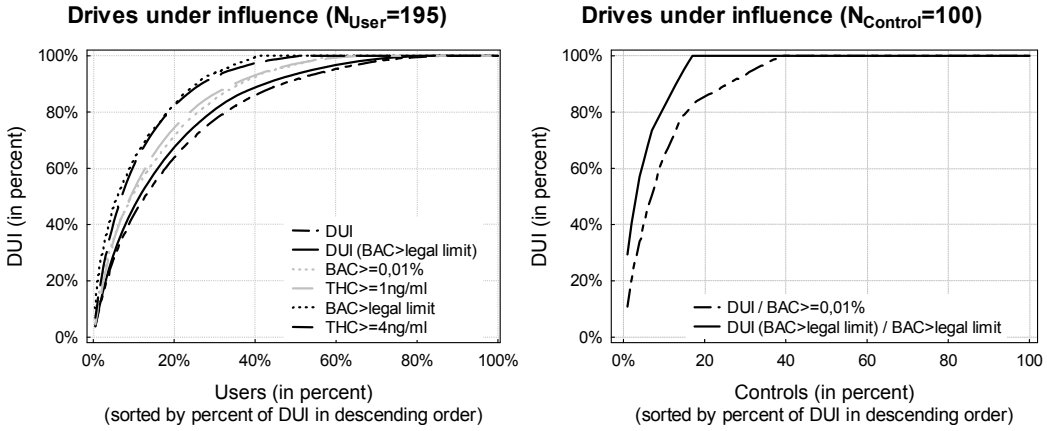


Figure 58: Percentage of drives under influence dependent on the percentage of users and controls who were responsible for (N_{User}=195; $N_{Control}$=100); for drives positive for any substance (DUI), drives positive for cannabis, stimulants and/or alcohol with a BAC above the legal limit (DUI (BAC>legal limit)), drives with a BAC of 0.01% and more (BAC≥0.01%), drives with a THC blood plasma level of 1ng/ml and more (THC≥1ng/ml), drives under alcohol above the legal limit (BAC>legal limit) and drives with a THC blood plasma level of 4ng/ml and more (THC≥4ng/ml).

11.7.9 Influence of consumption and driving frequency

In the above chapter it was shown that only one part of the subjects committed substance-positive drives whereas the other part did not drive under influence at all. The following chapters will focus on the identification of attributes that describe those who committed DUI and those who did not. In the following, the influence of driving and consumption frequency on the occurrence of drug driving is analysed.

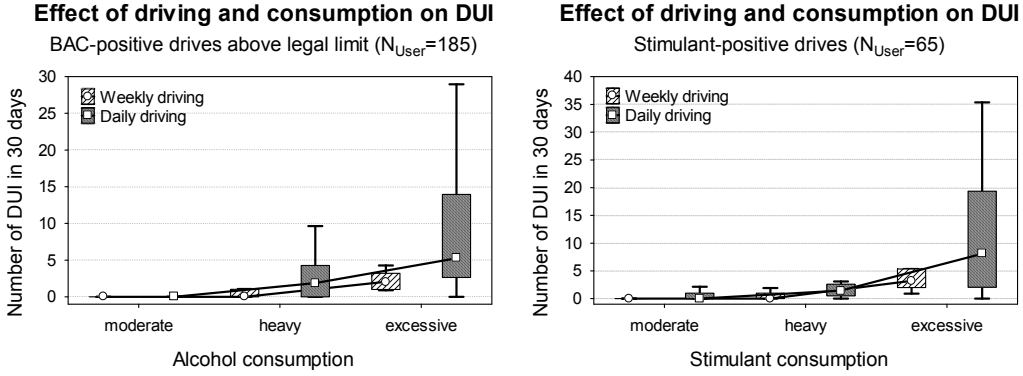
For this purpose the consumption and driving groups classified in Chapter 11.5.3 and Chapter 11.6.3 were compared concerning their number of substance-positive drives[42]. For alcohol-positive drives, only those drives were included in the analyses that were travelled with a BAC above the legal limit. Rank order tests were applied (Kruskal Wallis H-Test and Mann-Whitney U-test) to analyse the different degrees of consumption and driving frequency. To be able to indentify interactions between the main factors, the same procedure as described in Chapter 11.5.2 was applied. If main effects and interactions are not mentioned, the corresponding comparisons didn't result in a significant finding.

The driving frequency had no effect on the number of BAC-positive drives above the legal limit or on the occurrence of stimulant-positive drives (Figure 59). By contrast, moderate, heavy, and excessive alcohol and stimulant users had a significantly different number of BAC- (KW-H(2;185)=51.55; p=0.000) and stimulant-positive drives (KW-H(2;65)=28.02;

[41] All participants gave information (Q-Start) about the number of times they had used cannabis, amphetamine, ecstasy, LSD, psilocybin, cocaine, crack, heroin, sniffing agents, and other drugs in their lifetime. The information was given through the categories "never", "1x", "2x", "3-5x", "6-9x", "10-39x", "≥40x". For each category the mean frequency was adopted ("never"=0x, "1x"=1x, "2x"=2x, "3-5x"=4x, "6-9x"=7x, "10-39x"=24x, "≥40x"=40x) and summed up over all drug categories. Differences in the total amount of the so calculated lifetime drug use frequency between DUI-positive controls (N=17) and all other controls (N=87) was analysed by applying the Mann-Whitney U-test. No difference was found.

[42] Because of the varying number of available reports per person, the number of drives were extrapolated to 30 days (number of drives divided by number of reported days and multiplied by 30).

p=0.000), respectively. Excessive users had the most and moderate users the fewest number of substance-positive drives of all. Heavy users had less than excessive and more substance-positive drives than moderate users.



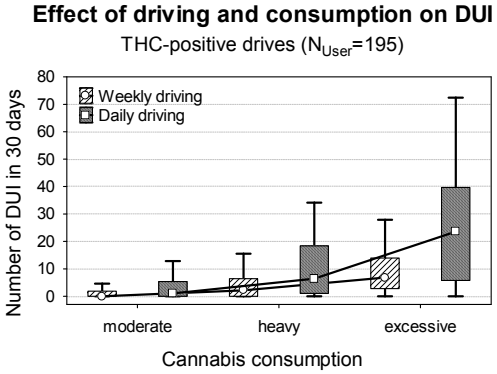
Percent (number) of subjects in each condition (alcohol)

.	moderate	heavy	excessive
Weekly driving	15.7% (29)	18.4% (34)	4.9% (9)
Daily driving	27.6% (51)	24.9% (46)	8.6% (16)

Percent (number) of subj. in each condition (stimulants)

.	moderate	heavy	excessive
Weekly driving	15.4% (10)	18.5% (12)	9.2% (6)
Daily driving	24.6% (16)	12.3% (8)	20% (13)

Figure 59: Number of DUI (left figure: BAC-positive drives above legal limit; right figure: stimulant-positive drives) in 30 days (Median; 25-75%; Range without outlier) for moderate (alcohol: males >0-≤24 g/day, females >0-≤12 g/day; stimulants: >0-≤2 days/4 weeks), heavy (alcohol: males >24-60 g/day, females >12-40 g/day; stimulants: ≤6 days/4 weeks) and excessive users (alcohol: males >60 g/day, females >40 g/day; stimulants: >6 days/week) depending on whether they drove weekly (>0-<4 days per week) or daily (≥4 days per week).



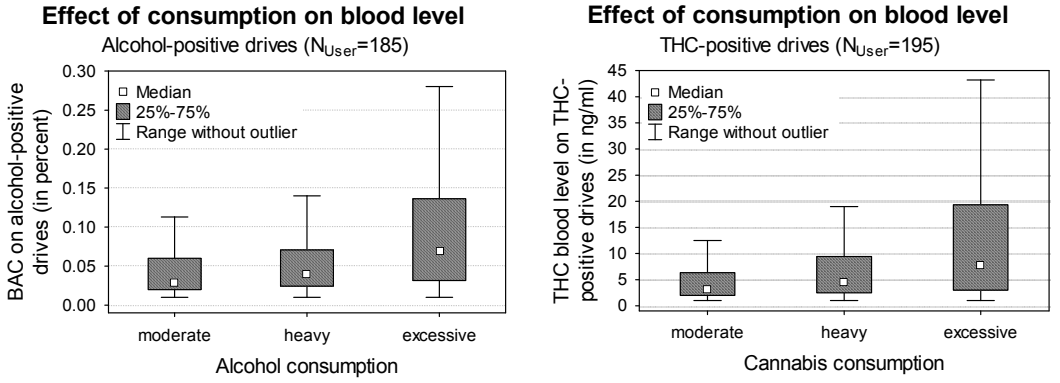
Percent (number) of subjects in each condition (cannabis)

.	moderate	heavy	excessive
Weekly driving	24.1% (47)	7.7% (15)	7.2% (14)
Daily driving	29.7% (58)	15.4% (30)	15.9% (31)

Figure 60: Number of DUI (THC-positive drives) in 30 days (Median; 25-75%; Range without outlier) for moderate (>0-<1 unit/day), heavy (1-<2 units/day) and excessive users (≥2 units/day) depending on whether they drove weekly (>0-<4 days/week) or daily (≥4 days/week).

The number of THC-positive drives (Figure 60) was both influenced by the frequency of driving (MWU:Z(1;195)=4.03; p=0.000) and the frequency of cannabis consumption (KW-H(2;195)=63.60; p=0.000). Daily drivers had more THC-positive drives than those users who drove a vehicle only 1-3 days a week. The increase in THC-positive drives because of cannabis consumption (moderate: MD=0.00; heavy: MD=4.14; excessive: MD=13.93) was higher than the increase because of driving (weekly: MD=0.97; daily: MD=4.29). Excessive cannabis users had the highest amount, heavy users a medium amount, and moderate users the lowest amount of drives under the influence of cannabis.

Furthermore, the influence of the intensity of drug use on the blood concentration level while driving was analysed. Therefore, all THC- and BAC-positive drives, respectively, were taken into account – regardless whether the driver was under the influence of alcohol or cannabis alone or in combination with another drug.



Percent (number) of subjects in each condition (alcohol)

moderate	heavy	excessive
43.2% (80)	43.2% (80)	13.5% (25)

Percent (number) of subjects in each condition (cannabis)

moderate	heavy	excessive
53.8% (105)	23.1% (45)	23.1% (45)

Figure 61: Blood level on alcohol- (left) and cannabis-positive drives (right) (Median; 25-75%; Range without outlier) for moderate (alcohol: males >0-≤24 g/day, females >0-≤12 g/day; cannabis: >0-<1 unit/day), heavy (alcohol: males >24-60 g/day, females >12-40 g/day; cannabis: 1-<2 units/day) and excessive users (alcohol: males >60 g/day, females >40 g/day; cannabis: ≥2 units/day).

Moderate, heavy, and excessive alcohol and cannabis users had significantly different BACs (KW-H(2;673)=46.49; p=0.000) and THC blood plasma levels (KW-H(2;1,521)=113.03; p=0.000) on substance-positive drives, respectively (Figure 61). Excessive users had the highest (BAC: MD=0.07%; THC: MD=7.7ng/ml) and moderate users the lowest blood levels (BAC: MD=0.03%; THC: MD=3.2ng/ml). Heavy users had lower blood levels than excessive and a little higher ones than moderate users (BAC: MD=0.04%; THC: MD=4.5ng/ml).

Thus, both frequent driving and frequent cannabis consumption increases the probability of driving under the influence of cannabis. For BAC- and stimulant-positive drives, the frequency of driving has no influence whereas the degree of consumption has influence on the frequency of drives under influence. For alcohol as well as for cannabis, a high intensity of substance use increases the median substance blood level found for substance-positive drives.

11.7.10 Other traffic related conspicuousness

11.7.10.1 Records in the Central Register of Traffic Offenders

Road users who have become conspicuous in road traffic are recorded in the Central Register of Traffic Offenders (for more information: http://www.kba.de/cln_015/nn_260396/EN/ZentraleRegister__en/VZR__en/vzr__node__en.html?__nnn=true). In the Central Register of Traffic Offenders, final and legally binding decisions are recorded based on:

- **Driving licence authorities** (approx. 650 nationwide), which refuse, withdraw or newly grant driving licences (including other measures like ordered or voluntary participation in a rehabilitation programme to lower the number of demerit points),
- **Authorities imposing fines** to punish administrative offences with a fine of at least 40 euros, with demerit points, or with a driving ban,
- **Courts**, which pass a sentence due to criminal offences associated with road traffic.

275 subjects gave a written consent to access their records at the Central Register of Traffic Offenders. 20 subjects, all users, did not agree to the accessing of their records. 118 users (67.4%) had no decisions reported in the file at all. Of the controls, 80 subjects (80%) were not recorded in the register. 57 users (32.6%) had in total 146 reported decisions (MD=2; Q25=1; Q75=3). 20 controls (20%) had in total 42 reported decisions (MD=1; Q25=1; Q75=1,5). Considering all subjects, not only those who were indeed registered, shows that users in general have more reported decisions than controls (MWU: $Z(1;275)=2.65$; $p=0.008$). When excluding records that are linked to DUI offences, this difference disappears.

Table 45: Decisions recorded in the Central Register of Traffic Offenders for users ($N_{User}=57$) and controls ($N_{Control}=20$).

Decisions in the Central Register of Traffic Offenders	User $N_{User}=57$	Control $N_{Control}=20$	Total
No disciplinary action	56 (38.4%)	28 (66.7%)	84 (44.7%)
Driving ban	25 (17.1%)	1 (2.4%)	26 (13.8%)
Voluntary participation in a rehabilitation programme	18 (12.3%)	4 (9.5%)	22 (11.7%)
Order to participate in a rehabilitation programme	15 (10.3%)	2 (4.8%)	17 (9%)
Driver licence reinstatements	10 (6.9%)	1 (2.4%)	11 (5.9%)
Licence withdrawal (permanent)	6 (4.1%)	1 (2.4%)	7 (3.7%)
Licence withdrawal (temporary)	0 (0%)	1 (2.4%)	1 (0.5%)
Voluntary relinquishment of licence within withdrawal procedure	8 (5.5%)	0 (0%)	8 (4.3%)
Warnings and advice to participate in a rehabilitation programme	5 (3.4%)	2 (4.8%)	7 (3.7%)
Warnings and advice to participate psychological counselling	1 (0.7%)	2 (4.8%)	3 (1.6%)
Licence ban	1 (0.7%)	0 (0%)	1 (0.5%)
Licence confiscation	1 (0.7%)	0 (0%)	1 (0.5%)
Total	146 (100%)	42 (100%)	188 (100%)

Most reported decisions (44.7%) did not involve any disciplinary action (e.g. driving ban, rehabilitation programme, etc., Table 45) but refer to offences that were exclusively punished by demerit points (and fines, see also Table 46). A great part of the reported decisions that refer to disciplinary actions refer to driving bans (13.8%), the voluntary participation in a rehabilitation programme (11.7%) or orders to participate in a rehabilitation programme (9%). The remaining decisions refer to driver licence reinstatements (5.9%), licence withdrawal (permanent or temporary) (4.3%), voluntary relinquishments of the licence within a withdrawal procedure (4.3%), warnings and advice to participate in a rehabilitation programme (3.7%) or psychological counselling (1.6%), licence ban (0.5%), and licence confiscation (0.5%). Most decisions reported for the controls (66.7%) do not refer to any disciplinary action whereas a large part of the users' decisions refer to driving bans (17.1%), orders to participate in a rehabilitation programme (10.3%), driver licence reinstatements (6.9%), licence withdrawal (4.1%), and voluntary relinquishment of the licence in the course of a withdrawal procedure (5.5%). Both users and controls had a large proportion of reported decisions concerning the voluntary participation in a rehabilitation programme (users: 12.3%; controls: 9.5%).

Table 46: Offences recorded in the Central Register of Traffic Offenders for users (N_{User}=49) and controls ($N_{Control}$=18) punished by demerit points ($N_{OffenceUser}$=84; $N_{OffenceControl}$=29) and partly connected to a disciplinary action, like driving ban, withdrawal, etc. (User=33.3%; Control=3.4%).

Offences recorded as decisions in the Central Register of Traffic Offenders		User N_{User}=49	Control $N_{Control}$=18	Total
Illegal drugs	Administrative	4 (4.8%)		4 (3.5%)
	Criminal	1 (1.2%)		1 (0.9%)
Alcohol	Administrative	4 (4.8%)		4 (3.5%)
	Criminal	5 (6%)		5 (4.4%)
Other administrative offences				
Speeding		39 (46.4%)	19 (65.5%)	58 (51.3%)
Red traffic light		9 (10.7%)	1 (3.4%)	10 (8.8%)
Right of way		3 (3.6%)		3 (2.7%)
Safety gab		1 (1.2%)		1 (0.9%)
Overtaking		1 (1.2%)		1 (0.9%)
Turning, backing up			1 (3.4%)	1 (0.9%)
General inspection			1 (3.4%)	1 (0.9%)
Driving in spite of ban because of smog		1 (1.2%)		1 (0.9%)
Other administrative offences		1 (1.2%)	2 (6.9%)	3 (2.7%)
Other administrative offences (probationary licence)		10 (11.9%)	4 (13.8%)	14 (12.4%)
Other criminal offences				
Driving without licence		2 (2.4%)	1 (3.4%)	3 (2.7%)
Injury		1 (1.2%)		1 (0.9%)
Driving with uninsured vehicle		1 (1.2%)		1 (0.9%)
Other criminal offences (probationary licence)		1 (1.2%)		1 (0.9%)
Total		84 (100%)	29 (100%)	113 (100%)

For some of the subjects (N_{User}=8, $N_{Control}$=2), exclusively disciplinary actions were registered. The offences that caused these disciplinary action were already erased. 49 users had in total 84 offences recorded that were punished by demerit points (i.e. 28% of all users for whom the data was available). Five of the users' offences were related to driving under the influence of illegal drugs (administrative offence: 4.8%, criminal offence: 1.2%) and nine to drink driving (administrative offence: 4.8%, criminal offence: 6%)[43] (Table 46). 29 offences punished by demerit points were committed by 18 controls (i.e. 18% of all controls). None of them were offences regarding drives under influence. A large part of the subjects, regardless whether user or control, committed offences regarding speeding (51.3%) and not further specified administrative offences during the probationary period (12.4%). The users also often drove through red lights (10.7%).

Including subjects who had no offences registered with a value of zero in the analysis of the number of offences, results in a higher number for users as compared to controls (MWU: $Z(1;275)=1.98$; $p=0.048$). The absolute number of recorded offences did not differ between users and controls when DUI offences were excluded or only those subjects were included in the analysis who had at least one offence registered.

Comparing the number of demerit points of users and controls for whom the information in the file was accessed, shows that the users have more demerit points than the controls (MWU: $Z(1;275)=2.31$; $p=0.021$) (Table 47). Excluding the points due to DUI offences does not result in any difference between users and controls. Moreover, when only con-

[43] $N_{DUIOffenders}$=14:
8.8% (N=10) of males, 6.5% (N=4) of females (chi2=0.32, df=1, p=0.570);
6.7% (N=10) of 18-29-year-olds, 16% (N=4) of **30-39-year-olds** (chi2=2.11, df=1, p=0.147);
3.9% (N=3) of rural subjects, 11.1% (N=11) of **urban/city subjects** (chi2=3.23, df=1, p=0.072).

sidering those subjects who had at least one point, users always had a higher number of recorded demerit points than controls, regardless whether DUI offences were included (MWU: Z(1;67)=3.27; p=0.001) or excluded (MWU: Z(1;61)=2.60; p=0.009).

Table 47: Number of demerit points of users (N_{User}=175) and controls ($N_{Control}$=100).

				Demerit points					
DUI substance		**Inclusion**	**$N_{Subject}$**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**MAX**
Users	**DUI included**	**All**	**175**	**0**	0	0	1	8	15
		>0 point	**49**	**4**	1	3	7	11	15
	DUI excluded	**All**	**175**	**0**	0	0	0	6	15
		>0 point	**43**	**3**	0	1	5	9	15
Controls		**All**	**100**	**0**	0	0	0	3	15
		>0 point	**18**	**1,5**	1	1	3	15	15

Those who became conspicuous in traffic before (any decision registered in the file) did not commit more drives under influence while participating in the study than those who did not become conspicuous before. When the subjects who had at least one demerit point recorded in the file were compared with those who had no points, a slight effect became apparent for the controls (MWU(1;100)=2.23; p=0.026) (Figure 62). The controls who had demerit points reported drove slightly more often with a BAC above the legal limit. The effect was very small (Controls with points: MD=0; Q25=0; Q75=1.07; Controls without points: MD=0; Q25=0; Q75=0). The users had no significantly differing number of drives under influence depending on whether or not demerit points were registered (and regardless whether or not demerit points due to DUI were regarded).

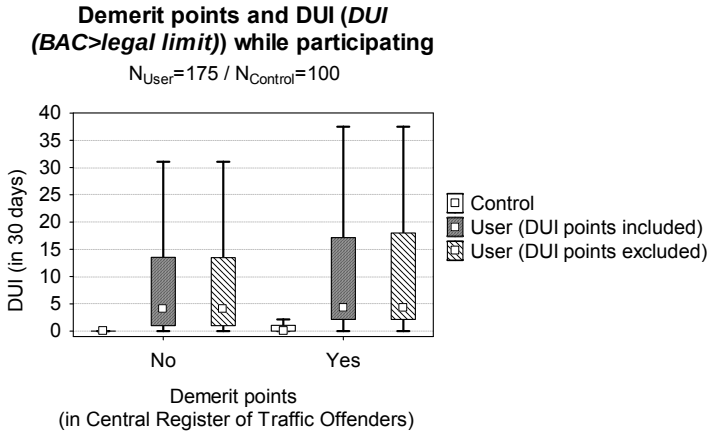


Figure 62: Drives under influence in 30 days (DUI (BAC>legal limit)) depending on whether or not demerit points where recorded in the Central Register of Traffic Offenders (no, yes) of users (N_{User}=175) and controls ($N_{Control}$=100) – in case of users demerit points caused by DUI are either included or excluded (Median, 25%-75%, Range without outlier).

Those users who had demerit points due to DUI did not have a significantly different amount of drug driving incidences while participating in the study compared to those users who had no DUI demerit points recorded in the register (Figure 63).

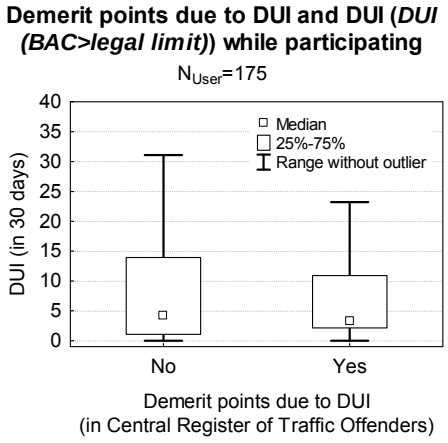


Figure 63: Drives under influence in 30 days (DUI (BAC>legal limit)) depending on whether or not the subjects had demerit points due to a DUI offence (N_{User}=175) (Median, 25%-75%, Range without outlier).

