HOW DO WE PERCEIVE TRAFFIC RISK?

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Abstract: Traffic risk perception has been defined as a subjective interpretation of the risk involved in traffic situations; this concept is important for road safety, since it may predict how road users behave in traffic. In addition risk perception is often reflected in safety assessments: both from experts (during road safety inspections or investigations) and lay persons (in road user safety complaints). Subjective risk perception is also valuable in cases when other safety data are missing, for example due to underreporting or newly-built infrastructure; hence it is of interest to study the factors which determine how we perceive traffic risk.
In this respect an on-line test was prepared, consisting of general questionnaire (gender, age, driving experience), risk perception assessment (rating level of risk in video clips of traffic situations), personality questionnaire, and Driver Behaviour Questionnaire. With objective of studying the links between subjective risk assessment and personality traits, as well as differences across several dimensions (such as male vs female drivers, less/more experienced drivers, drivers vs other road users, or lay persons vs safety experts), the test was used with 144 respondents, including students and adults, certified road safety auditors or Traffic Police officers. In total 9 hypotheses were formulated and statistically tested: some of the identified relationships provided expected results, consistent with previous studies: for example high risk perception of females compared to males or lack of differences between students (non-professionals) and experts (professionals); other findings were less expected, for example lack of relationships of risk perceptions to age and experience. Nevertheless in order to reduce potential consequences of subjective assessments, based on risk perception, the identified differences should be considered in future road safety auditors' or traffic conflict observers' training procedures.

Keywords: road safety, traffic risk, risk perception, driver behaviour.

1. Introduction

It is recognized that majority of road traffic accidents may be attributed to human error (Treat et al., 1979; Hendricks et al., 2001; Andres et al., 2012). In order to propose appropriate safety countermeasures, it is thus necessary to investigate road users' characteristics and behaviour. One of determinants is traffic risk perception (also referred to as hazard perception or situation awareness), i.e. a subjective interpretation of the risk involved in traffic situations (Deery, 1999). It is also closely related to subjective safety, which refers to anxiety regarding being unsafe in traffic for oneself and/or others (Vlakveld et al., 2008). Since road users modify their behaviour according to the risk they perceive, the concept is fundamental for traffic safety – knowing risk perception may enable prediction of safety. Past studies found links of risk perception to safety in various traffic environments (e.g. Watts and Quimby, 1980; Kanellaidis and Dimitropoulos, 1994; Kowtanapanich et al., 2006; Lipovac et al., 2016). Numerous studies also described risk perception as a skill that is highly correlated with traffic crashes: experienced drivers perceive potential risk situations better and more quickly than novice drivers, while drivers who can detect hazards faster are less involved in traffic crashes than those who detect hazards slower. In contrast, inexperienced drivers with less developed risk perception skills, were found more likely to be involved in a crash (Peltz and Krupat, 1974; Armsby et al., 1989; McKenna and Crick, 1997).
Several factors were found associated to risk perception and subjective safety, including:

- Traffic features, such as road geometry, speed, traffic volume or traffic separation (Żakowska, 1995; Cho et al., 2009; Sørensen and Mosslemi, 2009),
- Biological, psychometric, cultural and societal characteristics (af Wåhlberg, 2001; Nordfjærn et al., 2011; Lim et al., 2013).

In addition, subjective safety in traffic can lead to road users limiting their mobility and social activities, which is one of the reasons it warrants policy-related attention; understanding risk perception is also important for traffic enforcement and traffic education, or for design of appropriate safety campaigns. Another interesting application is local safety assessment – i.e. using perceived (or *subjective*) risk in order to determine safety level of specific location (e.g. an intersection) or the events, which take place on such location. Traditionally *objective* safety measures have been used for this purpose, based on frequency of accumulated accidents; however accident-based measures enable reactive (retrospective) approach only. In contrast, alternative (proactive) measures, which are valuable in cases of accident non-existence, rarity or underreporting, are so called safety performance indicators or surrogate safety measures, e.g. traffic conflicts (Ambros et al., 2014). The proactive measures, utilizing principles of risk perception, may complement process of road safety inspections (Ambros et al., 2016), which are mostly based on expert judgment. These assessments are usually done off-road (outside-of-vehicle) as opposed to typical hazard perception studies being conducted from the driver perspective (on-road or in driving simulators).

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Given the interesting concept of traffic risk and its applications, it is worth investigating the factors which determine how we perceive risk. With this focus we prepared an on-line test, consisting of general questionnaire (gender, age, driving experience), risk perception assessment (rating level of risk in video clips of traffic situations), personality questionnaire, and Driver Behaviour Questionnaire. We used the test with several groups of students and adults, including certified road safety auditors or Traffic Police officers. The objective was to study the link between subjective risk assessment and personality traits, as well as differences across several dimensions, such as male vs female drivers, less/more experienced drivers, drivers vs other road users (cyclists, pedestrians), or lay persons vs traffic safety experts. The paper presents data and methods, hypotheses testing and results, followed by discussion, summary and conclusions with focus on practical implications.