Decisions recorded in the Central Register of Traffic Offenders cover disciplinary actions and all administrative and criminal offences road traffic users have committed. In general, users had more decisions and more offences reported in the file. When excluding decisions and offences due to drug driving, this predominance disappears. 14 users had become conspicuous in road traffic because of drug driving. Controls had no DUI offences recorded in the register but other offences. In general, users received more demerit points. But again, the difference diminishes as soon as demerit points due to drug driving were excluded from the analysis. When only those subjects were analysed who have demerit points recorded in the register, it turned out that users have a higher number of points, regardless whether or not DUI offences are in- or excluded. So, the users' offences are in general punished by more demerit points than the controls' (e.g. higher speeding, running a red light). Subjects who were previously conspicuous in road traffic and registered in the Central Register of Traffic Offenders did not commit more drives under influence of illegal drugs and/or drives with a BAC above the legal limit while participating in the study. The 14 users who had a DUI offence reported in the file did not commit more drives under influence within the study period in comparison to those who were not conspicuous with respect to previous drug driving. So in total, except from offences concerning drug driving, users were not more often conspicuous in road traffic than controls. However, users who were recorded in the file had committed more severe offences than controls (as they were punished by more demerit points).

11.7.10.2 Dangerous traffic situations

Of all drives the subjects travelled as driver of a vehicle, in 1.2% of the cases (N=181) the subjects stated that a dangerous traffic situation occurred while driving. In the case that a dangerous situation was reported, the subjects were queried about what exactly happened and it was decided from the course of the story if the subject was culpable or not.

The users stated 109 dangerous traffic situations while driving (1.1% of the users' drives). 89 were sober drives (81.6%), 20 under influence (18.4%). In 44 of the cases (40.4%) the subjects were culpable. In 59 of the cases (54.1%) they were not culpable. In 6 of the cases (5.5%) no in-depth interview was conducted. The controls stated 72 dangerous traffic situations while driving (1.3% of the controls' drives). All were sober drives (100%).

In 33 of the cases (45.8%) the subjects were culpable. In 34 of the cases (47.2%) they were not culpable. In 5 of the cases (7%) no in-depth interview was conducted.

To estimate the risk of having a dangerous traffic situation when driving under influence, odds ratios were calculated. The risk of having a dangerous traffic situation when driving under the influence of alcohol (BAC≥0.01%, BAC≥0.05%, BAC≥0.11%), cannabis (THC≥1ng/ml, THC≥4ng/ml, THC≥10ng/ml), alcohol and cannabis (BAC≥0.01% and THC≥1ng/ml), stimulants or substance combinations other than alcohol and cannabis is not increased (Table 48). The corresponding chi squares did not reach significance.

Table 48: Absolute number of dangerous traffic situations per substance and study group (N_{User}=195; $N_{Control}$=100) and absolute number of sober drives, odds ratios, corresponding statistics.

Substance			No danger	Danger	OR	Chi squared	p-level
BAC	≥0.01%	User	405	5	1.02	0.00	0.963
		Control	127	0			
	≥0.05%	User	208	3	1.19	0.09	0.764
	≥0.11%	User	81	1	1.02	0.00	0.983
THC	≥1ng/ml		1,342	12	0.74	0.96	0.328
	≥4ng/ml		814	8	0.81	0.31	0.577
	≥10ng/ml		446	3	0.56	1.02	0.313
BAC≥0.01% & THC≥1ng/ml			106	1	0.78	0.06	0.806
Stimulants			146	1	0.57	0.33	0.569
Other			80	1	1.03	0. 001	0.973
Sober		User	7,365	89			
		Control	5,447	72			

The same procedure was applied to estimate the risk of being culpable for a dangerous traffic situation when driving under influence (Table 49).

Table 49: Absolute number of dangerous traffic situations per substance separated for culpability and absolute number of sober drives per study group (N_{User}=195; $N_{Control}$=100), odds ratios, corresponding statistics.

Substance			Not culpable	Culpable	OR	Chi squared	p-level
BAC	≥0.01%	User	3	2	0.98	0.00	0.983
		Control	0	0			
	≥0.05%	User	1	2	2.94	0.82	0.365
	≥0.11%	User	1	0			
THC	≥1ng/ml		6	5	1.23	0.10	0.752
	≥4ng/ml		4	3	1.10	0.02	0.902
	≥10ng/ml		2	0			
BAC≥0.01% & THC≥1ng/ml			0	1			
Stimulants			0	1			
Other			0	1			
Sober		User	50	34			
		Control	34	33			

The risk of being culpable for a dangerous traffic situation when driving under the influence of alcohol (BAC≥0.01%, BAC≥0.05%, BAC≥0.11%), cannabis (THC≥1ng/ml, THC≥4ng/ml, THC≥10ng/ml), alcohol and cannabis (BAC≥0.01% and THC≥1ng/ml), stimulants or substance combinations other than alcohol and cannabis is not increased. The corresponding chi squares did not reach significance.

Table 50: Number of self-inflicted dangerous traffic situations (Culpable) and number and percentage of users (N_{User}=195) and controls ($N_{Control}$=100) that were responsible for.

Culpable	User		Control		Total	
$N_{Dangerous\ traffic\ situations}$	$N_{Subjects}$	%	$N_{Subjects}$	%	$N_{Subjects}$	%
0	158	81%	73	73%	231	78.3%
1	30	15.4%	23	23%	53	18%
2	7	3.6%	3	3%	10	3.4%
4	0	0%	1	1%	1	0.3%

Of the users, 158 subjects (81%) had no dangerous traffic situation that they were responsible for. 30 users (15.4%) had one, and 7 (3.6%) had two such occasions. Of the controls, 73 subjects (73%) had no dangerous traffic situations they were responsible for, 23 (23%) had one, 3 (3%) had two and one control subject (1%) had four such incidences (Table 50). It was analysed if those who had at least one dangerous traffic situation that was caused by the subjects' own fault had more violations against the law by committing drives under the influence of illegal substances and/or a BAC above the legal limit while participating in the study (Figure 64).

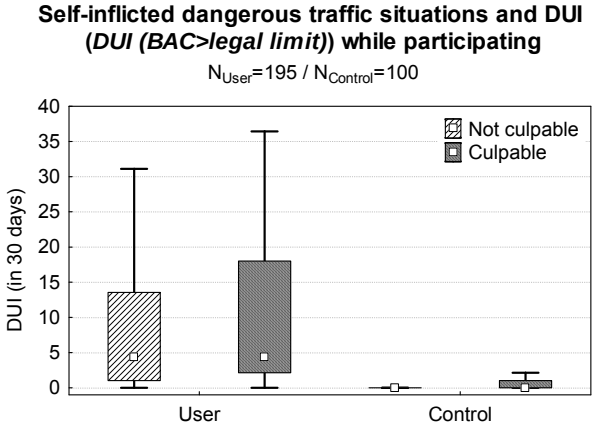


Figure 64: Drives under influence in 30 days while participating in the study (DUI (BAC>legal limit)) for users (N_{User}=195) and controls ($N_{Control}$=100) depending on whether or not the subjects had at least one dangerous traffic situation they were responsible for) (Median, 25%-75%, Range without outlier).

For controls the difference reached significance (MWU: Z(1;100)=2.49; p=0.013), but the effect was very small (Culpable controls: MD=0; Q25=0; Q75=1.03; Not culpable controls: MD=0; Q25=0; Q75=0). Users who had at least one self-inflicted dangerous traffic situation did not commit more drives under influence as compared to those who had no self-inflicted dangerous traffic episode.

The calculated odds ratios that describe the risk of having a dangerous traffic situation or being culpable in the case of a dangerous traffic situation suggest no increased risk for driving under influence. Subjects who were culpable for a dangerous traffic situation while participating were not conspicuous with respect to the frequency of drives under influence while participating in the study.

11.7.11 Influence of road traffic regulations

In Germany, there are two BAC limits for the operation of a vehicle that are found in the German Road Traffic Act (StVG):

- **Zero tolerance (0.00%)** for novice drivers, all drivers between the ages of 18 and 21 years and newly licensed drivers of any age for the first two years of having a licence,
- **0.05%** for all other drivers.

To make assumptions about the potential influence of current road traffic regulations on the occurrence of drug driving, the 18-24-year-old sample was analyzed regarding the influence of the current legal BAC on the following parameters:

- percentage of BAC-positive drives of all drives,
- total alcohol dose consumed within the study period, and
- total number of episodes with alcohol consumption within the study

Table 51 shows the number of subjects within the study sample for which the two BAC-levels were valid, separated according to their assignment to study group and age group.

Table 51: Sample size for legal alcohol limits depending on study group and age group (N=295).

		Legal BAC limit		
Study group	**Age group**	**0.05%**	**0.00%**	**Total**
User	**18-24**	50	67	
	25-29	49	1	
	30-39	27	1	
	Total	126	69	195
Control	**18-24**	27	28	
	25-29	26	0	
	30-39	19	0	
	Total	72	28	100

Since the data distribution of the analysed variables was not normal, rank order tests were applied (Mann-Whitney U-test). While the current legal BAC limit (BACLimit: 0.00% vs. 0.05%) had no influence on the total alcohol dose and the total number of alcohol consuming episodes within the study period, the percentage of BAC-positive drives of all drives was higher for those 18-24-year-olds for whom the legal BAC limit was 0.05% compared to those for whom the legal BAC limit was 0.00% (MWU: $Z(1;172)=2.10$; $p=0.036$). Furthermore, it was analyzed if the study group (users vs. controls), gender (male vs. female) or residence (rural vs. urban vs. city) had an influence on the proportion of BAC-positive drives beyond the legal BAC limit.

Kruskal Wallis H-Tests and Mann-Whitney U-tests were applied to test the influence of study group, gender, and residence on the percentage of positive BAC-drives. A significant result was found for study group (MWU: $Z(1;172)=4.14$; $p=0.000$). Possible interactions were analyzed according the testing procedure explained in Chapter 11.5.2. Because of the positive interaction found for Gender*BACLimit ($L(1;171)=4.64$; $p=0.031$) and an interaction by trend for Study group*BACLimit ($L(1;171)=3.85$; $p=0.050$), the analysis was conducted for the different levels of each factor.

When the 0.05% limit is considered, users and controls do not differ in their proportion of BAC-positive drives whereas they do when the 0.00% limit applies (MWU: Z(1;95)=4.43; p=0.000) (Figure 65 left). This results from a significant decrease in BAC-positive drives in the control group (MWU: Z(1;55)=3.86; p=0.000). The users did not drive less often under the influence of alcohol when the 0.00% limit applies compared to when the 0.05% level applies. Males have more BAC-positive drives than females when the 0.05% limit applies (MWU: Z(1;77)=2.20; p=0.028). No difference is found when the 0.00% limit applies (Figure 65 right). Males drove less often with a positive BAC when the 0.00% limit applies compared to when the 0.05% limit applies (MWU: Z(1;113)=3.23; p=0.001) whereas the proportion of positive BAC drives is low in both conditions for females.

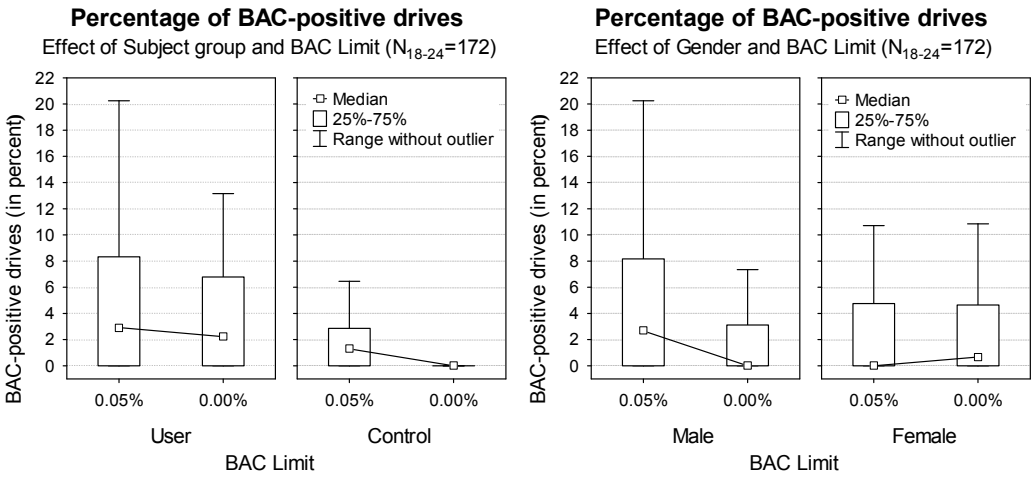


*Figure 65: Effect of Subject group*BAC Limit and Gender*BAC Limit on percentage of BAC-positive drives of all drives of the 18-24-year-old sample (N_{18-24}=172) (Median, 25%-75%, Range without outlier).*

The results show that the legal BAC limit has an effect on the occurrence of BAC-positive drives, but not for each considered group of subjects. Control persons and males reduce their BAC-positive drives according to the applied legal BAC whereas females and drug users do not. The former have a low number of drives under influence anyway, the latter often drive under influence independent of the height of the legal BAC limit.

11.7.12 Decisions against driving under influence

11.7.12.1 Frequency

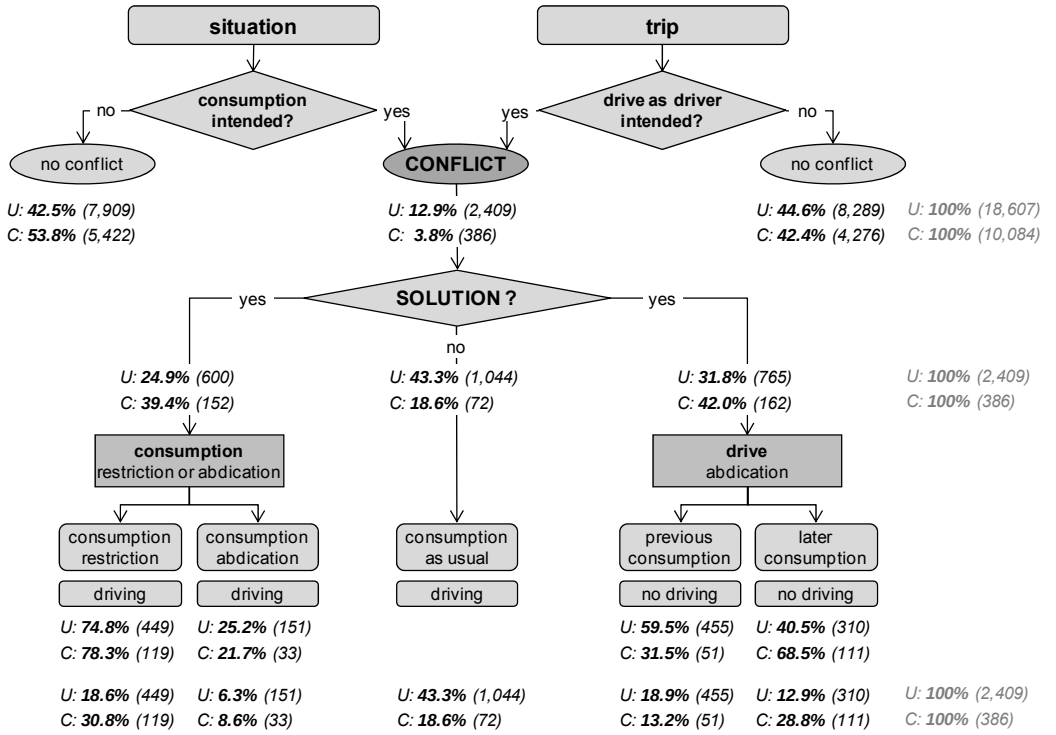
The present chapter will focus on trips that were travelled after the subjects decided against driving under influence by either abstaining from drug use because of a subsequent drive or from driving because of former or intended drug use. In Chapter 7.1.2 it was elaborately described how this substance use and driving interaction was queried.

In the case of a drive, the subjects had to declare if they had previously consumed any impairing substance (response option 1), regardless of the subsequent drive, or if they were indeed concerned about the drive and either restricted (response option 2) or abandoned consumption before driving (response option 3). If the consumption was not associated with the drive at all, i.e. the drive was no drive under influence and the subject did

not abstain from substance use because of the drive, a fourth, neutral response option was chosen.

In the case of a trip that was not travelled as driver of a motor vehicle, the subjects had to declare if they abstained from driving because of former substance use (response option 1) or because they intended to use impairing substances later on (response option 1). If the trip was not associated with drug use at all, this was indicated by a third, neutral response option. Figure 66 shows the absolute numbers and percentages of all conditions for users (N_{User}=195) and controls ($N_{Control}$=100). Trips that were not associated with driving under influence at all are indicated as trips that imply no conflict (*no conflict*). If trips were either drives under influence or the subjects consciously decided against driving under influence by either refraining from substance use or by refraining from driving, the trips are indicated as *conflicts*.

Figure 66: Absolute number and percentages of all drug and drive combinations separated for conflict situations and situations that imply no conflict for users (N_{User}=195) and controls ($N_{Control}$=100).



The users had far more conflicts (12.9% of all users' trips) than the controls (3.8% of all controls' trips). This is due to more drives that were consciously travelled under influence (Users: 43.3% of all users' conflicts; controls: 18.6% of all controls' conflicts). The controls more often refrained from alcohol consumption (8.6% of controls' conflicts) or consumed less alcohol than usually intended because of driving (30.8% of controls' conflicts) compared to the users (Consumption restriction: 18.6% of users' conflicts, consumption abdication: 6.3% of users' conflicts). Additionally, controls more often refrained from driving because of consumption compared to users (Controls: 42% of controls' conflicts, users: 31.8% of users' conflicts). Whereas users in general decided against driving after previous consumption (59.5% of all users' drive abdication conflicts), the controls solve a conflict more often by deciding against driving before consumption had already taken place (68.5% of all controls' drive abdication conflicts).

The question arises whether this difference is caused by different decision strategies or simply by different consumption patterns. Cannabis was the main illegal drug that was used by the users. It was used all day long whereas alcohol was mostly used in the evenings and at night (Chapter 11.5.1). Moreover, illegal drugs were mostly consumed at home (63.1%) whereas alcohol was consumed at home in only 25.3% (Controls) to 29% (Users) of the cases. 70.3% of the users' trips that were not travelled by a vehicle because of previous consumption were positive for illegal drugs and in 53.4% of these cases the place of departure was at home. When the subjects exclusively had a positive BAC, the place of departure was only in around 30% of the cases at home, no matter if users or controls are considered (users=31.1%; controls=33.3%). In the case the subjects decided not to drive in advance, the place of departure was in most of the cases at home (users=88.1%; controls=88.3%). This suggests that the difference between users and controls in deciding against driving because of consumption stems from the fact that the users were already under influence when going out which was caused by a higher consumption rate and because they consume more often at home than in public places.

Furthermore, the users had 1,493 drives for which they indicated that they used drugs beforehand (1,044 without restriction and 449 after restricted substance use). The controls had 191 drives under influence of alcohol according to the subjective statements for each drive (72 without restriction and 119 after restricted alcohol use). This does not correspond to the number of drives under influence found by the more objective concentration-based classification according to the consumed dose and time between consumption and driving (Chapter 11.7.2).

Figure 67 illustrates the difference between the number of objectively and subjectively classified drives under influence for users and controls. The subjective statement was set to 100% to point out an under- or overstatement of drives under influence compared to the number of drives under influence that were identified by the objective method applied in Chapter 10. When the users stated that they consumed impairing substances before driving, in most of the cases (70%) they did not restrict the consumption (Figure 67 left, bar #1). Controls restricted alcohol consumption in 60% of the cases (Figure 67 right, bar #1). The users had far more substance-positive drives than they stated they had (Figure 67 left, bar #2). The difference becomes smaller when only those drives are regarded as drives under influence that were positive for any illegal drug and/or were travelled with a BAC above the legal limit (Figure 67 left, bar #3). The controls reported more drives under influence than they actually had according to the objective classification (Figure 67 right, bar #2). The over reporting becomes even higher when only those drives were regarded that were travelled with a BAC above the legal limit (Figure 67 right, bar #3) and was still present when the number of subjective statements is reduced to non-restricted alcohol use (Figure 67 right, bar #1).

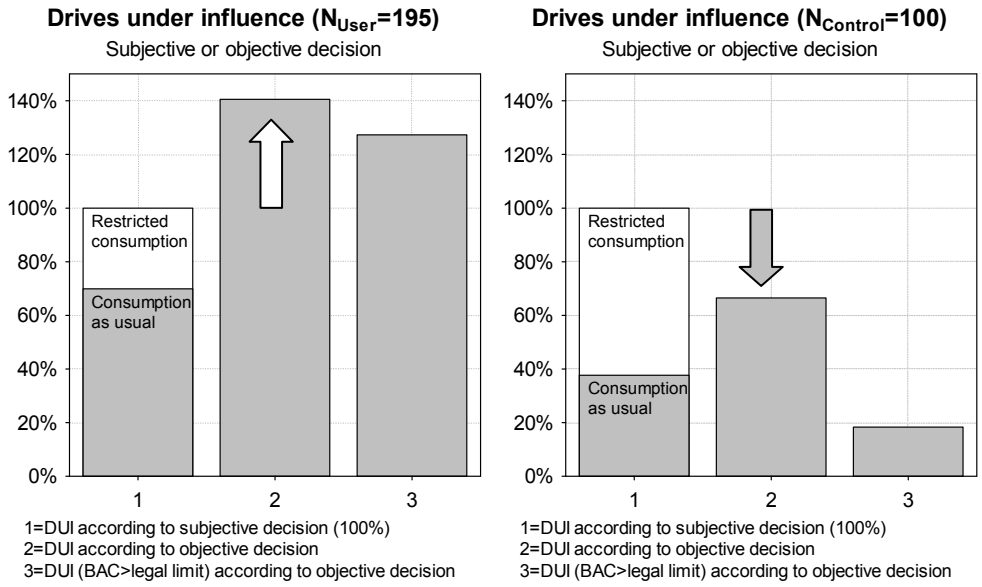


Figure 67: Occurrence of DUI according to subjective and objective decision for users (N_{User}=195) and controls ($N_{Control}$=100).

The users' underreporting of drives under influence could either be due to being unaware of being under influence or due to playing the incidences down. Especially when travelling with a low BAC or THC blood plasma level or when travelling after longer time periods between consumption and driving, the subjects could state that they are not under influence even if they actually are. Controls reported more drives under influence than found in the objective data and stated more often that they reduced alcohol consumption because of a forthcoming drive. This could indicate that they, in general, travel with increased cautiousness and reduced alcohol consumption to the extent that they were again sober by the time of the drive.

11.7.12.2 Level of intoxication

In this chapter the BAC, THC blood plasma level, and the time between last stimulants consumption and driving is shown for the different response options of the question concerning the reason for not driving (*previous consumption*, *later consumption*, *other reason*), and for each response option to the question about the intention to drug drive when a drive was reported (*no consumption*, *consumption as usual*, *consumption abdication, restricted consumption*). No concentration calculation was possible for stimulants. In the case of stimulants, no mathematical model about the relationship between consumed dose, consumption time, elimination, and blood concentration exists. Therefore, the time between the last consumption of stimulants and driving was used to analyse how the level of intoxication influences decisions about driving. The different substances were analysed separately. For each analysis only those drives were included that were either sober or positive for the substance in question (independent of a positive value for any other substance).

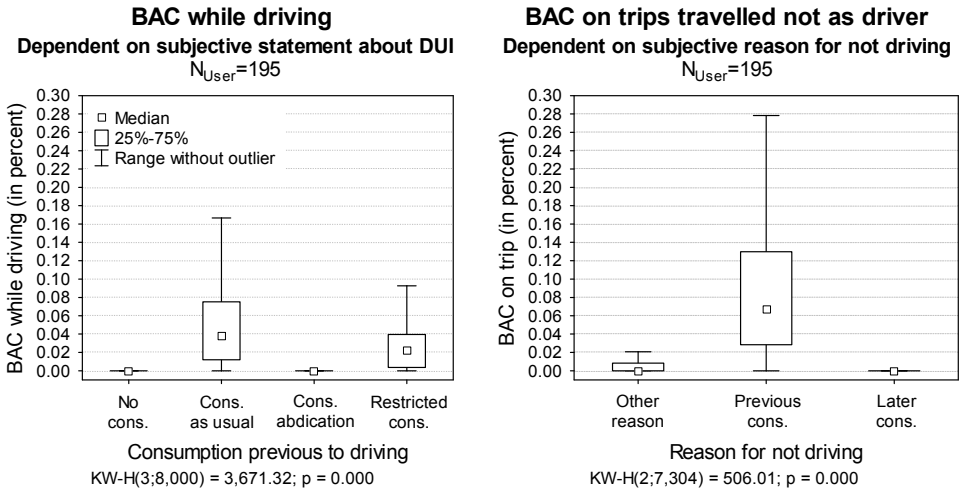


Figure 68: BAC on trip dependent on the subjective statement of the users (N_{User}=195) about consumption previous to driving (no consumption, consumption as usual, consumption abdication, restricted consumption) and reason for not driving (other reason, previous consumption, later consumption) (Median, 25%-75%, Range without outlier).

When the users stated that they had used impairing substances before driving (*cons. as usual*), 50% of the corresponding BACs were above 0.04% and 50% beneath (Figure 68 left). When they restricted previous consumption (*restricted cons.*), the median BAC was 0.02%. The highest BACs were found for trips that were not travelled as driver of a vehicle because of previous consumption (*previous cons.*). The median BAC was 0.07% in this case (Figure 68 right).

When the users stated that they did not use drugs before driving (*no cons.*, *cons. abdication*), the majority of the corresponding BACs were zero. But 215 drives out of 7,548 (2.8%) were with a BAC higher than 0.01%. 188 of these 215 (87.4%) drives were positive because of alcohol consumption on the previous day. Because the consumption was dated to further in the past, the users might have thought they were sober but actually were not.

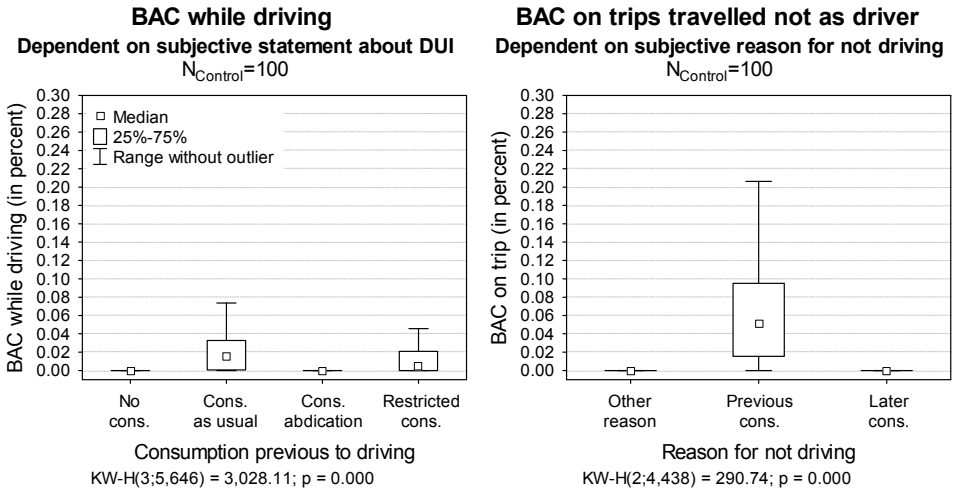
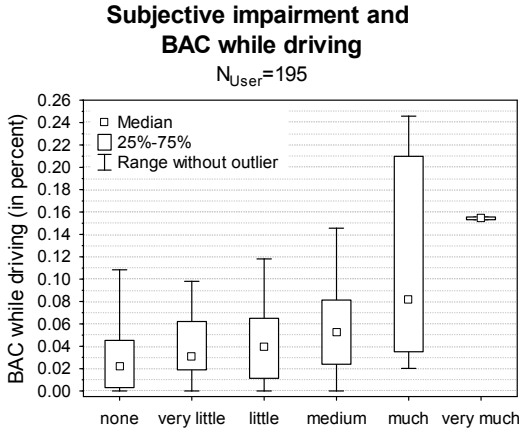


Figure 69: BAC on trip dependent on the subjective statement of the controls ($N_{Control}$=100) about consumption previous to driving (no consumption, consumption as usual, consumption abdication, restricted consumption) and reason for not driving (other reason, previous consumption, later consumption) (Median, 25%-75%, Range without outlier).

When the controls stated that they drank alcohol before driving (*cons. as usual*), 50% of the corresponding BACs were above 0.02% and 50% beneath (Figure 69; left). When they restricted previous consumption (*restricted cons.*), the median BAC was 0.01%. The highest median BAC was found for trips that were not travelled as driver of a vehicle because of previous consumption (*previous cons.*). The median BAC was 0.05% in this case (Figure 69; right).

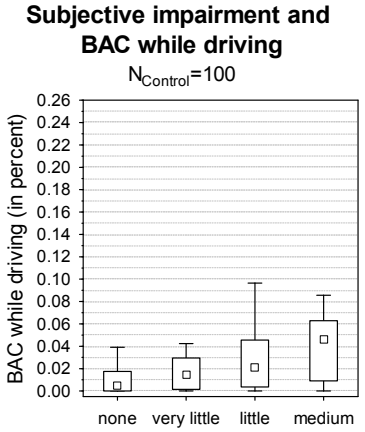
When the controls stated that they did not drink alcohol before driving (*no cons.*, *cons. abdication*), the greatest part of the corresponding BACs was negative. For 33 drives out of 5,455 (0.6%), a BAC higher than 0.01% was found. 29 of these 33 (87.9%) drives were positive because of alcohol consumption on the previous day.

So, when the subjects, regardless whether users or controls are considered, consciously drove after alcohol consumption (*cons. as usual*), the median BAC was below the main legal BAC limit of 0.05% (users: 0.04%; controls: 0.02%). When they restricted alcohol consumption because of driving (*restricted cons.*), the median BAC was even lower than 0.03%, which is the BAC limit in Germany by which a person can even be prosecuted for drink driving (users: 0.02%; controls: 0.01%). When the subjects refrained from driving because of alcohol consumption (*previous cons.*), the median BAC was as high as or higher than the main legal BAC limit in Germany (users: 0.07%; controls: 0.05%). When subjects were travelling under the influence of alcohol and were not aware of it (*no cons.*, *cons. abdication*), the positive BAC mainly stemmed from alcohol consumption on the previous day.



Percent (number) of drives in each condition (users)

none	very little	little	medium	much	very much
56.9% (257)	18.1% (82)	15% (68)	6.9% (31)	2.7% (12)	0.4% (2)



Percent (number) of drives in conditions (controls)

none	very little	little	medium
65.4% (125)	19.9% (38)	12% (23)	2.6% (5)

Figure 70: BAC on drive dependent on the subjective impairment of users (N_{User}=195; left) and controls ($N_{Control}$=100; right) (Median, 25%-75%, Range without outlier).

For each drive the subjects indicated that they had used impairing substances beforehand (either restricted or not) they were also asked how impaired they felt while driving (*none*, *very little*, *little*, *medium*, *much*, *very much*). Figure 70 shows the median BAC of users (left) and controls (right) on drives that were stated as drives after restricted or not restricted substance consumption for the different impairment categories. When the users

felt no impairment, they had a median BAC of 0.02%, the controls had a median BAC of 0.01%. When the users felt very little impaired, they had a median BAC of 0.03%, the controls had a median BAC of 0.02% . When both users and controls felt medium impairment, 50% of the corresponding BACs were above 0.05% and 50% beneath. The controls never felt much or very much impaired while driving after alcohol consumption. When the users stated that they felt much impaired, the median BAC was 0.08%. When the impairment was given the rating very much, the median BAC was 0.15%. So, the higher the BAC was while driving, the more the subjects felt impaired.

When considering the different consumption groups separately (controls not included), it became obvious that lower consumption in general leads to higher subjective impairment levels. While the moderate users felt at least a medium impairment in 17.3% (18 out of 104) of BAC-positive drives, this percentage is lower for heavy users (9.3%; 20 out of 216), and the lowest for excessive users (5.3%; 7 out of 132). A medium positive correlation between objective intoxication and subjective impairment was found for moderate (r=0.41) and heavy users (r=0.36). For excessive users, the correlation was zero (r=0.00). For moderate alcohol users a medium impairment correlates with a median BAC of 0.03%, for heavy users the corresponding value is 0.05% and for excessive users 0.08%.

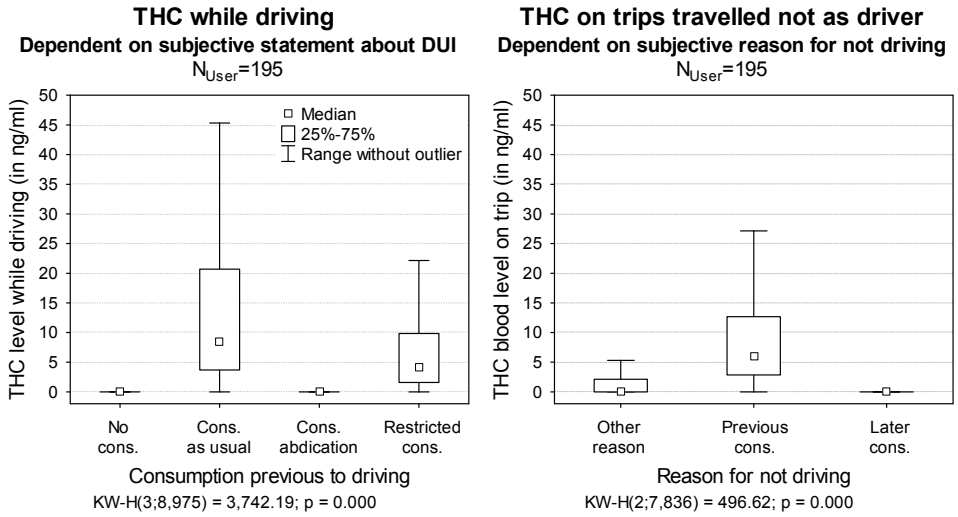
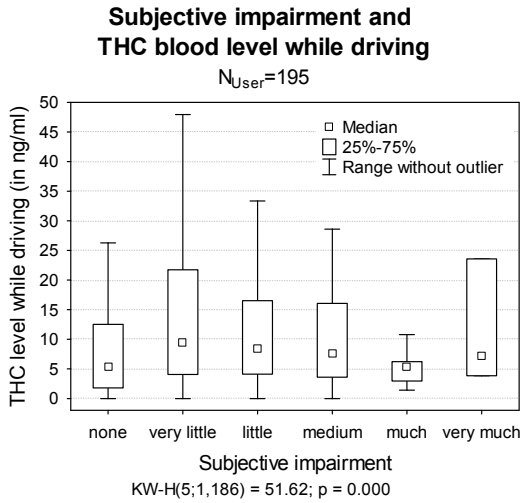


Figure 71: THC blood plasma level on trip dependent on the subjective statement of the users (N_{User}=195) about consumption previous to driving (no cons., cons. as usual, restricted cons., cons. abdication) and reason for not driving (other reason, previous cons., later cons.) (Median, 25%-75%, Range without outlier).

When the users stated that they used impairing substances before driving (*cons. as usual*), 50% of the corresponding THC blood plasma levels were above 8ng/ml and 50% beneath (Figure 71, left). When they restricted previous consumption (*restricted cons.*), the median THC blood plasma level was 4ng/ml. For trips that were not travelled as driver of a vehicle because of previous consumption (*previous cons.*), a median THC blood plasma level of 6ng/ml was found (Figure 71, right). Unlike in the case of conscious alcohol-positive drives, many rather high substance blood levels were found in the case of conscious THC-positive drives (*cons. as usual*). Most of these consciously impaired drives (61.2%) were travelled by excessive cannabis users, 23.6% by heavy users, and 15.2% by moderate users. The excessive users had far more THC blood plasma levels of 8ng/ml and higher while driving compared to the other two consumption groups (excessive user: 72%, heavy users: 36.3%, moderate users: 23.8%).

When the users stated that they did not use drugs before driving (*no cons.*, *cons. abdication*), the majority of corresponding THC blood plasma levels was zero. Nevertheless, for 456 drives out of 7,789 (5,9%) a THC blood plasma level higher than 1ng/ml was found. 147 of these drives (32.2%) were entirely caused by cannabis consumption from the previous day. 18 (3.9%) took place within one hour after cannabis consumption, 123 (27%) within one to three hours after cannabis consumption and the remaining 168 (36.8%) drives took place more than three hours after consumption.



Number of drives within each condition (users)

	none	very little	little	medium	much	very much
	43.4% (515)	29.1% (345)	18.6% (221)	7.4% (88)	1.2% (14)	0.3% (3)
Moderate users	46.3% (130)	18.5% (52)	19.6% (55)	11.4% (32)	3.9% (11)	0.4% (1)
Heavy users	40.9% (119)	35.1% (102)	14.1% (41)	8.9% (26)	0.3% (1)	0.7% (2)
Excessive users	43.3% (266)	31.3% (191)	20.4% (125)	4.9% (30)	0.3% (2)	0% (0)

Figure 72: THC blood plasma level on drive dependent on the subjective impairment of users (N_{User}=195) (Median, 25%-75%, Range without outlier).

Figure 72 shows the THC blood plasma level on drives that were stated as drives after restricted cannabis consumption or consumption that was not restricted for the different impairment categories (N_{User}=195). In contrast to alcohol, no dose-dependent impairment level was found. Regardless if the users felt no impairment or felt very much impaired, the corresponding median THC blood plasma levels ranged between four and 10ng/ml.

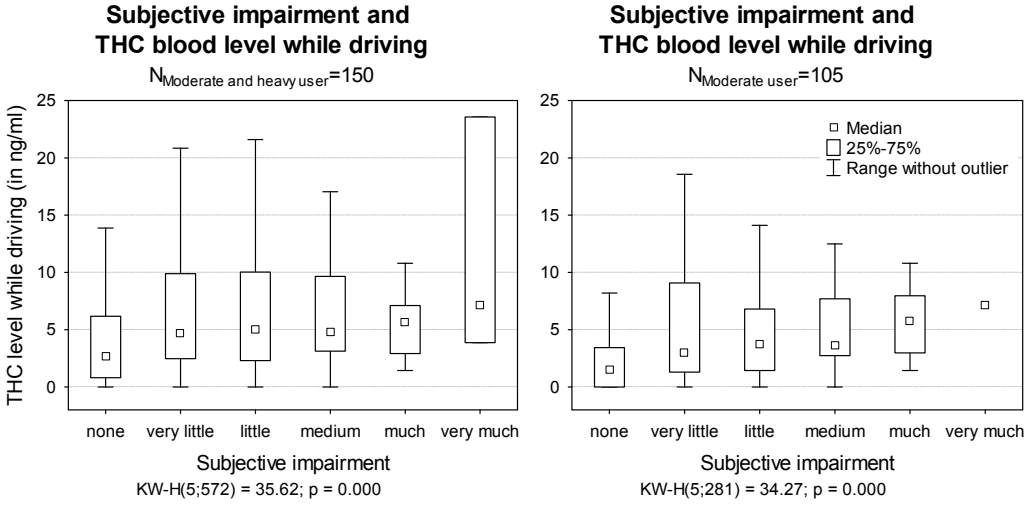


Figure 73: THC blood plasma level on drive dependent on the subjective impairment of moderate and heavy users ($N_{Moderate\ and\ heavy\ user}$=150) and of moderate users alone ($N_{Moderate\ user}$=105) (Median, 25%-75%, Range without outlier).

When considering the different consumption groups separately, it became obvious that lower consumption in general leads to higher subjective impairment levels. While the moderate users felt at least a medium impairment in 15.7% (44 out of 281) of their THC-positive drives, this percentage is lower for heavy users (10%; 29 out of 291) and the lowest for excessive users (5.2%; 32 out of 614). When the excessive users are excluded or only moderate cannabis users are taken into account, a dependence of THC blood plasma level and impairment comparable to alcohol can be found (Figure 73).

The correlation between objective intoxication and subjective impairment was lower than in the case of alcohol. A small correlation between objective intoxication and subjective impairment was found for moderate (r=0.18) and heavy users (r=0.15). For excessive users again, no correlation was found (r=0.09). For moderate cannabis users a medium impairment correlates with a median THC blood plasma level of 3.7ng/ml, for heavy users the corresponding value is 7.5ng/ml and for moderate users alone 18ng/ml.

When the users stated that they used impairing substances before driving (*cons. as usual*), the median time between stimulants consumption and driving was two hours (Figure 74, left). When they restricted previous stimulants consumption (*restricted cons.*), the median time delay was six hours. In the case of abdication from driving because of previous consumption (*previous cons.*), the last stimulants consumption was only three hours prior to the trip (Figure 74, right).

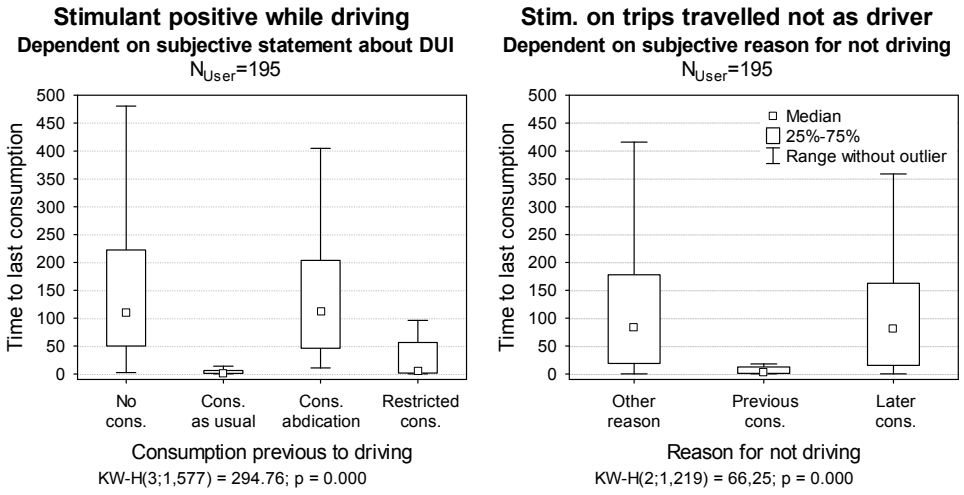


Figure 74: Time between last stimulant consumption and trip dependent on the subjective statement of the users (N_{User}=195) about consumption previous to driving (no cons., cons. as usual, cons. abdication, restricted cons.) and reason for not driving (other reason, previous cons, later cons.) (Median, 25%-75%, Range without outlier).

When the users stated that they did not use drugs before driving (*no cons.*, *cons. abdication*), in most of the cases the drives were classified as stimulant-negative and the last consumption of stimulants was 100 hours or more ago. Anyhow, 84 drives out of 7,417 (1.1%) were positive for stimulants. For 45 of the 84 (53.6%) drives, the stimulants consumption took place 12 hours or more in the past.

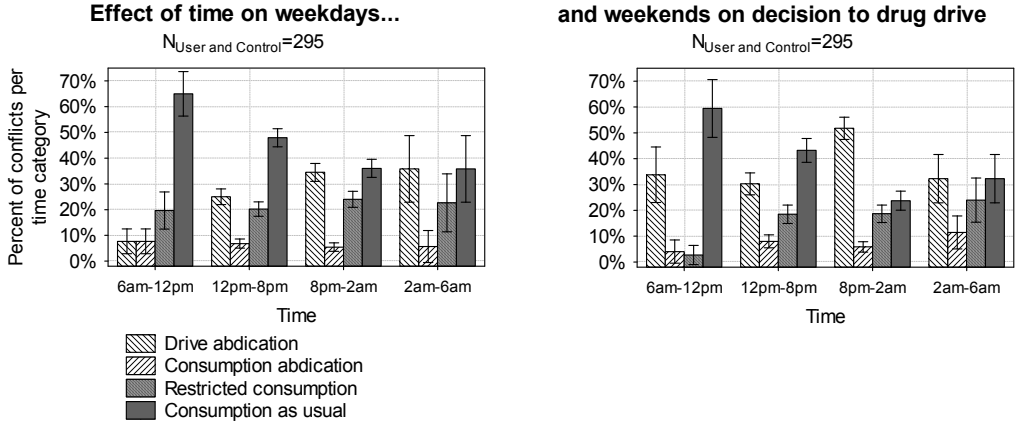
For alcohol, a dose-dependent decision making according to the current legal restrictions in Germany and, for moderate and heavy alcohol users, a dose-dependent subjective impairment (median BAC for medium impairment: 0.03%-0.05%) was found. The subjec-

tive impairment of excessive alcohol users did not correlate with the objective intoxication. A dose-dependent impairment was also found for moderate to heavy cannabis users (median THC blood plasma level for medium impairment: 4-8ng/ml) whereas excessive users felt highly impaired rather seldom but committed drug driving with rather high THC blood plasma levels. It was also found that the subjects are usually not aware of driving under influence when the consumption took place further back in time, especially when the consumption took place on the previous day.

11.7.12.3 Situational aspects

In this chapter it will be analysed if there are any route specific differences between the drives that were travelled under the influence consciously (*consumption as usual*), drives that were travelled after reduced consumption (*restricted consumption*) and trips for which the subjects stated having abdicated driving under influence by either abstaining from substance use (*consumption abdication*) or abstaining from driving (*drive abdication*: *previous consumption, later consumption*). These conditions were classified as *conflicts* (Chapter 11.7.12.1).

In total, 7.8% of all trips on weekdays were conflicts – the subjects either decided against driving under influence by refraining from substance use or from driving or drove after consuming impairing substances. On weekends 15.1% of all trips were such conflict situations. The time of the day had a clear influence on the decision to drive under influence (Figure 75).