2. Method

2.1. Test

An on-line test was prepared (http://riziko.cdvinfo.cz/), consisting of four parts:

1. General questionnaire (gender, age, driving experience, etc.)
2. Risk perception assessment (rating level of risk in video clips of traffic situations)
3. Personality questionnaire TVP (129 items)
4. Driver Behaviour Questionnaire (50 items)

The general questionnaire aimed at collecting basic demographic information in 30 items (gender, age, educational and marital status, occupation – including type of school and year of study in case of students, population of the city of residence, etc.) as well as information pertaining to driver experience (type and year of obtaining a driving licence, average monthly/yearly/accumulated mileage, driving offences and accidents, etc.). A five-point Likert scale was used for self-assessment of the respondents' driving skills (1 – excellent, …, 5 – very poor) and the participants were also asked to identify themselves with one group of the road users: drivers, cyclists or pedestrians.
Following the initial set of questions, a risk perception assessment was carried out using 35 video clips, i.e. short (approx. 10 seconds) records of traffic situations, displaying various situations in mostly urban environments. In terms of Czech traffic conflict technique (Ambros et al., 2014) severity grades, the interactions ranged from "none" to "severe". They displayed different interaction types between vehicles (crossing, turning, overtaking, rear-end) or between vehicles and pedestrians. The application text instructions informed the respondents that on a picture (prior to running the video) they can see the location of a traffic interaction. After running and watching the video (with one possible repetition) they were instructed to assess the perceived severity (not based on traffic rules compliance or non-compliance) on a drop-down menu (Fig. 1) using four-point Likert scale: 0 (none), 1 (slight), 2 (medium) or 3 (severe).

Fig. 1.
Interface of video clips in the on-line application, with perceived risk severity assessment on the right

The second half of the test comprised two questionnaires. First of them was the Personality questionnaire TVP ("Test zur Erfassung verkehrsrelevanter Persönlichkeitsmerkmale", Spicher and Hänsgen, 2003; Czech version by Černochová and Rudá, 2016), which is used for personality diagnostics within the scope of traffic psychology and consists of 129 four-point Likert-type items (1 – strongly disagree, …, 4 – strongly agree). There are 13 scales in total, with 7 to 12 items loading on each scale. The scales follow the Five Factor Model of personality (Neuroticism, Extraversion, Openness to experience, Agreeableness, Conscientiousness), with each factor being measured as "traffic-specific" and

"generic" (10 scales in total). Besides the five factors, "disparagement" (generic and traffic-specific) as a measure of socially desirable answers is assessed, and a reactance scale is added. The higher the score on each scale, the more noticeable the trait is for the participant.
The second was the Manchester driver behaviour questionnaire (DBQ, Reason et al., 1990; Czech version by Šucha et al., 2014), used to survey aberrant driving behaviour. It consists of 3 factors (Dangerous Violations, Dangerous Errors, Straying and Loss of Orientation) and 50 items in total. A six-point rating scale is used to measure the frequency of a particular behaviour (0 – never, …, 5 – nearly all the time): the higher the score on each factor, the more often the participant displays the aberrant driving behaviour.

2.2. Respondents

The selection of respondents followed the idea of sampling the driver population (i.e. only the holders of a driving licence) across age groups; additional idea was to use university students from several different backgrounds. Respondents were asked mostly through e-mail to participate in a survey, with no financial incentives. In the e-mail they were directed to the on-line application website, where they were to register, sign in and fill in all four mentioned parts of the test.
Following groups were targeted:

1. University students
    a. psychology students at Palacký University Olomouc (Czech abbreviation "UPOL")
    b. students of College of Logistics in Přerov ("VŠLG")
    c. transportation students of Czech Technical University in Prague ("ČVUT")
2. Traffic police officers, attending courses at Police College of the Ministry of the Interior in Prague ("VPŠ")
3. Road safety auditors, certified by the Ministry of Transport
4. Adults (i.e. non-students)

Participation of university students was arranged within their current classes; other groups participated in their free time. In total 263 respondents filled in the test; 144 (55%) of them, who completed all 4 parts, were used for the analysis. Due to small sub-samples, auditors and Traffic Police officers (VPŠ) were combined into Experts; Adults were renamed to Seniors in order to be distinguished from *adult* Experts. Selected characteristics of the subgroups are summarized in Table 1 in terms of their frequencies (counts and percents), age (minimum, maximum, mean, standard deviation) and gender structure.