Number of conflicts within each condition (weekdays)

6am-12pm	12pm-8pm	8pm-2am	2am-6am
7% (117)	46.7% (776)	43.1% (716)	3.2% (53)

Number of conflicts within each condition (weekends)

6am-12pm	12pm-8pm	8pm-2am	2am-6am
6.5% (74)	39.6% (449)	45.4% (514)	8.5% (96)

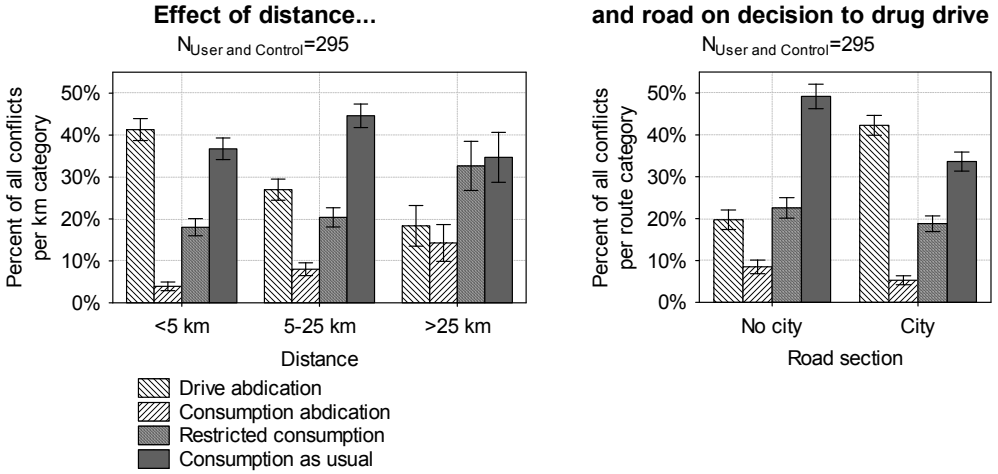
Figure 75: Effect of time (6am-12pm, 12pm-8pm, 8pm-2am, 2am-6am) on weekdays and weekends on the decision to drive after the consumption of impairing substances of users and controls ($N_{User\ and\ control}$=295) – percentage of conflicts per category (±0.95 CI).

If a conflict situation occurred between 6am and noon, the subjects decided to drive (*consumption as usual*) in around 60% of the cases whereas later on the proportion of refraining from driving increased (*drive abdication*). The proportion of trips that were travelled after *restricted consumption* or *consumption abdication* was relatively constant over time on weekdays. On weekends, the proportion of these trips increased in time. On weekends, the subjects more often refrained from driving compared to weekdays (*drive abdi-*

cation), especially from 6am until noon and from 8pm until 2am. At all other times, weekdays did not differ remarkably from weekends.

When short trips were travelled, 9.3% of the trips were conflicts. Of all trips of a medium distance, 10.4% were conflicts and long-distance trips had in 9.4% of the cases a conflict involved. So, the length of the trip had no influence on the proportion of conflicts. But when short trips were travelled the proportion of abstaining from driving (*drive abdication*) is higher than when longer trips are travelled (Figure 76, left). By contrast, the proportion of *restricted consumption* or *consumption abdication* becomes higher the longer the covered distance was. The proportion of conscious drives under influence (*consumption as usual*) was highest for drives with a distance of five to 25 km.

Furthermore, it was analysed if there are any differences between city trips (*City*) and out of city trips (*NoCity*) (Figure 76, right). No information was available about the proportion of the different road sections for trips that were not travelled by a motor vehicle. The distribution of all city drives and out of city drives with respect to their length indicates that drives shorter than 10 km are in 78% of the cases city drives whereas drives of 10 km and more are in 75% of all cases out of city drives. So, this kilometre classification was applied for trips for which no road section classification was available. Of the city trips, 8.5% were conflicts. When it comes to out of city trips, the percentage of conflicts on all trips was higher. Here 12.4% of all trips were conflicts. The proportion of decisions against drug driving was much smaller on out of city trips compared to city trips. Within cities especially the *abdication of driving* is very common whereas the proportion of refraining from consumption (*consumption abdication*) or *restricted consumption* is comparable between city and out of city sections. This is surely due to shorter distances within cities compared to rural areas and approves the effect found for the covered distance of the trips.



Number of conflicts within each km category

< 5 km	5-25 km	> 25 km
48.4% (1,353)	42.8% (1,197)	8.8% (245)

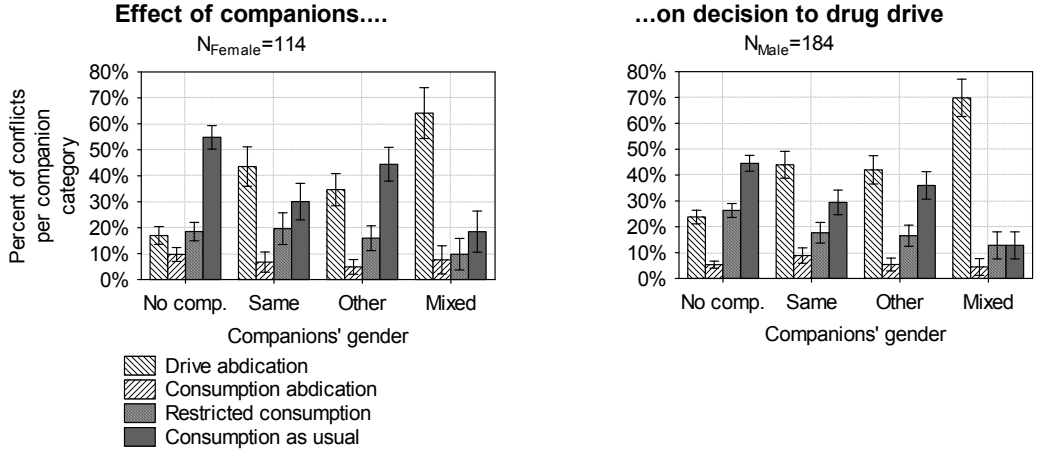
Number of conflicts within each road category

No city	City
40.4% (1,130)	59.6% (1,665)

Figure 76: Effect of distance and road section on the decision to drive after the consumption of impairing substances of users and controls ($N_{User\ and\ control}$=295) – percentage of conflicts per category (±0.95 CI).

In total, 10.6% of the male subjects' trips were conflicts – they either decided against driving under influence or consciously drove under influence. Female subjects had 8.4%

of their trips stated as conflict situations. Female subject, when facing a conflict situation, more often stated that they drove after consumption (*consumption as usual*) compared to males (Figure 77).



Number of conflicts within each condition (female)

No comp.	Same	Other	Mixed
49.2% (465)	17.3% (163)	23.8% (225)	9.7% (92)

Number of conflicts within each condition (male)

No comp.	Same	Other	Mixed
55.7% (1,030)	18.9% (350)	17% (314)	8.4% (156)

Figure 77: Effect of companions (no companions, same gender, other gender, mixed gender) on the decision to drive after the consumption of impairing substances of females (N_{Female}=114) and males (N_{Males}=184) – percentage of conflicts per category (±0.95 CI).

Companions had a clear influence on decisions against driving under influence. When companions of mixed gender were accompanying the driver, both male and female drivers decided more often not to drive after consumption than driving (*drive abdication*). They drove most often – after *restricted* or *usual consumption* – when they travelled alone, especially female subjects, followed by trips travelled with companions of the other sex. Here, especially females consciously drove after consumption (*consumption as usual*) whereas males more often refrained from driving (*drive abdication*). When companions of the same gender were travelling along, no differences between male and female drivers became apparent.

11.7.12.4 Influence of consumption and driving frequency

One of the users and 24 controls had no conflict situation at all while participating in the study of which nine controls drank no alcohol at all. Another control person refrained from consumption because of driving twice while participating, but did not drink alcohol and was therefore not classified as moderate, heavy or excessive user. These 26 subjects were excluded from the following analysis. To analyse whether or not the amount of substance use of the remaining subjects has an influence on the decision to drive under influence, the consumption groups concerning alcohol and cannabis were combined. The highest categorization out of the two consumption groups was chosen for each subject. If e.g. a subject is a moderate alcohol user and an excessive cannabis user, the person was classified as excessive user. For the controls the alcohol classification was used.

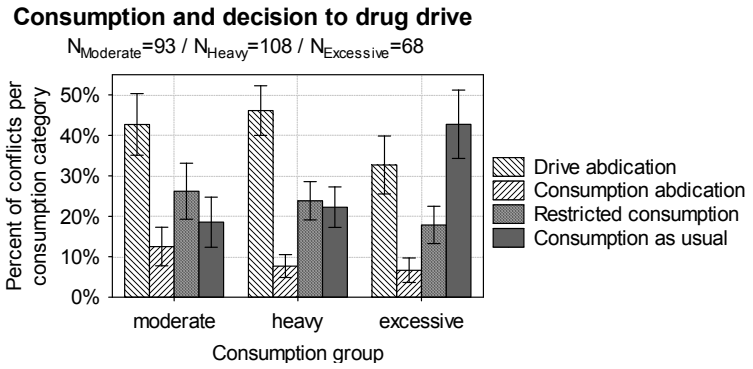


Figure 78: Effect of consumption group (moderate, heavy, excessive alcohol and/or cannabis user) on the decision to drive after the consumption of impairing substances ($N_{Moderate}$=93 / N_{Heavy}=108 / $N_{Excessive}$=68) – mean percentage of conflicts per category (±0.95 CI).

In general, the excessive users had the most conflict situations of all and the moderate users the fewest[44]. The consumption group had a clear effect on the decision to drive after consumption (Figure 78). The highest proportion of conscious drives under influence was found for excessive users (*consumption as usual*). They also less often *restricted* or *abdicated consumption*. The proportions of heavy and moderate users do not differ much. Heavy users marginally more often *abdicated driving* and moderate users marginally more often *abdicated consumption*.

Daily drivers had slightly more conflict situations than weekly drivers . But this difference didn't reach significance (MWU: Z(1;295)=1.74; p=0.081). Daily and weekly drivers with at least one conflict situation did not differ in their proportion of driving after consumption in conflict situations (*consumption as usual*) (Figure 79). However, they differed in their proportion of *abdicating driving*. Daily drivers abstained less often compared to weekly drivers, yet they *restricted consumption* more often than weekly drivers.

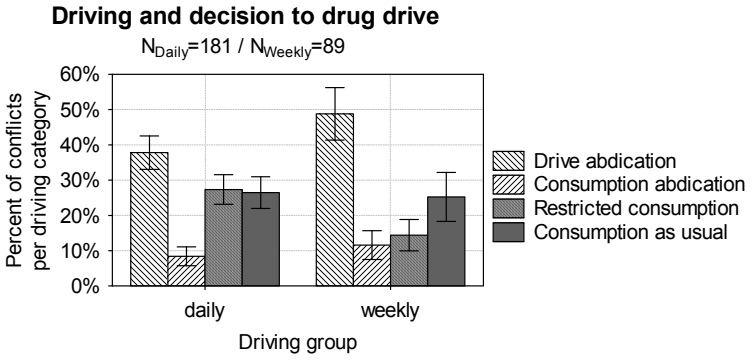


Figure 79: Effect of driving group (daily, weekly) on the decision to drive after the consumption of impairing substances (N_{Daily}=181 / N_{Weekly}=89) – mean percentage of conflicts per category (±0.95 CI).

[44] Excessive-moderate: MWU: Z(1;177)=8.91; p=0.000; excessive-heavy: MWU: Z(1;177)=4.02; p=0.000; moderate-heavy: MWU: Z(1;216)=7.68; p=0.000 (For this calculation the subjects who had no conflict situation were included in the analysis with a value of zero; because of the varying number of available reports per person, the numbers of conflicts were extrapolated to 30 days).

11.7.13 Influence of perceived detection risk

The subjects' evaluation of the probability of getting caught and detected while driving under influence depending on characteristics of the route and on the substance under which the drive was travelled was asked for in a questionnaire at the beginning of the study (Table 52).

Table 52: Q-Start questions concerning detection risk.

Question
In the following question you should estimate the risk of getting stopped by the police on different routes at different times. Please assume that you are driving a five year old VW Golf without attracting attention. How do you estimate the probability of getting caught by the police on the following routes at the stated times (road section: city/city-suburb/suburb/rural, time: 6am-12pm/12pm-8pm/8pm-2am/2am-6am, and weekday: weekday/weekend)? 1=very unlikely, 2=unlikely, 3=likely, 4=very likely **→ Risk of being stopped by police**
Someone drives under the influence of one of the following drugs (1 beer, more than 4 beers, cannabis, amphetamine, ecstasy, LSD/psilocybin, cocaine, opiates, and sedatives) and gets into a police stop. Do the police notice in a roadside stop that the driver is under the influence of drugs? 0=influence definitely does not get detected by the police... 10=influence definitely gets detected **→ Detection risk**

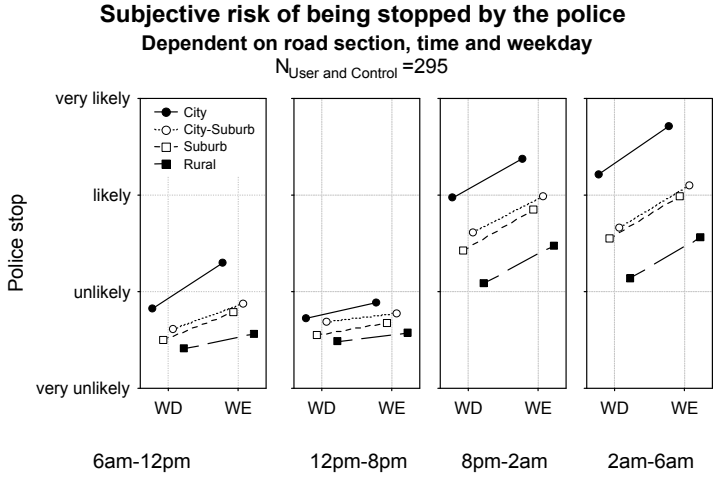


Figure 80: Subjective risk of getting stopped (police stop very unlikely, unlikely, likely, very likely) dependent on road section (city, city-suburb, suburb, rural), time (6am-12pm, 12pm-8pm, 8pm-2am, 2am-6am) and weekday (WD=weekday, WE=weekend) of users and controls ($N_{User\ and\ Control}$=295).

The subjective risk of getting caught by the police was graded higher on weekends than weekdays and higher at night (8pm-6am) than during the day (6am-8pm) (Figure 80). The road section had a clear effect with the highest grades for city roads. Here, the risk of getting stopped in the morning hours (6am-12pm) was also rated relatively high, especially on weekends. The lowest ratings are found for rural areas.

The distribution of drives under influence resembles the distribution of the subjective risk evaluations shown in Figure 80 concerning *time* and *weekday* (Figure 81). The proportion of drives under influence of all drives was higher on weekends than weekdays and higher at night (8pm-6am) than during the day (6am-8pm). The *road section* had a clear effect also, but the effect was contrariwise to the subjective risk evaluations. Regardless of time and weekday, the percentage of drives under influence was always lower for city routes than for rural routes.

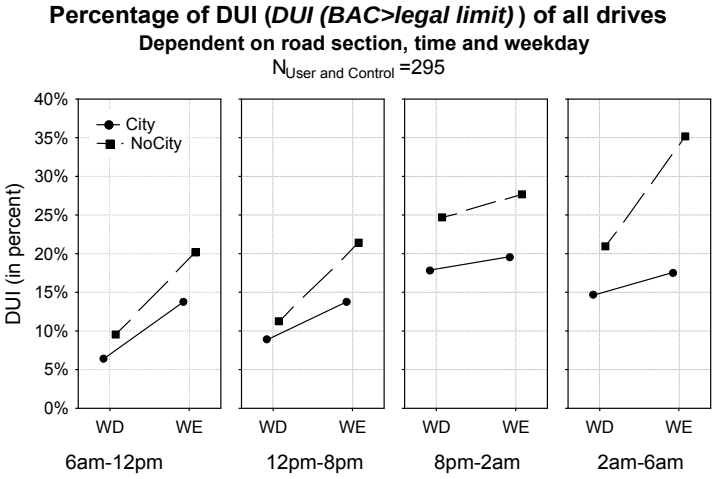


Figure 81: Percentage of DUI (DUI=under influence of any drug and/or BAC>legal limit) dependent on road section (City: percentage of city roads 70% of route and more; NoCity: percentage of city roads less than 70% of route), time (6am-12pm, 12pm-8pm, 8pm-2am, 2am-6am) and weekday (WD=weekday, WE=weekend) of users and controls ($N_{User\ and\ Control}$=295).

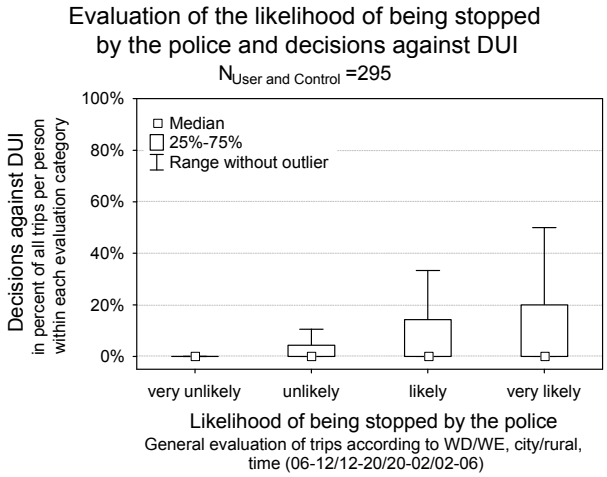


Figure 82: Percentage of decisions against driving under influence of all trips per person according to the subjective evaluation of the likelihood of being stopped by the police ($N_{User\ and\ Control}$=295).

To directly analyse how the estimated probability of getting caught influences the decision to drive under influence, the percentage of trips that were travelled after consciously avoiding driving under the influence of drugs (by either refraining from drug use or by refraining from driving) of all trips was examined with respect to the perceived risk of getting stopped for the different routes (Figure 82)[45]. The more likely the subjects think a police stop will be, the more they avoid driving under influence (KW-H (3;3,145)=56.34; p=0.000).

The subjects do not believe that it is very likely that after drinking one beer or using sedatives or cannabis the police would notice in a roadside stop that the driver is under influence (see Table 53; 0=influence definitely does not get detected by the police... 10=influence definitely gets detected). In contrast to users, control persons believe that the detection risk concerning cannabis is rather high. For drinking more than 4 beers or

[45] Therefore, the individual evaluations of the likelihood of getting stopped by the police according to weekday, route, and time were allocated to each trip depending on weekday, route, and time of the trip.

using any other substance (amphetamine, cocaine, ecstasy, LSD/psilocybin, opiates), the perceived detection risk increases and is the highest for LSD/psilocybin and opiates. Concerning stimulants (amphetamine, cocaine, ecstasy) controls grade the detection risk higher than users. The reported difference reaches significance for cannabis and stimulants (Cannabis: MWU: Z(1;293)=4.27; p=0.000; Stimulants: MWU: Z(1;293)=3.07; p=0.002).

Table 53: Detection risk for different substances of all subjects, of users (N_{User}=193) and controls ($N_{Control}$=100) (0=influence definitely does not get detected…10=influence definitely gets detected).

	MD All	MD Control	MD User	Z	p-level	$N_{Control}$	N_{User}
1 beer	2	2	2	1.10	0.273	99	193
Sedatives	5	6	5	1.73	0.084	100	193
Cannabis	5	7	5	4.27	**0.000**	100	193
More than 4 beers	7	7	8	-0.13	0.900	100	193
Amphetamine	7	8	7	4.22	**0.000**	100	193
Cocaine	7	8	7	4.48	**0.000**	100	193
Ecstasy	8	9	8	2.25	**0.024**	100	193
LSD/psilocybin	9	9	9	-0.65	0.513	100	193
Opiates	9	9	9	-0.18	0.860	100	193

The perceived detection risk had no influence on the number of drives under influence of illegal drugs and/or alcohol above the legal limit within 30 days. An effect was found for gender with regards to the perceived detection risk when drinking 1 beer, more than 4 beers or sedatives. Males believe that it is more likely to be detected when getting stopped by the police after consuming alcohol than females believe (1 beer: MWU: Z(1;292)=3.75; p=0.000; more than 4 beers: MWU: Z(1;293)=4.59; p=0.000). Females believe that it is more likely to be detected when getting stopped by the police after consuming sedatives (MWU: Z(1;292)=2.12; p=0.034). Moreover, 18-24-year-olds think it is more likely to be detected after the consumption of stimulants than 30-39-year-olds (MWU: Z(1;147)=3.24; p=0.001). If effects concerning the residence reached significance, it indicated that people from rural and city areas perceived the detection risk as less likely compared to subjects from urban areas (i.e. the detection of amphetamine, ecstasy, LSD/psilocybin) (amphetamine-rural-urban: MWU: Z(1;219)=2.35; p=0.019; ecstasy-rural-urban: MWU: Z(1;219)=2.15; p=0.032; ecstasy-city-urban: MWU: Z(1;179)=2.71; p=0.007; LSD/psilocybin-rural-urban: MWU: Z(1;219)=2.72; p=0.007; LSD/psilocybin-city-urban: MWU: Z(1;179)=2.07; p=0.038).

12. Discussion

12.1 Study aim and methodological approach

Whereas national and international data about drug use and driving do exist separately (for Germany MiD, ESA), data about driving in combination with information about drug use were not available. In general, roadside surveys are conducted to collect valid information about the prevalence of drug driving within a population. In Germany, the only survey of this kind was conducted more than 15 years ago in 1994 (Krüger et al., 1996). Besides amendments to traffic regulations for drink and drug driving, the mobility rate, youth culture, and demographic trends have changed in recent years. Therefore, the validity of those data for the current situation is very limited.

The present study (DYDD 2007-2009) tried to fill this gap of information by implementing a new study approach. Instead of detecting drugs in the driving population – like roadside surveys do – 200 illegal drug using persons and 100 control persons (no drug use within the last year) who regularly drive a motor vehicle were queried for four weeks about their driving and drug consumption behaviour by a questionnaire deployed on smartphones. Through the synchronization of consumption and driving data, it was possible to identify the occurrence of drug driving incidences of each subject over a 4-week time period. The daily reports covered individual drug use and driving behaviour in a broader context. Conditions like time of day, companions, and reasons for driving were recorded as well. Included in the study was also an extended diagnostic part to gather relevant person-related information to gain insight into driver or – more specifically – drugged driver characteristics.

The use of smartphones as study devices was realised by developing a smartphone application programme using the BlackBerry graphical user interface and network access. The questionnaire was deployed on the smartphones, so the subjects could operate it wherever and whenever they wanted to. They had to send each report at the latest two days after the recorded day. This procedure made data collection very convenient. In the case of logical errors within the data, a system-controlled error-feedback was triggered by the smartphones. The subjects had to correct the error before they could continue and before they could send the report. Not all data inconsistencies were detectable by system-controlled consistency checks. So, much effort had to be spent on controlling the data, calling the subjects in the case of inconsistencies, and correcting false statements. For this purpose, a control form was designed in Microsoft Access, which was accessible from all workstations at the study centre. Therein the reports were listed and clearly arranged per subject in chronological order. Thus, the investigators could scroll through the individual days, refer to previous reports, and easily detect inconsistencies. The questionnaire was very complex. The subjects had to list every situation and intermediate trip in chronological order with special emphasis on situations in which they used drugs and trips that were travelled as driver of a vehicle. If the questionnaire was less complex, the frequency of data inconsistencies should decrease or could probably even entirely be averted by system-controlled error-feedback. The system itself was reliable in terms of the technical setup. The database server's internet connection, and thus the connection

to the smartphones, was rarely lost. The server's main board broke once during the study. However, since a copy of the server's hard disk had been created, no data was lost.

The compliance was very good. 328 subjects were initially included in the survey. Nine cancelled the participation because of personal reasons. Another 19 were excluded because their driving and drug use occurred too infrequently within the 4-weeks study period. All but 13% of the remaining 300 subjects provided complete data sets (i.e. at least 28 daily reports). The good compliance rate can mainly be attributed to the staggered financial reward system that was applied. The subjects did not get a fixed amount of money for taking part in the study but rather could earn credits for every single effort carried out over the whole study period. The total amount of credits was paid in cash in the end. The study design does not allow for a non-responder analysis because nothing is known about the characteristics of the users who did not take part in the study. Nevertheless, the good agreement between the survey data and the representative data about driving and drug use in Germany support the conclusion that those who did not take part and those who were participating do not differ much concerning the relevant variables. To inspire confidence in the study, assuring the protection of data privacy and providing a transparent picture of the study in public were very important issues. For this purpose, a web-site was created (www.doyoudrugdrive.de) on which interested persons could find detailed information about the study and a special section about every provision that had been taken and maintained concerning the anonymous data recording. To validate the reported data about drug use, a urine sample had to be delivered without previous announcement once within the study period. The agreement between the results from the toxicological analysis and the data about previous drug use reported in the daily questionnaire was extremely satisfying.

12.2 Study results

The primary aim of the survey was to get an estimate about the prevalence of drug driving. The main prerequisite to extrapolate the results of the survey into representative values is that the study sample represents the general population regarding all crucial characteristics. To account for this, well-defined selection criteria (age 18-39, regular driving, and regular drug use vs. no drug use for the control persons) were applied to include only those subjects who are at risk of driving under influence in the first place. Furthermore, the sample was stratified according to the variables gender, age (18-24, 25-29 and 30-39), and residence (rural, urban, city areas), which are known to serve as confounders for driving and drug use, respectively. Because of a very effective and widespread recruitment strategy (media relations, flyer, web-site, word-of-mouth-recommendation), a final sample comparable with the corresponding proportions of the population of interest on all relevant variables was achieved and a good agreement between driving and drug use data of the sample and the data from national surveys (MiD, ESA) could be demonstrated.

To decide whether a drive was conducted under the influence of illegal drugs or alcohol, BACs (according to Widmark formula; Widmark, 1932) and THC blood plasma concentrations (according to THC elimination curve by Sticht; G. Sticht, personal communication, December 2009) were calculated for each drive, using the reported information about the

dose of cannabis and alcohol, respectively, that was consumed previous to a drive, and taking into account the time lag between consumption and driving. A drive was classified as substance-positive drive when the calculated BAC was 0.01% or higher and/or the calculated THC blood plasma concentration was 1ng/ml or higher. For the remaining substances the doubled half-life of each substance was applied (provided by Schulz & Schmoldt, 2003; Passie, Seifert, Schneider & Emrich, 2002; Prisinzano, 2005). For the interpretation of the following numbers, it should be kept in mind that within the present study regular drug users were queried who consume drugs rather often (at least once a week; median consumption days per week: 5 days) and drive on a regular basis. This sub-population does not even account for 1% of the traffic volume on German streets. The relatively high frequency of drug driving within the user sample diminishes as soon as it is extrapolated into representative prevalence rates for the general driving population.

- How often does driving under impairing substances occur within the study sample?[46]

Averaged per person, 20.5% of the users' drives were under the influence of drugs. The mean percentage of drives under the influence of cannabis alone was 13.1% (total – i.e. drug combinations included: 14.8%). On average, 4.1% of the users' drives were under the influence of alcohol (total: 5.4%) and 1.5% under the influence of stimulants (amphetamine, ecstasy, cocaine – total: 2.2%). The mean percentage of drives under the influence of multiple drugs was 1.8% (cannabis/alcohol, cannabis/stimulants, alcohol/stimulants, cannabis/heroin, cannabis/alcohol/stimulants), most of which under the influence of alcohol and cannabis (1%). For all other reported drugs (LSD, sedatives, psilocybin, GHB, salvia divinorum, non-prescribed methylphenidate), no substance-positive drive was found. It turned out that users drove more than twice as often under the influence of alcohol (5.4% - thereof 1.3% combined with other substances) compared to controls (2.2%). For alcohol and cannabis, concentration dependent data were provided. The cut-off values for defining a drive as drive under influence are rather low (BAC≥0.01%, THC blood plasma level≥1ng/ml). When applying higher cut-off values, like a BAC of 0.05% and a THC blood plasma level of 4ng/ml[47], the mean percentage of drives under influence within the user sample drops by around 40% from a previous 20.5% to 13.1%.

- How high is the proportion of DUI in the general population (estimated by the survey results)?

Via existing mobility measures and prevalence data for drug use in Germany, the survey results were extrapolated into alcohol and THC prevalence rates for the general German driving population – assuming that 40-year-olds and older do not drive after cannabis consumption because the drug prevalence rate for this age group is very low[48]. Because of the high prevalence of risky alcohol consumption in the population older than 39 years (ESA 2006, DHS 2008), this age group cannot be neglected in the case of alcohol. The calculation of the alcohol prevalence rate was therefore reduced to the 18-24- and the 25-

[46] In the following, all questions that were lined out in Chapter 11.3 to show the main points of the data analysis provided by the survey in this report are listed again to structure the summary of the results.
[47] According to Berghaus, Sticht and Grellner (2011) a THC blood plasma concentration of 3.8ng/ml corresponds to a BAC of 0.05% concerning the performance impairing effects of the substance.
[48] 30-days-prevalence of 40-64-year-old population: 0.7% / regular drug use (>3x in last 30 days): 0.3% (ESA 2006).

39-year-old German population. According to this estimation, the prevalence for THC-positive drives (THC blood plasma level≥1ng/ml) in Germany is 0.14% (95% CI: 0.09% - 0.2%). For drives under the influence of stimulants (cocaine in- or excluded) the prevalence is 0.02% (95% CI: 0.01% - 0.04%), for drives under the influence of multiple drugs (any drug combination, alcohol included) the prevalence is 0.02% (95% CI: 0.01% - 0.03%), and for drives under the influence of alcohol in combination with an illegal drug the prevalence is 0.01% (95% CI: 0.006% - 0.02%). For the 18-24-year-old German population the prevalence for alcohol-positive drives (BAC≥0.01%) is 1.57% (95% CI: 0.52% - 2.7%) and 3.3% (95% CI: 1.63% - 5%) for the 25-39-year-olds.

Compared to the results of the German roadside survey (Cannabis: 0.57%; alcohol: 18-24-year-olds: 3.76, 25-49-year-olds: 5.48) from 1994 (Krüger et al., 1996), the prevalence rates found within the present study seem pretty low. However, amendments to traffic regulations for drink and drug driving within the last several years might serve as an explanation for changed prevalence rates for drives under influence in Germany. In 1998, the legal BAC limit for driving a motor vehicle in traffic was lowered from 0.08% to 0.05%. Moreover, the 0.00% BAC limit for novice drivers[49] was introduced in 2007. A decreasing trend concerning alcohol drives within the last several years can also be shown by other traffic related indicators. Alcohol-related accidents (Vorndran, 2009) or alcohol related records at the Central Register of Traffic Offenders (Federal Motor Transport Authority – Jahresbericht 2004, Jahresbericht 2009) have decreased within the last several years. Furthermore, it was not until 1998 that a law was introduced in Germany that makes driving under the influence of illegal substances prosecutable in the first place. Since then, the screening of illegal drugs in traffic has become more prevalent and the detection devices more precise. So, the probability of getting detected while driving under the influence of an illegal drug has become higher. Because of the higher deterrence effect drug users may have altered their drug driving behaviour towards more conformity with the law within the last several years.

In addition to the estimation of the prevalence of drives under influence in Germany, the study pursued the aim of providing information about situational characteristics of drives under influence and personal attributes of persons who commit them. The great advantage of the present study is that not only information about one single drive of a person is available. Instead, information about each trip and each drug intake of a person who took place over an extended period of time can be observed. Thus, the typical drug use, driving, and drug driving patterns of a person within the typical situational context can be analysed. From this knowledge, important recommendations for rehabilitation and prevention can be drawn.

- How do people spend an average day?
- When and what kind of substance do people use?

It was found that users are awake longer at night compared to controls. From 9pm until approximately 5am substance, consumption took place in around fifty percent of the time. On weekends, this proportion was even higher and spanned further into the morning. In general, the controls are more often out at public places whereas the users spend more time at friends' – on weekends the whole day, on weekdays especially at night. Cannabis

[49] All drivers between the ages of 18 and 21 and newly licensed drivers of any age for the first two years of having a licence.

is the most commonly used drug, especially in the daytime. In the evening, the percentage of alcohol use, alone or in combination with cannabis, increases. In the early morning hours, the consumption of other drugs than alcohol and cannabis increases strikingly. Outside of alcohol and cannabis, stimulants are mainly used. By trend, females use stimulants more often than males. In total, 29.2% of the 65 users (33.3%) that currently use stimulants use the drug on more than six occasions per month. The remaining stimulants users use it less frequently. Users drink alcohol more frequently and in higher doses compared to controls. 12.8% of the users are excessive alcohol users whereas only 3% of the controls are in this consumption group. Males drink more alcohol than females, as do younger subjects compared to older ones. Subjects from city and urban areas drink more alcohol compared to subjects from rural areas. This might be due to the fact that in rural areas people have less opportunity to go out and drink alcohol. In urbanized areas, there are more restaurants, bars, and clubs – places to go out to and places where people usually drink alcohol. Cannabis is used more often by younger subjects compared to older ones. Besides, subjects from rural areas use cannabis more often than subjects from urban areas. This again might be due to the restricted offer of public places to go out to. Therefore, more illegal substance consumption might take place at private locations. 23.1% of the users who were surveyed consume two or more joints a day whereas the remaining cannabis users within the study use cannabis less often. In general, the subjects never evaluate their consumption behaviour as highly problematic, regardless of the substance they used.

- When do people drive a vehicle and when do they use other modes of transportation?
- When does drug driving occur?

On weekdays, the users have on average 3.4 trips per day, and 3.1 on weekends. On weekdays, 1.9 (54%) of the trips are drives compared to 1.3 (43%) on weekends. On weekdays, users drive on average 19% of all drives under the influence of alcohol, cannabis or other substances or drug combinations (mainly cannabis). On weekends, this number rises to 32% of all drives. At night-time between 9pm to 4-5am, on weekends even until 8-9am, around 50% of the users' drives are under influence. The controls' positive drives are basically restricted to common times for going out (8pm-2am).

In general, users are more mobile at night compared to controls, who are more mobile at usual rush-hour times. So, the controls' days proceed more along a daily working routine. Even if users are out more on weekends, controls drive more at that time. Users use other modes of transportation instead. They walk or use a bicycle more often at night compared to controls. Moreover, they travel more often by taxi. Thus in general, there is a higher need or willingness among users to go by alternative modes of transportation instead of driving. Female subjects, 18-24-year-olds, and subjects from urban or city areas especially use other modes of transportation instead of driving. Female subjects often travel as passenger, much like young subjects do. 18-24-year-olds also use public transportation more often than older subjects who drive a car more often instead. Urban and city mobility is characterised by a high proportion of trips by foot, bicycle, public transportation, and the use of taxi. In rural areas, the proportion of motorised private transport either as driver or as passenger is higher instead. In this area and in city areas, the users drive most often under the influence of cannabis. This could be caused by the fact that in urban areas the distances that have to be covered to reach usual destinations are shorter than in rural and city areas. Thus, using alternative modes of transport – especially at

night, when public transport runs less often – is much easier in urban areas. The subjects can walk or use the bicycle instead of driving. Moreover, 18-29-year-olds have more THC-positive drives compared to 30-39-year-olds. For all other substances, no differences concerning driving under influence were found with respect to residence, gender, and age.

- What are the situational characteristics of DUI?

Drives under the influence of cannabis are committed quite often at any time of the day, on weekdays especially in the evening, on weekends also late at night. Drives under the influence of alcohol most often occur in the evening/at night, on weekends additionally in the morning/afternoon due to residual effects from drinking the day before. Drives under the influence of stimulants most often occur on weekends, mostly in the evening/at night, but also quite often in the morning/afternoon. Drives under influence are more common on short trips than trips that cover longer distances. When the drivers are accompanied by male companions, the drivers are more often under influence than when they drive alone. On the other hand, female companions have a preventive effect on drug driving.

- Does everybody who uses drugs and drives regularly commit DUI?

Furthermore, it was shown that not all persons per se drive after the consumption of illegal drugs or alcohol. Within the control group, 61% (CI: 51.4% - 70.6%) do not drive with a BAC above the legal limit. Within the user group the percentage is lower. 14.4% do not drive under influence at all (CI: 9.5% - 19.3%). 80% of the users' BAC- (BAC above the legal limit) and THC-positive drives (THC≥4ng/ml) were committed by only 20% of all users.

- Do heavy users or people who drive a lot commit more DUI than others?

The consumption frequency was found to be the most striking predictor for drug driving. 47% of the users' drives with a BAC above the legal limit were committed by only 13% of the users who were classified as excessive alcohol users. In the case of THC-positive drives, 59% of all drives under influence were committed by 23% of users who were classified as excessive cannabis users. Excessive alcohol and cannabis users were also found to be more intoxicated while driving compared to heavy and moderate users. Higher substance concentration levels (BAC, THC blood plasma level) while driving were found. When it comes to cannabis, it was shown that not only consumption but also the driving frequency has an influence. The more frequently a person uses a vehicle, the more drives under influence he/she commits. This might be due to the fact that in contrast to alcohol and stimulants, which are mainly used at night-time, cannabis is more likely used all day long. When someone smokes a joint in the morning, all subsequent drives within approximately six hours after consumption are THC-positive drives. The greatest part of drives is travelled at daytime. At night driving occurs rather infrequently. So, if someone uses drugs at night, it is less likely that a drive follows and more likely that a sleeping period lies between consumption and driving. Therefore, it is not surprising that the driving frequency has an influence on the occurrence of THC-positive drives within the present sample that exclusively contains users who use cannabis quite often and often use it all day long.

- Do subjects who were conspicuous in road traffic before (measured by the records in the Central Register of Traffic Offenders) commit more drives under influence compared to those who had no entry in the register?

One question that arises while studying the phenomenon of drug driving is if drug driving is a single problem or if drug driving is indicative of other traffic related problems as well. The present study was able to demonstrate that based on the records that are stored in the German Central Register of Traffic Offenders – except from offences considering drug driving – the users are not more conspicuous in road traffic than the controls. Furthermore, subjects who were conspicuous in traffic before do not inevitably commit more drug driving. Getting caught has no preventive effect on drug driving, since subjects who had lost their license due to DUI offences or had a driving ban (N=14) in the past are not characterised by a lower number of current drug driving compared to those who had no DUI offence stored in the German Central Register of Traffic Offenders.

- Do subjects who reported dangerous traffic situations while participating commit more drives under influence compared to those who had no dangerous traffic situation?

It was shown that those who reported self-inflicted dangerous traffic situations did not commit more drives under influence while participating. Thus, except from driving under influence there is no evidence to suggest that the DUI offenders show problematic behaviour in other traffic-related measures as well.

- Does the legal BAC limit have an effect on alcohol-positive drives?

In Germany, the 0.00% BAC level applies for novice drivers, i.e. all drivers between the ages of 18 and 21 and newly licensed drivers of any age for the first two years of having a licence. For all other drivers, the 0.05% BAC level applies. 18-24-year-olds drive less often under the influence of alcohol when the 0.00% BAC level applies compared to when the 0.05% BAC level applies. But this effect is only true for controls. Users do not drive less often with a positive BAC when the lower limit applies.

- How often do people decide not to drive under influence by either refraining from driving or refraining from drug use?
- Is there a correlation between the degree of impairment and the decision against drug driving?

One striking gain of knowledge gathered in the present study is the information about trips that are not driven under influence because the person consciously decided against drug driving. When comparing users and controls, it became apparent that users more often decide not to drive after they had consumed whereas controls more often do not drive because they planned on consuming later on. The following situations are responsible for this. Alcohol consumption occurs more in public places than the consumption of illegal substances. Users often consume at home or at other private locations before going out whereas controls drink alcohol while they are out. If users decide against drug driving in these cases, they indicate previous consumption as reason whereas controls indicate later consumption.

The users minimise their drug driving behaviour as they less often state that they are driving under influence than what is actually found by calculating the corresponding blood levels according to the drug dose and time lap between consumption and driving. Controls in contrast overstate their drink driving incidences.

For alcohol a dose-dependent decision making according to the present legal restrictions in Germany was found. When the subjects, regardless whether users or controls are considered, consciously drive after alcohol consumption, the median BAC lays below the main legal BAC limit of 0.05%. When they restrict alcohol consumption because of driving, the median BAC is even lower than 0.03%, which is the threshold for fitness to drive in Germany. When the subjects refrain from driving because of alcohol consumption, the median BAC is as high as or higher than the main legal BAC limit in Germany. This dependency on the height of the BAC is also found for the subjects' statements about their feeling of impairment, but only for moderate to heavy alcohol users. The higher the BAC, the more they feel impaired. A medium impairment of moderate to heavy alcohol users corresponds to a median BAC of 0.03%-0.05%. For cannabis, this correlation could also be replicated for moderate to heavy users. Here, a medium impairment corresponds to a median THC blood plasma level of 4-8ng/ml. Excessive users on the other hand felt highly impaired rather seldom but committed more highly intoxicated drives with respect to the calculated THC blood plasma levels. The finding could be an indicator for the positive effect of the implementation of thresholds for driving under influence, especially for rather moderate consumers. This then allows the substance user to develop a realistic judgement of impairment according to the consumed dose, the time delay since the last consumption, and the subjective feeling of impairment.

- Do moderate users or people who drive a motor vehicle less regularly refrain from drug driving more often?

Excessive users hardly ever decide against drug driving whereas heavy users do not differ much from moderate users concerning the proportion of solved (decision against DUI) and unsolved conflict situations (DUI). Heavy and moderate users often refrain from driving. Additionally, heavy users marginally more often abdicated driving and moderate users marginally more often abdicated consumption. All in all, the more one consumes, the less likely the person will refrain from consumption in order to avoid driving under influence. When it comes to the frequency of driving, it becomes apparent that those who drive less frequently more often refrain from driving because of previous consumption to avoid driving under influence.

- What are the situational circumstances like in which people decide against DUI?

Especially for trips with a medium distance of five to 25 kilometres, the subjects least often solve a conflict situation by either refraining from drug use or refraining from driving. On city routes and especially on city routes within smaller cities the subjects decide more often against driving under influence compared to out of city routes because the short distances in city areas can also easily be travelled by foot or by bicycle. So, the persons are free to choose between driving or using other transportation[50]. On short trips, the

[50] From the interview with the subjects, it is known that some subjects from rural areas have access to a night bus that is employed in particular for young people who go out at night to avoid drug driving. The subjects said that they make use of this alternative mode of transport quite willingly and quite often.

persons refrain from driving many times but they still drive fairly often under influence. They probably do not see an increased risk of having an accident or getting caught because of the short time and distance of being on the road. Companions had a clear influence on decisions against driving under influence. When travelling alone, followed by trips travelled with companions of the other sex, the subjects most often decided to drive under influence whereas together with companions of the same or of both gender the proportion of decisions against drug driving rises. Male drivers accompanied by female passengers have a lower proportion of drives under influence than female drivers accompanied by male passengers.

- Does the perceived risk of being stopped by the police or the perceived risk of being detected when stopped by the police while driving under influence have an effect on DUI?

The perceived risk of being stopped by the police has an influence on the occurrence of drug driving. The more probable a person thinks a police stop could occur, the more often the person decides against drug driving.

The perceived detection risk when getting stopped by the police while driving under influence has no influence on the number of drives under influence. An effect was found for gender. Males assess it more likely than females that the police will recognize the influence of alcohol. Females believe that it is more likely to be detected when getting stopped by the police after consuming sedatives. Moreover, 18-24-year-olds evaluate it as more likely to be detected after the consumption of stimulants than 30-39-year-olds. If effects concerning the subject's residence reached significance, this usually indicated that people from rural and city areas perceive the detection risk as less likely compared to subjects from urban areas (i.e. the detection of amphetamine, ecstasy, LSD/psilocybin).

12.3 Pros and Cons of the approach

The generalization from sample results to population parameters strongly depends on the way the study sample was composed. The via regia is random sampling which reproduces conditions within the population. Unfortunately, randomization requires a lot of subjects. Their number can be reduced if relevant factors for the behaviour under study can be identified and introduced as stratifying variables.

Because drug driving is a rather seldom incidence, a sufficiently high number of subjects is crucial for generating reliable prevalence estimations. What is the main difference between the smartphone survey compared to roadside surveys that are usually conducted to assess prevalence rates for drug driving? The behaviour itself is not the sample. Instead, the sample consists of persons who reported their behaviour over a period of time. Inter-individual variance is mixed with intra-individual variance, i.e. one person is observed for a certain period of time and all behavioural "products" of that person within the observation period became part of the "behavioural sample".

The mixture of intra- and inter-individual variance enables combined evaluations that cannot be conducted if only the one or the other data source is available. Through the inter-individual variance, assumptions concerning the general frequency of the behaviour

in question and general circumstances under which the behaviour occurs can be made. Because each person provided approximately the same amount of data (approximately 28 days), it is not mandatory that the data have to be averaged over persons when making such assumptions. But by averaging the behaviour on the individual level, person-related attributes can be compared. Furthermore, the intra-individual variance enables the evaluation of behavioural patterns and a more precise evaluation of motives behind the behaviour.

The representativeness of the person-sample (i.e. drug users and non-users) is of major interest for the generalization of the results. Therefore, a stratified sample with the factors age, gender, and residence – variables that are found to be confounders with respect to drug use and driving – was sought. By comparing the frequencies of the different values of the stratifying variables (males, females, 18-24-year-olds, 25-29-year-olds, 30-39-year-olds, subjects from rural, urban, and city areas) within the sample with the corresponding proportions in the general German population that uses drugs and drives a vehicle regularly, showed a good representation of the population of interest through the study sample. It was also shown that in terms of the consumed substances the sample is comparable to the representative data provided by the ESA survey. By looking for mainly cannabis consuming subjects, a quasi-representative sample in terms of co-consumption could be established. The same accounts for the driving frequency that was found. The subjects' driving is nearly the same as the representative data (MiD) for the general population.

For alcohol, a good correspondence could be demonstrated between the daily amount of alcohol consumption of the controls within the study and the general population whereas users were found to drink more than the general population. Nothing can be stated about the representativeness of the consumption intensity of cannabis and all other substances as no representative data exist. Possible biases could be both an over- and/or underreporting of the amount of consumed drugs. Although no objective data can be provided to invalidate such assumptions, some points should be mentioned. Most of the users participated in the study in order to contribute to a reasonable legislation concerning DUI, especially to driving under the influence of cannabis[51]. Most cannabis users who took part feel victimized because of the harsh sanctions and strict regulations concerning driving under cannabis consumption. In their opinion, driving after alcohol consumption is as dangerous as driving after cannabis consumption. But the prosecution when caught under influence of cannabis is much harsher. Most users define this as a political decision to prohibit drug use in general. Through their participation in the study they wanted to foster scientifically based decision-making in policy. So, a massive underreporting of drug use or at least DUI could be the consequence of corresponding motives. Looking at the extent of cannabis consumption and DUI that was actually reported, an underreporting is indeed possible but rather unlikely. Reasons for a systematic over-reporting of drug use or DUI are rare. Nevertheless, false statements about consumption and drives under influence cannot be entirely excluded.

Two striking biases could be inherent on the subject level. Persons could have participated in the study as users in order to get the monetary reward without consuming drugs. Or they participated as controls while consuming drugs because they were worried about

[51] This is known from the interviews with the subjects and can be seen in the comments in the guestbook on the DYDD-website (www.doyoudrugdrive.de)

prosecution. Both biases can be denied by considering the results of the urine sample analysis, which was assessed randomly in the study period.

Another well-known bias is the change of the behaviour just by the fact of being observed. Therefore, an analysis of (self-reported) former and current consumption was performed. Although the results are not very detailed, there is at least some indication that no massive change of behaviour took place. At the end of the survey, the subjects were also asked if their drug use and driving behaviour within the study period was comparable to their usual behavioural habits. The subjects in general stated no behavioural changes (no change of driving frequency: 99%, no change of consumption frequency: 94%). However, many subjects stated that they were rather surprised and became more aware of the real extent of their consumption behaviour by the daily reporting (18%). One subject for example contacted the investigators several months after taking part in the study and mentioned that he had undergone a stay in hospital to treat his alcohol dependency. The hospital stay was initiated by the individual himself after he became aware of his risky drinking behaviour through the daily reports and through the counselling by the investigators at the end of the survey.

One simple source of error could be mistakes committed by the subjects when reporting their days. Again no objective data can be provided to invalidate this criticism. But during data processing, several steps were taken to minimize errors: (1) subjects were given very detailed instructions, (2) subjects were trained on how to use the smartphone and to answer the daily questionnaire, (3) a system controlled consistency check for logical data inconsistencies, which were immediately announced by the system, was utilized and (4) a prompt person-controlled consistency check, which accounts for errors that only become obvious by considering the context of the current and surrounding situations was in place. Furthermore, a good relationship was established between the subjects and the investigators within the study period. The subjects described the atmosphere as friendly and cooperative.

From the perspective of the authors, an undeniable constraint of the smartphone survey is the estimation of substance blood levels in contrast to real measurements in body fluids. The BAC was estimated by the well-known Widmark formula. THC levels were estimated by the elimination curve by Sticht (G. Sticht, personal communication, December 2009). For both estimation methods, assumptions had to be made about the exact point in time of consumption. It was decided to divide the amount of the reported substance intake within a longer period of time (e.g. 3 joints in 5 hours) evenly over all 15min periods within this time span, which of course can lead to incorrect estimations. In order to be as precise as possible, every modifying variable, which was feasible to assess, was taken into account (e.g. individual body weight, gender).

All in all, it seems that the new methodological approach implemented by the present study does not have too many restrictions in comparison to the also complex design of roadside surveys. Moreover, the present study established a database for not only quantifying the drug driving prevalence but also for analysing mediating and modifying factors.

13. References

Adriani, W., Caprioli, A., Granstrem, O., Carli, M. & Laviola, G. (2003). The spontaneously hypertensive-rat as an animal model of ADHD: evidence for impulsive and non-impulsive subpopulations. *Neuroscience and Biobehavioral Reviews, 27*(7), 639-651.

Armstrong, K., Wills, A. & Watson, B. (2005). *Psychosocial influences on drug driving in young Australian drivers.* Paper presented at the Australasian Road Safety Research, Policing and Education Conference, Wellington, New Zealand.

Beauducel, A., Strobel, A. & Brocke, B. (2003). Psychometrische Eigenschaften und Normen einer deutschsprachigen Fassung der Sensation Seeking-Skalen, Form V. *Diagnostica, 49*(2), 61-72.

Borkenau, P. & Ostendorf, F. (1993). *NEO-Fünf-Faktoren Inventar (NEO-FFI), Handanweisung*. Göttingen: Hogrefe.

Bortz, J. & Schuster, C. (2010). *Statistik für Human- und Sozialwissenschaftler* (7. Aufl.). Heidelberg: Springer.

Bukasa, B., Piringer, A. & Wenninger, U. (2003). *SENSO Test zur Erfassung der Sensomotorik, Manual*. Wien: Kuratorium für Verkehrssicherheit.

Bukasa, B., Piringer, A. & Wenninger, U. (2004). *PVT Test zur Erfassung der peripheren Wahrnehmung bei gleichzeitiger Trackingaufgabe, Manual*. Wien: Kuratorium für Verkehrssicherheit.

Bukasa, B. & Wenninger, U. (2001a). *MAT Test zur Erfassung der nonverbalen Intelligenz, Manual*. Wien: Kuratorium für Verkehrssicherheit.

Bukasa, B. & Wenninger, U. (2001b). *Q1 Test zur Erfassung der Konzentrationsfähigkeit unter Monotonie, Manual*. Wien: Kuratorium für Verkehrssicherheit.

Bukasa, B. & Wenninger, U. (2001c). *LL5 Test zur Erfassung der visuellen Strukturierungsfähigkeit, Manual*. Wien: Kuratorium für Verkehrssicherheit.

Bukasa, B. & Wenninger, U. (2001d). *GEMAT Test zur Erfassung der optischen Merkfähigkeit, Manual*. Wien: Kuratorium für Verkehrssicherheit.

Bukasa, B. & Wenninger, U. (2001e). *RST3 Test zur Erfassung der reaktiven Belastbarkeit, Manual*. Wien: Kuratorium für Verkehrssicherheit.

Burger, M., Bronstrup, A. & Pietrzik, K. (2004). Derivation of tolerable upper alcohol intake levels in Germany: a systematic review of risks and benefits of moderate alcohol consumption. *Preventive Medicine*, 39 (1), 111–27.

Caspi, A., Begg, D., Dickson, N., Harrington, H., Langley, J., Moffitt, T. E. et al. (1997). Personality differences predict health-risk behaviors in young adulthood: Evidence from a longitudinal study. *Journal of Personality and Social Psychology, 73*(5), 1052-1063.

Castella, J. & Perez, J. (2004). Sensitivity to punishment and sensitivity to reward and traffic violations. *Accident Analysis & PrEpisodeion, 36*(6), 947-952.

Conover, W. J. & Iman, R. L. (1981). Rank transformations as a bridge between parametric and nonparametric statistics. *The American Statistician, 35*, 124-129.

Costa, P. T. & McCrae, R. R. (1985). The NEO personality inventory manual. Odessa, FL: Psychological Assessment Resources.

Darke, S., Kelly, E. & Ross, J. (2004). Drug driving among injecting drug users in Sydney, Australia: Prevalence, risk factors and risk perceptions. *Addiction, 99*(2), 175-185.

DHS – Deutsche Hauptstelle für Suchtfragen (2008). Informationen zum Thema: Alkohol im Alter, *Fact Sheet*, Retrieved from http://www.dhs.de/makeit/cms/cms_upload/dhs/09-02-fs__alkohol__im__alter_neu.pdf (23.10.2010).

Donovan, D. M., Marlatt, G. A. & Salzberg, P. M. (1983). Drinking behavior, personality factors and high-risk driving. A review and theoretical formulation. *Journal of Studies on Alcohol, 44*(3), 395-428.

Erdmann, G. & Janke, W. (2008). Stressverarbeitungsfragebogenn / Stress, Stressverarbeitung und ihre Erfassung durch ein mehrdimensionales Testsystem, 4., überarb. und erw. Aufl. Göttingen: Hogrefe.

Federal Motor Transport Authority (2004): Jahresbericht 2004. Retrieved from http://www.kba.de/cln_005/nn_124834/DE/Presse/Jahresberichte/jahresbericht__2004__pdf,templateId=raw,property=publicationFile.pdf/jahresbericht_2004_pdf.pdf.

Federal Motor Transport Authority (2009): Jahresbericht 2009. Retrieved from http://www.kba.de/cln_005/nn_124834/DE/Presse/Jahresberichte/jahresbericht__2009__pdf,templateId=raw,property=publicationFile.pdf/jahresbericht_2009_pdf.pdf.

Gray, J. A. (1972). The psychophysiological basis of introversion-extraversion: a modification of Eysenck's theory. In V. D. Nebylitsyn & J. A. Gray (Eds.), *The biological basis of individual behavior*. New York: Academic.

Gray, J. A. (1981). A critique of Eysenck's theory of personality. In H. J. Eysenck (Ed.), *A model for personality*. Berlin: Springer

Hoyt, M. F., 1973. Internal-external control and beliefs about automobile travel. *Journal of Research in Personality, 7*, 288-293.

Janker, H. (Ed.). (2009). Straßenverkehrsrecht (StVR). Beck-Texte (49th ed.). München: Deutscher Taschenbuch Verlag.

Jonah, B. A. (1997). Sensation seeking and risky driving: A review and synthesis of the literature. *Accident Analysis and Prevention, 29*(5), 651-665.

Kaplan, H. B. (1975): *Self-attitudes and deviant behavior*. Pacific Palisades, CA: Goodyear.

Krampen, G. (1981). *IPC-Fragebogen zu Kontrollüberzeugungen („Locus of Control"), Handanweisung*. Göttingen: Hogrefe.

Kraus, L., Pfeiffer-Gerschel, T. & Pabst, A. (2006). Cannabis und andere illegale Drogen: Prävalenz, Konsummuster und Trends. Ergebnisse des Epidemiologischen Suchtsurveys 2006. *Sucht, 54*(S1), 16-25.

Krüger, H.-P., Schulz, E. & Magerl, H. (1996). *Medikamenten- und Drogennachweis bei verkehrsunauffälligen Fahrern – Roadside Survey*. Berichte der Bundesanstalt für Straßenwesen, M 60. Bremerhaven: Wirtschaftsverlag NW.

Lapham, S. C., Smith, E., de Baca, J. C., Chang, I., Skipper, B. J., Baum, G. et al. (2001). Prevalence of psychiatric disorders among persons convicted of driving while impaired. *Archives of General Psychiatry, 58*(10), 943-949.

Lewrenz, H.. (2000). *Begutachtungs-Leitlinien zur Kraftfahrereignung*. Berichte der Bundesanstalt für Straßenwesen, M 115. Bremerhaven: Wirtschaftsverlag NW.

Madea, B., & Dettmeyer, R. (2007). Basiswissen Rechtsmedizin. Heidelberg: Springer.

Miller, D. K. & Blum, K. (1996). *Overload: Attention deficit disorder and the addictive brain.* Kansas City: Andrews McMeel.

Moeller, F. G., Barratt, E. S., Dougherty, D. M., Schmitz, J. M. & Swann, A. C. (2001). Psychiatric aspects of impulsivity. *The American Journal of Psychiatry, 158*(11), 1783-1793.

Müller, C. P., Topic, B., Huston, J. P., Strohbeck-Kühner, P., Lutz, B., Skopp, G. & Aderjan, R. (2006). *Cannabis und Verkehrssicherheit*. Berichte der Bundesanstalt für Straßenwesen, M 182. Bremerhaven: Wirtschaftsverlag NW.

Pabst, A., & Kraus, L. (2006). Alkoholkonsum, alkoholbezogene Störungen und Trends. Ergebnisse des Epidemiologischen Suchtsurveys 2006. *Sucht, 54*(S1), 16-25.

Passie, T., Seifert, J., Schneider, U. & Emrich, H. M. (2002). The pharmacology of psilocybin. *Addiction Biology, 7*(4), 357-364.

Prisinzano, T. E. (2005). Psychopharmacology of the hallucinogenic sage Salvia divinorum. *Life Sciences, 78*(5), 527-531.

Rotter, J. (1966). Generalized expectancies for internal versus external control of reinforcements, *Psychological Monographs*, *80*, whole no. 609.

Ryb, G. E., Dischinger, P. C., Kufera, J. A. & Read, K. M. (2006). Risk perception and impulsivity: Association with risky behaviors and substance abuse disorders. *Accident Analysis and PrEpisodeion, 38*(3), 567-573.

Schmidt, L. & Piringer, A. (1986). *VIP Verkehrsspezifischer Itempool. Testhandbuch*. Wien: Kuratorium für Verkehrssicherheit.

Schulz, M. & Schmoldt, A. (2003). Therapeutic and toxic blood concentrations of more than 800 drugs and other xenobiotics. *Pharmazie, 58*(7), 447-474.

Searles, J. S., Perrine, M. W., Mundt, J. C. & Helzer, J. E. (1995). Self-report of drinking using touch-tone telephone: extending the limits of reliable daily contact. *Journal of Studies on Alcohol, 65*(4), 375-382.

Selzer, M. L. & Barton, E. (1977). The drunken driver: A psychosocial study, *Drug and Alcohol Dependence 2*, 239-253.

Selzer, M. L., Vinokur, A. & Wilson, T. D. (1977). A psychosocial comparison of drunken drivers and alcoholics, *Journal of Studies on Alcohol, 38*, 1294-1312.

Federal Statistical Office (2009). Statistical Yearbook 2009 Retrieved from http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Content/Publikationen/QuerschnittsveroeffentlichungenStatistischesJahrbuch/JahrbuchDownload, templateId=renderPrint.psml.

Swann, A. C., Bjork, J. M., Moeller, F. G. & Dougherty, D. M. (2002). Two models of impulsivity: relationship to personality traits and psychopathology. *Biological Psychiatry, 51*(12), 988-994.

Tellegen, A. (1982). *Brief manual of the multidimensional personality questionnaire*. Unpublished manuscript. University of Minnesota.

Thomas, J. R., Nelson, J. K. & Thomas, K. T. (1999). A generalized rank-order method for nonparametric analysis of data from exercise science: a tutorial. *Research Quarterly for Exercise and Sport, 70*(1), 11-23.

Torrubia, R., Ávila, C., Moltó, J. & Caseras, X. (2001). The sensitivity to punishment and sensitivity to reward questionnaire (SPSRQ) as a measure of Gray's anxiety and impulsivity dimensions. *Personality and Individual Differences, 31*(6), 837-862.

Ullrich, R. & Ullrich, R. (1998). *Das Assertiveness-Training-Programme ATP: Einübung von Selbstvertrauen und sozialer Kompetenz, Anleitung für den Therapeuten, Teil II. Der Unsicherheitsfragebogen, Testmappe U*. München: Pfeiffer.

Vorndran, I (2009). Unfallentwicklung auf deutschen Straßen 2008. *Wirtschaft und Statistik 7/2009*, 697-710. Retrieved from http://www.destatis.de/jetspeed/potal/cms/Sites/destatis/Internet/DE/Content/Publikatioen/Querschnittsveroeffentlichungen/WirtschaftStatistik/Monatsausgaben/WistaJuli09,property=file.pdf.

Widmark, E. M. (1932). *Die theoretischen Grundlagen und die praktische Verwendbarkeit der gerichtlich-medizinischen Alkoholbestimmung*. Berlin: Urban & Schwarzenberg.

Wittchen, H.-U., Zaudig, M. & Fydrich, T. (1997). *SKID – Strukturiertes Klinisches Interview für DSM-IV Achse I und II, Handanweisung*. Göttingen: Hogrefe.

Zeberlein, K. & Küfner, H. (2003). Deutsche Version des Attention Deficit and Hyperactivity Disorders Fragebogens. Ergebnisse einer psychometrischen Analyse. In A. Glöckner-Rist, F. Rist & H. Küfner (Eds.), *Elektronisches Handbuch zu Erhebungsinstrumenten im Suchtbereich (EHES)*. Version 3.00. Mannheim: Zentrum für Umfragen, Methoden und Analysen.

Zuckerman, M., Eysenck, S. B. & Eysenck, H. J. (1978). Sensation seeking in England and America: Cross-cultural, age, and sex comparisons. *Journal of Consulting and Clinical Psychology, 46*(1) 139-149.

14. Annex

14.1 Description of the website

In the following, the main sections of the website that was developed and launched within the frame of the study are briefly described (http://www.doyoudrugdrive.de / http://www.dydd.de):

- *Info*: information for potential participants about the background, the main objectives, the aim and the conducting institution of the study.
- *Study:* inclusion criteria (age, consumption and driving habits), registration procedure, necessary effort, incentives, and privacy of the data.
- *Smartphone*: introduction of the smartphone as main research instrument and short exemplary section of the questionnaire.
- *News:* update regarding important project steps.
- *Visitor's book*: feedback from former participants.
- *Press*: contact details, existing press reports about the study.
- *Contact:* contact details.
- *FAQ*: most asked questions about data protection, privacy and prosecution.
- *Links:* information about further research in this area, drug information services, and advisory services.

Figure 83: Abstract of the doyoudrugdrive-website.

14.2 Q-Start-Questionnaire

Figure 84: Q-Start-Questionnaire about socio-demographic attributes, driving and drug use experience, previous drug driving, corresponding peer behaviour and attitudes.

Center for Traffic Sciences at the University of Würzburg IZVW

VpID: _____ date: _____

code: _____

Dear participant,

thank you for agreeing to participate in our study.

As an institute for traffic sciences we want to figure out by this examination, if people who take drugs even drive on drugs.

Below, you will find a set of questions regarding your driving experience as well as your drug experience (controls: if any). Please, read the questions carefully and attend especially to the bold passages. The questionnaire will be introduced by questions concerning your person.

Of course, we treat your statements as strictly confidential and anonymous. Please register the **date and month of birth of your mother** and **your year of birth** in the domain „code“ in the top margin on the right.

Example: date of birth of your mother: **20.03**.1948 / own date of birth: 07.05.19**78**
code: **200378**

There is no right or wrong in your answers, and you don’t have to be an expert for answering the questions. You serve the study’s purpose best, if you answer as honestly as possible, i.e. in an appropriate way for you personnally. Please respond to the questions swiftly but carefully and preferably attend to all questions.

Q-Start 1

Center for Traffic Sciences at the University of Würzburg IZVW -

PERSONAL INFORMATION

(1) Your gender: ❍ male ❍ female

(2) How old are you? _____ years

(3) What is your nationality? _____

(4) Your marital status:

- ❍ single
- ❍ married
- ❍ have been married (divorced, widowed)

(5) Who do you live with permanently?

- ❍ alone
- ❍ with partner and ____ children
- ❍ without partner and ____ children
- ❍ in a flat-sharing community (number of flat mates, you included: ____)
- ❍ in residential home
- ❍ with parents/relatives
- ❍ with parents/relatives, but in own flat

(6) What is your highest level of **general** education completed?

- ❍ left school without degree
- ❍ (Hauptschulabschluss)
- ❍ GCSE (General Certificate of Secondary Education)
- ❍ vocational diploma (Fachhochschulreife)
- ❍ A-Level
- ❍ other degree _____
- ❍ still student

(7) Your highest **professional** education completed:

- ❍ skilled worker (Teilfacharbeiter)
- ❍ apprenticeship (Abschluss einer beruflich-betrieblichen Berufsausbildung (Lehre))
- ❍ vocational school (Abschluss einer beruflich-schulischen Ausbildung (Berufsfach-/ Handelsschule))
- ❍ masterschool, technical school (Abschluss an einer Fachschule, Meister- oder Technikerschule, Berufs- oder Fachakademie)
- ❍ university of applied sciences (Fachhochschulabschluss)
- ❍ university (Hochschulabschluss)
- ❍ conferral of a doctorate (Promotion)
- ❍ other degree _____
- ❍ no degree
- ❍ still in apprenticeship/studies (noch in der Ausbildung/im Studium/Schüler(in))

(8) What applies to you at present?
(*Please, just check one!)*

- ❍ full time employed
- ❍ part time employed (15 to max. 35 hours a week)
- ❍ marginal employed (under 15 hours a week)
- ❍ apprentice
- ❍ scholar
- ❍ student (branch of study: _____)
- ❍ currently unemployed
- ❍ temporarily released (e.g. maternity-/ childcare leave)
- ❍ house wife / -husband
- ❍ pensioner
- ❍ conscript / alternative civilian service
- ❍ other _____

(9) Which occupation do you have at present or did you have at last?
(*Please, just check one!)*

- ❍ worker
- ❍ clerk in simple occupation (e.g. shop assistant)
- ❍ clerk in qualified occupation (e.g. administrator, accountant, draughtsman)
- ❍ clerk in highly qualified occupation (university graduate)
- ❍ clerk in administrative function (e.g. director, executive, manager of bigger enterprises and organizations)
- ❍ civil servant in the lower grade of the civil service
- ❍ civil servant in the middle grade of the civil service
- ❍ civil servant in the upper grade of the civil service
- ❍ civil servant in the higher grade of the civil service
- ❍ independet graduate (e.g. medic, advocate, tax consultant) / artist
- ❍ independent in trade, business, services, industry
- ❍ independent agriculturist
- ❍ working for a family member
- ❍ other _____

(10) If you are employed, which job do you have at present? _____

(11) Are you working in your free time to earn money? ❍ yes ❍ no

(12) How large is the city you live in?

- ❍ less than 2,000 inhabitants
- ❍ 2,000-5,000 inhabitants
- ❍ 5,000-20,000 inhabitants
- ❍ 20,000-50,000 inhabitants
- ❍ 50,000-100,000 inhabitants
- ❍ 100,000-500,000 inhabitants
- ❍ more than 500,000 inhabitants
- ❍ I don't know, I live in _____

(13) What's your **net income** you have at your disposal per month (including scholarship, housing subsidy, financial support from parents)

- ❍ less than 500 euros
- ❍ 500-1,000 euros
- ❍ 1,000-1,500 euros
- ❍ 1,500-2,000 euros
- ❍ 2,000-2,500 euros
- ❍ more than 2,500 euros

(14) How would you assess your general state of health?

very bad 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 very well

(15) Do you suffer from a chronic disease (e.g. rheumatism, diabetes, thyroid diseases...)? Or were you diagnosed with ADHD?

- ❍ yes, which? _____
- ❍ no

(16) How much do you weigh? _____ kg

(17) If you take medication regularly, please list the exact names of the medication, the dosage and how long you have been taking it.

Name of medication	Dose (morning-midday-evening)	Intake since (month/year)
	O if required	
	O if required	

DRIVING EXPERIENCE

(18) For which type of vehicle do you have a driving licence? How many years ago did you get it?

- ❍ motor-assisted bicycle /moped since (year) _____
- ❍ motorbike since (year) _____
- ❍ car since (year) _____
- ❍ truck since (year) _____

(19) Do you have your driving licence probationary? ❍ yes ❍ no

(20) Which of the following vehicles do you own?

- ❍ motor-assisted bicycle /moped
- ❍ motorbike
- ❍ car
- ❍ none

(21) How often do you have your car available?

- ❍ anytime
- ❍ occasionally
- ❍ very seldom
- ❍ not at all

(22) How often are you the driver of the car?

- ❍ almost every day
- ❍ 1-3 times per week
- ❍ 1-3 times per month
- ❍ very seldom
- ❍ (almost) not at all

(23) If you drive a moped or motorbike: How often do you have it available?

- ❍ anytime
- ❍ occasionally
- ❍ very seldom
- ❍ not at all

(24) If you drive a moped or motorbike: How often are you the driver?

- ❍ almost every day
- ❍ 1-3 times per week
- ❍ 1-3 times per month
- ❍ very seldom
- ❍ (almost) not at all

(25) If you have a truck driver's licence: How often do you have the truck available?

- ❍ anytime
- ❍ occasionally
- ❍ very seldom
- ❍ not at all

(26) If you have a truck driver's licence: How often are you the driver?

- ❍ almost every day
- ❍ 1-3 times per week
- ❍ 1-3 times per month
- ❍ very seldom
- ❍ (almost) not at all

(27) What is the public transport connection from your home to your ordinary destinations like?

don't know	very good	good	to some extent	bad	very bad
0	1	2	3	4	5

(28) How many kilometres do you drive per year as the driver of a car?

- ❍ up to 4,999 km
- ❍ 5,000 to 9,999 km
- ❍ 10,000 to 14,999 km
- ❍ 15,000 to 19,999 km
- ❍ 20,000 to 29,999 km
- ❍ 30,000 km and more
- ❍ didn't drive last year

(29) How many kilometres have you driven since you got your driving licence?

- ❍ less than 10,000 km
- ❍ 10,000 to 50,000 km
- ❍ 50,000 to 100,000 km
- ❍ 100,000 to 300,000 km
- ❍ more than 300,000 km

(30) How essential is your driving licence to your private life (work excluded)?

I don't need it 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 I can't get along without

(31) How essential is your driving licence to your profession (including drive to work)?

I don't need it 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 without it I can't do my job

(32) Does your profession include driving a motor vehicle (driving to and return from work is not meant!)?

❍ yes ❍ no

(33) Do you have part time jobs, which entail driving a motor vehicle?

❍ yes ❍ no

(34) In general, do you prefer to be the driver or passenger?

- ❍ driver
- ❍ passenger
- ❍ I have no preference

(35) How much do you like driving the car you most often use?

very much	much	medium	little	very little
1	2	3	4	5

(36) How do you rate your current driving skills?

very good	good	medium	bad	very bad
1	2	3	4	5

(37) Which motor vehicle do you drive most often at present?

brand / type: _____ year of construction: _____

motor capacity: _____ ○ kW ○ hp (please mark)

(38) Have you ever gotten points in the Central Register of Traffic Offenders?

❍ yes occasion(s): _____

❍ no

(39) How many points do you approximately have at the Central Register of Traffic Offenders at present?

_____ points

(40) Was your driving licence ever revoked?

_____ times occasion(s): _____

(41) Have you ever got a parking ticket?

❍ yes, how many times approx.? _____ ❍ no

(42) How dangerous is driving by car in your opinion?

absolutely safe 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 extremely dangerous

(43) What are in your opinion the three most important causes of traffic accidents? Please, name the most important first, the second-important next and the third-important last. Rate additionally, how dangerous the cause is in your opinion.

1st cause of accident: _____

absolutely safe 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 extremely dangerous

2nd cause of accident: _____

absolutely safe 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 extremely dangerous

3rd cause of accident: _____

absolutely safe 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 extremely dangerous

(44) If you haven't already named alcohol in the previous question, please rate how dangerous drink-driving is as a cause of accidents in your opinion.

absolutely safe 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 extremely dangerous

(45) Even if you have named illegal drugs in the previous question, please rate in more detail how dangerous the following drugs on driving are as a cause of traffic accidents.

	absolutely safe	extremely dangerous
cannabis	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10	
stimulants (e.g. amph.,speed)	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10	
ecstasy	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10	
hallucinogens (e.g. LSD, mushrooms)	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10	
cocaine	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10	
opiates (heroin and others)	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10	
tranquillizers	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10	

ACCIDENT EXPERIENCE

(46) How many accidents were you involved in as driver?

in ____ accidents

Please describe briefly the accident(s) below. If you were involved in more than three accidents, please describe the last three.

accident No 1: _____

_____

_____

time (month / year): _____

injury to persons:	❍ yes	❍ no	
negligence:	❍ personal	❍ third party	❍ contributary
field sobriety test by police:	❍ yes	❍ no	
under the influence of alcohol:	❍ myself	❍ the other	❍ none
drug test by police:	❍ yes	❍ no	
under the influence of drugs:	❍ myself	❍ the other	❍ none
accident registered by police:	❍ yes	❍ no	

accident No 2: _____

_____

_____

time (month / year): _____

injury to persons:	❍ yes	❍ no	
negligence:	❍ personal	❍ third party	❍ contributary
field sobriety test by police:	❍ yes	❍ no	
under the influence of alcohol:	❍ myself	❍ the other	❍ none
drug test by police:	❍ yes	❍ no	
under the influence of drugs:	❍ myself	❍ the other	❍ none
accident registered by police:	❍ yes	❍ no	

accident No 3: _____

_____

_____

time (month / year): _____

injury to persons:	❍ yes	❍ no	
negligence:	❍ personal	❍ third party	❍ contributary
field sobriety test by police:	❍ yes	❍ no	
under the influence of alcohol:	❍ myself	❍ the other	❍ none
drug test by police:	❍ yes	❍ no	
under the influence of drugs:	❍ myself	❍ the other	❍ none
accident registered by police:	❍ yes	❍ no	

Center for Traffic Sciences at the University of Würzburg IZVW -

DRUG EXPERIENCE

(47) Do you currently smoke or did you smoke in the past?

- ❍ yes, I am smoker (started at the age of ___)
- ❍ yes, I have smoked in the past (at the age of ___ till ___)
- ❍ no, I am non-smoker and never smoked in the past

(48) If yes, how many cigarettes do you smoke per day or did you smoke per day?

- ❍ less than 5
- ❍ 5-9
- ❍ 10-17
- ❍ 1 packet
- ❍ 2 packets
- ❍ more than 2 packets

(49) Have you ever taken any of the following drugs (incl. alcohol)? If yes, when was the first time? How many years ago?

❍	alcohol:	___ years ago
❍	cannabis (hemp, marihuana, weed):	___ years ago
❍	(meth-)amphetamines/speed:	___ years ago
❍	ecstasy:	___ years ago
❍	LSD:	___ years ago
❍	mushrooms:	___ years ago
❍	cocaine:	___ years ago
❍	crack:	___ years ago
❍	heroin:	___ years ago
❍	sniffing:	___ years ago
❍	other: _____	___ years ago

(50) Which of the following drugs would you never take or would you never take again?

- ❍ alcohol
- ❍ cannabis (hemp, marihuana, weed)
- ❍ (meth-)amphetamines/speed
- ❍ ecstasy
- ❍ LSD
- ❍ mushrooms
- ❍ cocaine
- ❍ crack
- ❍ heroin
- ❍ sniffing
- ❍ other: _____
- ❍ I would take all of these substances.

(51) User: How would you describe the effects of the drugs you have taken (question 49)? (examples → see next page)

❍	alcohol	(BAC<0.05%):	_____
		(BAC>0.05%):	_____
❍	cannabis:		_____
❍	(meth-)amphetamines/speed:		_____
❍	ecstasy:		_____
❍	LSD:		_____
❍	mushrooms:		_____
❍	cocaine:		_____
❍	crack:		_____
❍	heroin:		_____
❍	sniffing:		_____
❍	other: _____		_____

examples: stimulating, performance-enhancing, intensifies emotions, euphoriant, anxiolytic, relaxing, sedative, dulling, flustering, leeds to psychoses, leeds to overestimation of one's own capabilities, leeds to depressive moods

(52) From the first time to this day, how often have you taken the following drugs?

	never	1x	2x	3-5x	6-9x	10-39x	≥ 40x
cannabis							
(meth-)amphetamines/speed							
ecstasy							
LSD							
mushrooms							
cocaine							
crack							
heroin							
sniffing							
other: _____							

(53) How long has it been since you have taken the following drugs for the last time?

	< 1 month	1-5 months	6-11 months	≥ 12 months	≥ 2 years	≥ 5 years	never consumed
cannabis							
(meth-)amphetamines/speed							
ecstasy							
LSD							
mushrooms							
cocaine							
crack							
heroin							
sniffing							
other: _____							

(54) User: How often have you taken the following drugs in the past 30 days?

	not at all	on 1 day	on 2-5 days	on 6-9 days	on 10-19 days	on 20-30 days
cannabis						
(meth-)amphetamines/speed						
ecstasy						
LSD						
mushrooms						
cocaine						
crack						
heroin						
sniffing						
other: _____						

Control: How often have you drank alcohol in the past 30 days?

- ❍ not at all
- ❍ on 1 day
- ❍ on 2-5 days
- ❍ on 6-9 days
- ❍ on 10-19 days
- ❍ on 20-30 days

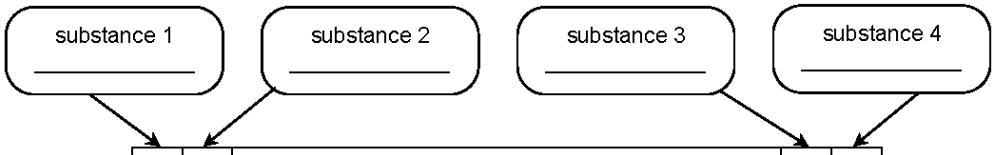
(55) User: If you've taken one of the following drugs in the past 30 days, how was the dosis per consumption unit compared to other consumers?

	smaller dose than others	normal dose	higher dose than others
cannabis (per joint, pipe...)			
(meth-)amphetamines/speed			
mushrooms			
cocaine (per "line"...)			
crack (per pipe)			
heroin			

(56) User: If you've taken one of the following drugs in the past 30 days, please state as exactly as possible how many milligrams you've taken or assess the amount on the basis of your spendings on drugs or weigh the dose at your next consumption. (1g = 1000mg).

- ❍ cannabis (per joint, pipe...): hemp _____ mg
- ❍ cannabis (per joint, pipe...): weed _____ mg
- ❍ (meth-)amphetamines/speed: _____ mg
- ❍ mushrooms: _____ mg
- ❍ cocaine (per "line"...): _____ mg
- ❍ crack (per "line"...): _____ mg
- ❍ heroin: _____ mg

(57) User: Why do you take drugs (incl. alcohol)?
Please refer to those substances you've marked in question 54 (maximum 4) and check the two most applying reasons for each substance.



		1	to have fun	1		
		2	against boredom	2		
		3	to be more powerful	3		
		4	to relax	4		
		5	to experience a sense of community	5		
		6	to experience a good physical feeling	6		
		7	to forget problems	7		
		8	to feel better	8		
		9	to overcome my restraints in social contexts	9		
		10	by habit	10		
		11	I had a great craving	11		

(58) User: How problematic is your consumption in your opinion?

	not at all	very little	little	medium	much	very much
	0	1	2	3	4	5
alcohol						
cannabis						
(meth-)amphetamines/speed						
ecstasy						
LSD						
mushrooms						
cocaine						
crack						
heroin						
sniffing						
other: _____						

Control: How problematic is your alcohol consumption in your opinion?

- ❍ not at all
- ❍ very little
- ❍ little
- ❍ medium
- ❍ much
- ❍ very much

(59) User: How much, in euros, do you spend on drugs per month (without alcohol!)?

____ euros

(60) Imagine a period of 10 Friday evenings and 10 Saturday evenings. On how many of those 20 days do you drink notedly more than usual on weekends?

on ____ days

(61) On how many days do you drink a regular amount?

on ____ days

(62) And finally: On how many days do you not drink any alcohol?

on ____ days

(Please pay attention that the sum of the three previous statements results in 20 days!)

(63) If you drink „regular" on a Friday or Saturday evening, how much do you drink? Please, specify beer and wine in litres and liquor (or mixed drinks) in glasses.

____ litres of beer
○ and ○ or ____ litres of wine
○ and ○ or ____ glasses of liquor

(64) If you drink „notedly more than usual on weekends" on a Friday or Saturday evening, how much beer, wine and liquor do you drink?

____ litres of beer
○ and ○ or ____ litres of wine
○ and ○ or ____ glasses of liquor

(65) Imagine an average or typical week. On how many of the five days from Sunday to Thursday do you drink alcohol?

on ____ days

(66) If you drink alcohol during the week, how much beer, wine and liquor do you drink?

____ litres of beer
○ and ○ or ____ litres of wine
○ and ○ or ____ glasses of liquor

(67) In general, have you ever drink-driven with less than 0.05% BAC?

❍ yes ❍ no

(68) If yes, how often did you drive drunk with less than 0.05% BAC in the past 30 days?

_____ number of days drunk-driving **(< 0.05% BAC)**

(69) In general, have you ever drink-driven with more than 0.05% BAC?

❍ yes, how often approx.? _____ ❍ no

(70) If yes, did you drive drunk mainly in town or out of town?

- ❍ in town
- ❍ out of town
- ❍ don't know

(71) If yes, how many kilometres did you drive drunk?

❍ km: _____ ❍ don't know

(72) If yes, how much had you drunk at that time? (If you were driving more than once with more than 0.05% BAC, please state the most you've ever drunk.)

____ litres of beer
○ and ○ or ____ litres of wine
○ and ○ or ____ glasses of liquor

❍ don't know

(73) How often did you drive drunk with more than 0.05% BAC in the past 30 days?

_____ number of days drunk-driving **(> 0.05% BAC)**

(74) In general, were you ever driving under the influence of one of the substances named above (except alcohol)?

❍ yes, under the influence of _____
how often approximately? _____

❍ no

(75) User: If yes, how often did you drive under the influence of one of the substances named above in the past 30 days (except alcohol)?

____ number of days under the influence of drugs (namely under _____)

(76) User: Did you take any drug combinations (incl. alcohol) in the past 30 days?

❍ yes, namely the following combination(s) of drugs:

combination	alcohol	cannabis	amph./speed	ecstasy	LSD	mushrooms	cocaine	crack	heroin	sniffing	other:____
1											
2											
3											
4											
5											

❍ no

(77) User: In former times, did you take any drug combination not named in question (76) (incl. alcohol)?

Control: In former times, did you take any drug combination (incl. alcohol)?

❍ yes, namely the following combination(s) of drugs:

combination	alcohol	cannabis	amph./speed	ecstasy	LSD	mushrooms	cocaine	crack	heroin	sniffing	other:____
1											
2											
3											
4											
5											

❍ no

(78) User: Did you drive under the influence of a drug combination (incl. alcohol) in the past 30 days?

❍ yes, namely the following combination(s) of drugs:

combination	alcohol	cannabis	amph./speed	ecstasy	LSD	mushrooms	cocaine	crack	heroin	sniffing	other:___
1											
2											
3											
4											
5											

❍ no

(79) User: In former times, did you drive under the influence of any drug combination not named in question (78) (incl. alcohol)?

Control: In former times, did you drive under the influence of a drug combination (incl. alcohol)?

❍ yes, namely the following combination(s) of drugs:

combination	alcohol	cannabis	amph./speed	ecstasy	LSD	mushrooms	cocaine	crack	heroin	sniffing	other ___
1											
2											
3											
4											
5											

❍ no

(80) If you were ever driving under the influence of drugs, did you drive mainly in or out of town?

❍ in town
❍ out of town
❍ don't know

(81) If you were ever driving under the influence of drugs, how many kilometers did you drive on average?

❍ km: _____ ❍ don't know

(82) How bad or condemnable do you take driving under the influence of drugs (incl. alcohol)?

	not bad at all very bad
1 beer	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
more than 4 beers	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
cannabis	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
stimulants (e.g. amph.,speed)	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
ecstasy	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
hallucinogens (e.g. LSD, mushrooms)	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
cocaine	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
opiates (heroin and others)	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
sedatives	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10

(83) Under which of the following substance would you never drive, regardless if you've already taken it or not?
(Multiple answers possible!)

- ❍ 1 beer
- ❍ more than 4 beers
- ❍ cannabis
- ❍ stimulants (e.g. amph.,speed)
- ❍ ecstasy
- ❍ hallucinogens (e.g. LSD, mushrooms)
- ❍ cocaine
- ❍ opiates (heroin and others)
- ❍ sedatives
- ❍ I'd drive under all of these substances.
- ❍ I'd drive under none of these substances.

(84) Do you take driving under the influence of a combination of drugs more dangerously than driving under the influence of just one substance (incl. alcohol)?

- ❍ yes, more dangerous
- ❍ no, no more dangerous

(85) In your opinion, how common is driving under the influence of the following substances?

	not at all 0	very little 1	little 2	medium 3	much 4	very much 5
1 beer						
more than 4 beers						
cannabis						
stimulants (e.g. amph.,speed)						
ecstasy						
hallucinogens (e.g. LSD, mushrooms)						
cocaine						
opiates (heroin and others)						
sedatives						

(86) User: How much does your decicion to drive or not to drive after the consumption of drugs (incl. alcohol) depend on the following points?

	not at all 0	very little 1	little 2	medium 3	much 4	very much 5
(on the consumption / on the effects …)						
…how much I've taken						
…when I've taken the drug						
…which drug/combination of drugs I've taken						
…how roadworthy/tired I feel						
(on possible alternatives…)						
…whether I have money for a taxi or not						
…whether I can walk/take the public transport or not						

...whether I can go with someone or not						
...whether I have to be at home the next morning or whether I can sleep over or not						
...whether I need the car at home the next morning or not						
(on the route...)						
...on the kind of route (motorway, rural, city)						
...on the length of the route						
...on the level of familiarity to the route						
...on the density of controls on the route						
(social reasons...)						
...whether I have passengers who I could endanger or not						
...whether I should take somebody home or not						
...whether it bothers my passengers or not						
...how sober I am compared to other potential drivers						

(87) How often do you go out on average (meet friends, party, disco, bar)?

- ❍ 5-7 times per week
- ❍ 3-4 times per week
- ❍ 1-2 times per week
- ❍ 1-3 times per month
- ❍ less frequently

(88) How much beer, wine or liquor does your father drink on a usual Saturday evening?

____ litres of beer
○ and ○ or ____ litres of wine
○ and ○ or ____ glasses of liquor

- ❍ don't know

(89) How much beer, wine or liquor does your mother drink on a usual Saturday evening?

____ litres of beer
○ and ○ or ____ litres of wine
○ and ○ or ____ glasses of liquor

- ❍ don't know

(90) If you have a permanent partner, does he or she take drugs?

- ❍ yes, so-called „soft" drugs (cannabis)
- ❍ yes, so-called „hard" drugs (amphetamines, opiates, cocaine)
- ❍ yes, so-called „soft" and „hard" drugs
- ❍ no, my partner doesn't take drugs
- ❍ I have no permanent partner.

(91) How many of your friends, with whom you have regular contact, take so-called „soft" drugs (cannabis)?

- ❍ no one
- ❍ few
- ❍ about the half
- ❍ many

(92) How many of your friends, with whom you have regular contact, take so-called „hard" drugs (amphetamines, opiates, cocaine)?

- ❍ no one
- ❍ few
- ❍ about the half
- ❍ many

(93) How many of your friends, with whom you have regular contact, take illegal drugs and drive afterwards?

- ❍ no one
- ❍ few
- ❍ about the half
- ❍ many

(94) User: What do your friends think about your consumption of illegal drugs?

Controls: If you consumed illegal drugs, what would your friends think about?

it doesn't bother them	0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 10	they extremely disapprove it

(95) Assume that you are driving after the intake of the following substances, how would your friends react if they found out?

	it wouldn't bother them										they would react very disapproved
1 beer	0	1	2	3	4	5	6	7	8	9	10
more than 4 beers	0	1	2	3	4	5	6	7	8	9	10
cannabis	0	1	2	3	4	5	6	7	8	9	10
stimulants (e.g. amph.,speed)	0	1	2	3	4	5	6	7	8	9	10
ecstasy	0	1	2	3	4	5	6	7	8	9	10
hallucinogens (e.g. LSD, mushrooms)	0	1	2	3	4	5	6	7	8	9	10
cocaine	0	1	2	3	4	5	6	7	8	9	10
opiates (heroin and others)	0	1	2	3	4	5	6	7	8	9	10
sedatives	0	1	2	3	4	5	6	7	8	9	10

(96) „If I know the driver had taken the following substances, I don't go with him." To what extent do you agree to this statement?

	don't agree										completely agree
1 beer	0	1	2	3	4	5	6	7	8	9	10
more than 4 beers	0	1	2	3	4	5	6	7	8	9	10
cannabis	0	1	2	3	4	5	6	7	8	9	10
stimulants (e.g. amph.,speed)	0	1	2	3	4	5	6	7	8	9	10
ecstasy	0	1	2	3	4	5	6	7	8	9	10
hallucinogens (e.g. LSD, mushrooms)	0	1	2	3	4	5	6	7	8	9	10
cocaine	0	1	2	3	4	5	6	7	8	9	10
opiates (heroin and others)	0	1	2	3	4	5	6	7	8	9	10
sedatives	0	1	2	3	4	5	6	7	8	9	10

(97) Do you like the prohibition of alcohol for novice drivers in their probationary period and for under 21-year-olds, which was introduced on August 1st 2007?

- ❍ yes, it was high time, better would be 0.00% for everyone
- ❍ yes, I am in favour of it, it is safer
- ❍ I really don't care
- ❍ no, I don't like it, one beer should be permitted

(98) For cannabis, should there be a threshold concerning the substance level in the blood – similar to alcohol - under which you are allowed to drive (in contrast to the current applied zero-tolerance rule)?

- ❍ yes
- ❍ no
- ❍ don't know

reason: _____

(99) User: How many euros penalty will definitely restrain you from driving under the influence of illegal drugs?

- ❍ as of 100 €
- ❍ as of 500 €
- ❍ as of 1,000 €
- ❍ as of 3,000 €
- ❍ not at all, I'd drive at all times
- ❍ I never drive under the influence of illegal drugs

(100) How often have you roughly been stopped by the police since you possess your driving licence?

about _____ times

(101) How often were you tested for alcohol by the police?

about _____ times

(102) How often were you tested for illegal drugs?

about _____ times

(103) How often were you stopped by the police in the last two years?

about _____ times

(104) Have you ever been stopped and caught by the police under the influence of alcohol (>0.05% BAC) or illegal drugs?

- ❍ yes, _____ times
  namely under the influence of _____
- ❍ no

(105) Have you ever been stopped by the police under the influence of alcohol (>0.05% BAC) or illegal drugs without the police noticing the influence?

- ❍ yes, _____ times
  namely under the influence of _____
- ❍ no

(106) Which blood alcohol limit do you believe to be right?

- ❍ 0.00
- ❍ 0.05
- ❍ 0.08
- ❍ other: _____

(107) What do you think you are allowed to drink to reach 0.1% BAC? Please estimate the amount on the drink you drink most.

____ litres of beer
○ and ○ or ____ litres of wine
○ and ○ or ____ glasses of liquor

- ❍ don't know

(108) How much alcohol would you drink at maximum to drive still safely? Please estimate the amount on the drink you drink most.

	____ litres of beer
○ and ○ or	____ litres of wine
○ and ○ or	____ glasses of liquor
❍ don't know	

(109) Someone drinks beer with his meal and drives afterwards. Should that be allowed?

no, I'm strictly against	0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 10	yes, this should really be allowed

(110) In the following question you should estimate the risk of getting stopped by the police on different routes at different times. Please assume you are driving a five year old VW Golf without attracting attention.

How do you estimate the probability of getting caught by the police on the following routes at the stated times

?	don't know
1	**VERY UNLIKELY** nearly to exclude, that ought to be a mischance
2	**UNLIKELY** but cannot be excluded
3	**LIKELY** definitely within the realms of possibility
4	**VERY LIKELY** if the police are checking today, than here and now – better to take a taxi

ON WORKING DAYS

route / time	region	within city	within outskirt	city <->outskirt	just across country
	distance	<3km	<3km	<10km	>10km
	example	Boot -> L music club	innerhalb Lengfeld	Innenstadt <-> Lengfeld	Uettingen -> Marktheidenfeld
time	06am-12am	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4
time	12am-08pm	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4
time	08pm-02am	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4
time	02am-06am	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4

WEEKEND

route / time	region	within city	within outskirt	city <->outskirt	just across country
	distance	<3km	<3km	<10km	>10km
	example	Boot -> L music club	innerhalb Lengfeld	Innenstadt <-> Lengfeld	Uettingen -> Marktheidenfeld
time	06am-12am	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4
time	12am-08pm	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4
time	08pm-02am	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4
time	02am-06am	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4

(111) Someone drives under the influence of one of the following drugs and gets into a police stop. Do the police notice in a sobriety roadblock that the driver is under the influence of drugs?

	definitely not										definitely
1 beer	0	1	2	3	4	5	6	7	8	9	10
more than 4 beers	0	1	2	3	4	5	6	7	8	9	10
cannabis	0	1	2	3	4	5	6	7	8	9	10
stimulants (e.g. amph.,speed)	0	1	2	3	4	5	6	7	8	9	10
ecstasy	0	1	2	3	4	5	6	7	8	9	10
hallucinogens (e.g. LSD, mushrooms)	0	1	2	3	4	5	6	7	8	9	10
cocaine	0	1	2	3	4	5	6	7	8	9	10
opiates (heroin and others)	0	1	2	3	4	5	6	7	8	9	10
sedatives	0	1	2	3	4	5	6	7	8	9	10

(112) User: Have you ever thought about ceasing or restricting the consumption of one of the drugs you take (incl. alcohol)?
(In every answer several substances can be named!)

- ❍ Yes, I seriously consider ceasing the consumption of the following substance(s) within the next 6 months: _____
- ❍ Yes, it is my intention to stop the consumption of the following substance(s), but not within the next 6 months (but later): _____
- ❍ Yes, it is my intention to restrict my consumption of the following substance(s): _____
- ❍ No, I neither want to cease nor restrict my consumption.

(113) User: If you would like to stop the consumption of illegal drugs, for which reasons you would do it? *(Please, check <u>two</u> at maximum!)*

Controls: Why don't you take drugs? *(Please, check <u>two</u> at maximum!)*

- ❍ (1) for fear of penalty/legal consequences
- ❍ (2) it's to expensive
- ❍ (3) because my friends don't take drugs, too
- ❍ (4) because I can have fun without drugs
- ❍ (5) because other things became more important to me
- ❍ (6) for fear not to get my life on track
- ❍ (7) for fear of getting/being addicted
- ❍ (8) for fear of harmful effects
- ❍ (9) for fear/because of unpleasant side-effects of the drug
- ❍ (10) due to family reasons (parents, partner, relationship, pregnancy...)
- ❍ (11) other: _____
- ❍ (12) I don't want to stop.

YET ANOTHER FOUR DIFFERENT QUESTIONS…

(114) How satisfied are you with your personal life situation on the whole?

totally dissatisfied 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 totally satisfied

(115) To what extent do you agree to the following statement: „If a constitutional state should work, all laws have to be observed strictly!"?

don't agree 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 completely agree

(116) To what extent do you agree to the following statement: „I try to live on healthy food.“?

don't agree 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 completely agree

(117) To what extent do you agree to the following statement: „Someone who is always occupied with his health has no fun.“?

don't agree 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 completely agree

14.3 Q-Daily-Questionnaire

Table 54: Questions and response options of the daily questionnaire deployed on the smartphones (and serial number, corresponding data level, question number and number of response options).

Serial number	Level	Question number	Response number	Question	Response option
1	Day	1	1	For which day do you fill in the questionnaire?	date
2	Day	2	1	When did you wake up today?	time
3	Day	3	1	How long did you sleep?	0 - 14/> 14
4	Day	4	1	How well was your sleep?	very good
5	Day	4	2		good
6	Day	4	3		medium
7	Day	4	4		bad
8	Day	4	5		very bad
9	Situation	5	1	Situation?	at home
10	Situation	5	2		friends
11	Situation	5	3		relatives
12	Situation	5	4		job
13	Situation	5	5		school
14	Situation	5	6		private business
15	Situation	5	7		culture, sports
16	Situation	5	8		restaurant, bar
17	Situation	5	9		club
18	Situation	5	10		event
19	Situation	5	11		outside
20	Situation	5	12		excursion
21	Situation	5	13		accomodation
22	Situation	5	14		miscellaneous response
23	Situation	6	1	from…	time
24	Situation	7	1	to…	time
25	Drug	8	1	Did you take drugs/medicines in this situation?	yes
26	Drug	8	2		no
27	Drug	9	1	Which sort of drugs did you take?	alcohol
28	Drug	9	2		cannabis
29	Drug	9	3		amphetamine
30	Drug	9	4		ecstasy
31	Drug	9	5		LSD
32	Drug	9	6		mushrooms
33	Drug	9	7		cocaine, crack
34	Drug	9	8		heroin
35	Drug	9	9		sniffing
36	Drug	9	10		miscellaneous response
37	Drug	10	1	How much alcohol did you drink?	beer
38	Drug	10	2		wine
39	Drug	10	3		liquor
40	Drug	10	4		miscellaneous response
41	Drug	11	1	Number of consumption units?	2cl - 7l
42	Drug	12	1	consumption from…	time
43	Drug	13	1	consumption to…	time
44	Drug	14	1	How did you consume cannabis?	joint/inhalation
45	Drug	14	2		pipe/line
46	Drug	14	3		cookie/pill
47	Drug	14	4		tea/injection
48	Drug	15	1	Number of co-consumers?	1 - 5/> 5
49	Drug	16	1	Number of consumption units?	0.5 - 5/> 5
50	Drug	17	1	consumption from…	time
51	Drug	18	1	consumption to…	time
52	Drug	19	1	How did you consume amphetamines, speed?	joint/inhalation
53	Drug	19	2		pipe/line
54	Drug	19	3		cookie/pill
55	Drug	19	4		tea/injection
56	Drug	20	1	Number of co-consumers?	1 - 5/> 5
57	Drug	21	1	Number of consumption units?	0.5 - 5/> 5
58	Drug	22	1	consumption from…	time
59	Drug	23	1	consumption to…	time
60	Drug	24	1	How much ecstasy did you take? (Number of pills)	0.5 - 5/> 5
61	Drug	25	1	consumption from…	time
62	Drug	26	1	consumption to…	time
63	Drug	27	1	How much LSD did you take? (Number of blotters)	0.5 - 5/> 5
64	Drug	28	1	consumption from…	time
65	Drug	29	1	consumption to…	time
66	Drug	30	1	How many mushrooms did you take?	< 5
67	Drug	30	2		5-10
68	Drug	30	3		10-15
69	Drug	30	4		15-20
70	Drug	30	5		20-30
71	Drug	30	6		> 30

Serial number	Level	Question number	Response number	Question	Response option
72	Drug	31	1	consumption from…	time
73	Drug	32	1	consumption to…	time
74	Drug	33	1	How did you consume cocaine/crack?	joint/inhalation
75	Drug	33	2		pipe/line
76	Drug	33	3		cookie/pill
77	Drug	33	4		tea/injection
78	Drug	34	1	Number of co-consumers?	1 - 5/> 5
79	Drug	35	1	Number of consumption units?	0.5 - 5/> 5
80	Drug	36	1	consumption from…	time
81	Drug	37	1	consumption to…	time
82	Drug	38	1	How did you consume heroin?	joint/inhalation
83	Drug	38	2		pipe/line
84	Drug	38	3		cookie/pill
85	Drug	38	4		tea/injection
86	Drug	39	1	Number of co-consumers?	1 - 5/> 5
87	Drug	40	1	Number of consumption units?	0.5 - 5/> 5
88	Drug	41	1	consumption from…	time
89	Drug	42	1	consumption to…	time
90	Drug	43	1	How much sniffing agent did you take? (Number inhalations)	0.5 - 5/> 5
91	Drug	44	1	consumption from…	time
92	Drug	45	1	consumption to…	time
93	Drug	46	1	Did you take any other drugs? If yes, what kind of drug?	miscellaneous response
94	Drug	47	1	How did you take it?	joint/inhalation
95	Drug	47	2		pipe/line
96	Drug	47	3		cookie/pill
97	Drug	47	4		tea/injection
98	Drug	47	5		drops
99	Drug	48	1	Number of co-consumers?	1 - 5/> 5
100	Drug	49	1	Number of consumption units?	0.5 - 5/> 5
101	Drug	50	1	consumption from…	time
102	Drug	51	1	consumption to…	time
103	Drug	52	1	Was the consumption planned?	planned / routine
104	Drug	52	2		spontaneous
105	Drug	53	1	Have you consumed more or less than initially thought?	more
106	Drug	53	2		normal
107	Drug	53	3		less
108	Drug	54	1	How did you feel before drug-intake?	very good
109	Drug	54	2		good
110	Drug	54	3		medium
111	Drug	54	4		bad
112	Drug	54	5		very bad
113	Drug	55	1	How did you feel after drug-intake?	very good
114	Drug	55	2		good
115	Drug	55	3		medium
116	Drug	55	4		bad
117	Drug	55	5		very bad
118	Drug	56	1	How strong was the drug effect?	very weak
119	Drug	56	2		weak
120	Drug	56	3		medium
121	Drug	56	4		strong
122	Drug	56	5		very strong
123	Companion	57	1	Were any companions present?	no
124	Companion	57	2		yes
125	Companion	58	1	How many companions were present?	1 - 5/> 5
126	Companion	59	1	Gender of companions?	male
127	Companion	59	2		female
128	Companion	60	1	Age of companions?	< 13
129	Companion	60	2		13-17
130	Companion	60	3		18-24
131	Companion	60	4		25-29
132	Companion	60	5		30-39
133	Companion	60	6		> 39
134	Companion	61	1	Did companions use drugs in this situation?	no
135	Companion	61	2		yes, alcohol
136	Companion	61	3		yes, others
137	Companion	61	4		yes, both
138	Companion	61	5		don't know
139	Trip	62	1	After the situation travelled by…	on foot
140	Trip	62	2		bicycle
141	Trip	62	3		public transport
142	Trip	62	4		taxi
143	Trip	62	5		vehicle
144	Trip	62	6		transporter
145	Trip	62	7		truck
146	Trip	62	8		moped
147	Trip	62	9		motorcycle
148	Trip	62	10		miscellaneous response
149	Trip	63	1	In the car, I was the…	passenger
150	Trip	63	2		driver

Serial number	Level	Question number	Response number	Question	Response option
151	Trip	64	1	Did you take drugs on the trip? (see situation)	no
152	Trip	64	2		yes
153	Trip	65	1	Were any companions present on the trip? (see situation)	no
154	Trip	65	2		yes
155	Trip	66	1	How long was the distance of the trip?	< 1 km
156	Trip	66	2		1-5 km
157	Trip	66	3		5-10 km
158	Trip	66	4		10-25 km
159	Trip	66	5		25-100 km
160	Trip	66	6		> 100 km
161	Trip	67	1	Was the trip planned?	planned / routine
162	Trip	67	2		spontaneous
163	Trip	68	1	Why didn't you drive by yourself?	not planned
164	Trip	68	2		previous consumption
165	Trip	68	3		later consumption
166	Trip	69	1	Was the route known?	no
167	Trip	69	2		yes
168	Trip	70	1	On what road did you drive (in %)?	city
169	Trip	70	2		rural
170	Trip	70	3		motorway
171	Trip	71	1	Was there any dangerous situation?	yes
172	Trip	71	2		no
173	Trip	72	1	How dangerous was the situation?	none
174	Trip	72	2		very little
175	Trip	72	3		little
176	Trip	72	4		medium
177	Trip	72	5		much
178	Trip	72	6		very much
179	Trip	73	1	How well/safe did you drive?	very good
180	Trip	73	2		good
181	Trip	73	3		medium
182	Trip	73	4		bad
183	Trip	73	5		very bad
184	Trip	74	1	How trying was the journey?	none
185	Trip	74	2		very little
186	Trip	74	3		little
187	Trip	74	4		medium
188	Trip	74	5		much
189	Trip	74	6		very much
190	Trip	75	1	How tired have you been while driving?	none
191	Trip	75	2		very little
192	Trip	75	3		little
193	Trip	75	4		medium
194	Trip	75	5		much
195	Trip	75	6		very much
196	Trip	76	1	Did you take drugs before or during this trip?	no, no consumption intended
197	Trip	76	2		yes, consumption
198	Trip	76	3		no, abdication
199	Trip	76	4		yes, restriction
200	Trip	77	1	How impaired have you felt by the drugs?	none
201	Trip	77	2		very little
202	Trip	77	3		little
203	Trip	77	4		medium
204	Trip	77	5		strong
205	Trip	77	6		very strong
206	Trip	78	1	Did you change your driving behaviour because of the drugs?	no
207	Trip	78	2		yes, other route
208	Trip	78	3		yes, more careful
209	Trip	78	4		yes, later
210	Trip	78	5		yes, more conform
211	Trip	79	1	Today, you were driving by yourself and stated to have refrained from / restricted drug consumption therefore. Please note, in which situations that was the case.	yes
212	Trip	79	2		no
213	Trip	80	1	Did the driver consume drugs?	yes
214	Trip	80	2		no
215	Trip	80	3		don't know
216	Trip	81	1	Which drugs did the driver take?	no drugs
217	Trip	81	2		alcohol
218	Trip	81	3		cannabis
219	Trip	81	4		amphetamine
220	Trip	81	5		ecstasy
221	Trip	81	6		LSD
222	Trip	81	7		mushrooms
223	Trip	81	8		cocaine/crack
224	Trip	81	9		heroin
225	Trip	81	10		sniffing
226	Trip	81	11		miscellaneous response
227	Trip	82	1	What was the age of the driver?	<21
228	Trip	82	2		>20

Serial number	Level	Question number	Response number	Question	Response option
229	Trip	83	1	Does the driver have his license on probation?	yes
230	Trip	83	2		no
231	Trip	83	3		don't know
232	Trip	84	1	Did the driver drink more than one beer/wine?	yes
233	Trip	84	2		no
234	Day	85	1	Was the day in any way uncharacteristic for you?	no, normal
235	Day	85	2		holiday
236	Day	85	3		illness
237	Day	85	4		higher consumption
238	Day	85	5		less consumption
239	Day	85	6		higher mobility
240	Day	85	7		less mobility
241	Day	85	8		international journey
242	Day	85	9		domestic journey
243	Day	85	10		miscellaneous response
244	Day	86	1	How much occupational stress did you have today?	none
245	Day	86	2		very little
246	Day	86	3		little
247	Day	86	4		medium
248	Day	86	5		much
249	Day	86	6		very much
250	Day	87	1	How much private stress did you have today?	none
251	Day	87	2		very little
252	Day	87	3		little
253	Day	87	4		medium
254	Day	87	5		much
255	Day	87	6		very much
256	Day	88	1	In which mood have you been today?	very good
257	Day	88	2		good
258	Day	88	3		medium
259	Day	88	4		bad
260	Day	88	5		very bad
261	Day	89	1	How active did you feel today?	none
262	Day	89	2		very little
263	Day	89	3		little
264	Day	89	4		medium
265	Day	89	5		much
266	Day	89	6		very much
267	Day	90	1	How much tired have you felt today?	none
268	Day	90	2		very little
269	Day	90	3		little
270	Day	90	4		medium
271	Day	90	5		much
272	Day	90	6		very much
273	Day	91	1	How was your health today?	very good
274	Day	91	2		good
275	Day	91	3		medium
276	Day	91	4		bad
277	Day	91	5		very bad
278	Day	92	1	What were the road conditions today?	dry
279	Day	92	2		wet
280	Day	92	3		aquaplan
281	Day	92	4		slushy
282	Day	92	5		slick
283	Day	92	6		snow
284	Day	93	1	Why didn't you take drugs today?	no need
285	Day	93	2		reduction
286	Day	93	3		want be fit
287	Day	93	4		must be fit
288	Day	93	5		not available
289	Day	93	6		miscellaneous response
290	Day	94	1	Do you intend to take drugs tomorrow?	yes
291	Day	94	2		rather yes
292	Day	94	3		rather no
293	Day	94	4		no
294	Day	94	5		don't know

14.4 THC elimination curve

Table 55: THC elimination curve by Sticht (G. Sticht, personal communication, December 2009).

Elimination time (hh:mm:ss)	ng/ml per mg smoked THC	Elimination time (hh:mm:ss)	ng/ml per mg smoked THC
00:15:00	3.143	**06:15:00**	0.084
00:30:00	1.440	**06:30:00**	0.077
00:45:00	0.833	**06:45:00**	0.070
01:00:00	0.627	**07:00:00**	0.064
01:15:00	0.536	**07:15:00**	0.058
01:30:00	0.479	**07:30:00**	0.053
01:45:00	0.435	**07:45:00**	0.049
02:00:00	0.396	**08:00:00**	0.044
02:15:00	0.361	**08:15:00**	0.041
02:30:00	0.329	**08:30:00**	0.037
02:45:00	0.301	**08:45:00**	0.034
03:00:00	0.275	**09:00:00**	0.031
03:15:00	0.251	**09:15:00**	0.028
03:30:00	0.229	**09:30:00**	0.025
03:45:00	0.209	**09:45:00**	0.023
04:00:00	0.191	**10:00:00**	0.021
04:15:00	0.174	**10:15:00**	0.019
04:30:00	0.159	**10:30:00**	0.018
04:45:00	0.145	**10:45:00**	0.016
05:00:00	0.133	**11:00:00**	0.015
05:15:00	0.121	**11:15:00**	0.013
05:30:00	0.110	**11:30:00**	0.013
05:45:00	0.101	**11:45:00**	0.011
06:00:00	0.092	**12:00:00**	0.010

14.5 Consumption on previous day

Table 56: Percentage of drives positive for cannabis and/or alcohol with (same day) and without (previous day) previous consumption on same day.

Time	Consumption on previous day	Consumption on same day
5	4.26%	95.74%
6	52.22%	47.78%
7	57.01%	42.99%
8	63.96%	36.04%
9	62.96%	37.04%
10	50.91%	49.09%
11	35.14%	64.86%
12	28.42%	71.58%
13	23.48%	76.52%
14	21.58%	78.42%
15	14.71%	85.29%
16	8.81%	91.19%
17	5.05%	94.95%
18	3.15%	96.85%
19	2.30%	97.70%
20	2.15%	97.85%
21	1.15%	98.85%
22	2.00%	98.00%
23	0.29%	99.71%
24	0.97%	99.03%
1	0.99%	99.01%
2	6.40%	93.60%
3	0.00%	100.00%
4	1.39%	98.61%

14.6 Confidence intervals for BAC- / THC-positive drives

Table 57: Confidence intervals (±0.95 CI) for BAC-positive drives within the sample of users (N_{User}=195) and of controls ($N_{Control}$=100) for the age groups 18-24 and 25-39.

BAC (in %)	18-24 Control	18-24 User	25-39 Control	25-39 User
≥0.1	0.42% - 2.34%	3.62% - 6.97%	1.61% - 4.88%	3.66% - 7.53%
≥0.2	0.23% - 2.08%	3.07% - 6.28%	0.81% - 3.51%	2.89% - 6.27%
≥0.3	0.02% - 1.75%	2.34% - 5.48%	0.36% - 2.28%	1.94% - 5.08%
≥0.4	-	1.95% - 4.8%	0.06% - 1.77%	1.4% - 4.26%
≥0.5	-	1.6% - 4.37%	-	0.99% - 3.82%
≥0.6	-	1.28% - 3.81%	-	0.82% - 3.12%
≥0.7	-	1.05% - 3.51%	-	0.63% - 2.41%
≥0.8	-	0.9% - 3.14%	-	0.45% - 2.09%
≥0.9	-	0.73% - 2.71%	-	0.25% - 1.66%
≥1.0	-	0.56% - 2.43%	-	0.16% - 1.36%
≥1.1	-	0.49% - 2.23%	-	0.09% - 1.24%
≥2.0	-	0.15% - 1.37%	-	-

Table 58: Confidence intervals (±0.95 CI) for THC-positive drives within the sample of users (N_{User}=195) for the age groups 18-24 and 25-39.

THC blood plasma level (in ng/ml)	18-24	25-39
≥1	11.7% - 18.97%	8.84% - 18.93%
≥2	9.43% - 15.71%	6.63% - 15.85%
≥3	7.91% - 13.67%	5.35% - 13.82%
≥4	6.75% - 12.09%	4.46% - 12.58%
≥5	5.58% - 10.37%	3.82% - 11.55%
≥6	4.93% - 9.4%	3.47% - 10.91%
≥7	4.25% - 8.11%	3.06% - 10.28%
≥8	3.8% - 7.36%	2.54% - 9.41%
≥9	3.56% - 6.89%	2.38% - 9.01%
≥10	3.1% - 6.28%	1.99% - 8.4%
≥20	1.14% - 2.55%	0.84% - 5.3%
≥40	0.21% - 0.84%	0.07% - 2.33%