Table 1
Selected descriptive characteristics of the respondents' sub-samples

	Frequency		**Age**				**Gender**	
	N	**%**	**Min.**	**Max.**	**Mean**	***SD***	**Male**	**Female**
VŠLG	55	38.2	20	25	21.8	1.12	32	23
ČVUT	24	16.7	20	32	22.4	2.18	17	7
UPOL	19	13.2	19	38	23.5	4.13	3	16
Seniors	22	15.3	30	79	53.1	13.71	16	6
Experts	24	16.7	28	67	41.3	9.94	20	4
Total	**144**	**100.0**	**19**	**79**	**30.2**	**13.83**	**88**	**56**

Respondents were mostly single (69%) or married (26%). In total, 65% and 35% identified themselves as drivers and "other users" (pedestrians or cyclists), respectively. They mostly used their traffic mode in order to get to their work or study location (40%), or short trips for shopping, socializing, sport, etc. (38%). They reported average monthly mileage 1080 km (range 0 – 10,000; *SD* = 1507.46). Škoda was reported as a typical vehicle brand (41%). Roughly one third confessed to having been fined for a traffic offence, such as speeding or wrong parking. Six respondents (4%) reported having their driving licenses withdrawn; seven respondents (5%) obtained penalty points. In total 22% caused an accident and 26% participated in accident, both mostly with slight injuries. Due to the differences in further demographic and driver experience-related characteristics, the 5 groups presented in Table 1 were retained in the study.

2.3. Data analysis and hypotheses testing

Individual respondents' data, which were obtained from on-line application, were treated as:

- Independent variables (demographic data and variables related to driver experience)
- Dependent variables (average of perceived risk from 35 video clips, 13 TVP scores and 3 DBQ factors)

We formulated following 9 hypotheses:

- H1: The average risk perception of traffic situations is lower for males than for females.
- H2: The average risk perception of traffic situations is lower for road users, who identify themselves as drivers, than for those identifying themselves as "other users".

- H3a: There is a positive association between perceived risk and age (the older the respondents, the higher their average risk perception).
- H3b: There is a negative association between perceived risk and years of holding a driving licence (the more years, the lower the average risk perception).
- H4a: There is a negative association between perceived risk and average monthly mileage (the higher the monthly mileage, the lower the average risk perception).
- H4b: There is a negative association between perceived risk and total accumulated mileage (the higher the total mileage, the lower the average risk perception).
- H5: There is a negative association between perceived risk and self-assessment of driving skills (the better the grade for the driving skills, the higher the average risk perception).
- H6: There is a negative association between perceived risk and population of city of residence (the higher the population, the lower the average risk perception).
- H7: There is a difference in average risk perception between the student groups UPOL, VŠLG, ČVUT, the expert group and the group of seniors.

Hypotheses were tested in IBM SPSS according to the following steps:

1. For each hypothesis containing an association measure, the level of each variable was determined based on the scale used (e.g., ordinal scale for self-assessment of driving skills, continual scales for age, mileages, years of holding a driving license and average risk perception).
2. For each hypothesis containing a group comparison, the normality assumption of the dependent variable was tested for each group using Shapiro-Wilk test with $\alpha = 0.05$.
3. For each hypothesis containing a group comparison, the homogeneity of variances assumption was tested using Levene's test with $\alpha = 0.05$.
4. Based on the results of the assumption testing, following methods were chosen to test the individual hypotheses:
    a. for H1 and H2, an independent-samples t-test (one-tailed, $\alpha = 0.05$) and Cohen's *d* as a measure of effect size;
    b. for H3a, H3b, H4a, H4b and H6, Pearson correlation coefficient (one-tailed, $\alpha = 0.05$);
    c. for H5, Spearman correlation coefficient (one-tailed, $\alpha = 0.05$);
    d. for H7, one-way analysis of variance ($\alpha = 0.05$).

Besides the hypotheses, between-group differences (UPOL, VŠLG, ČVUT, experts, and seniors) were also tested for TVP scales and DBQ factors. Shapiro-Wilk test was firstly used to investigate normality assumption of all dependent variables for each group. Normality held ($p > 0.05$) for most TVP scores, with exception of generic extraversion for VŠLG students ($p = 0.037$), traffic-specific extraversion for UPOL students ($p = 0.004$), traffic-specific agreeableness for UPOL students ($p < 0.001$) and reactance scale for all student groups ($p < 0.05$). Each DBQ factor showed non-normal distribution of the scores for at least 2 of the groups ($p < 0.01$), which could be expected due to the nature of the variables (aberrant behaviour). Differences between groups in terms of all TVP scores, with the exception of reactance scale, were then analysed using one-way analysis of variance ($\alpha = 0.05$) and post-hoc tests with Bonferroni correction where necessary. Kruskal-Wallis test was used to test for group differences for the reactance scale and DBQ factors ($\alpha = 0.05$; post-hoc tests with adjusted p-value were also carried out where necessary).

3. Results

Overall differences between groups in the TVP scale scores are summarized in Table 2.

Table 2
Differences between groups in generic (g) and traffic-specific (t) TVP scales, using one-way analysis of variance (ANOVA, df1 = 4, df2 = 139)

	VŠLG		ČVUT		UPOL		Seniors		Experts		ANOVA	
	Mean	***SD***	**Mean**	***SD***	**Mean**	***SD***	**Mean**	***SD***	**Mean**	***SD***	***F***	**Sig.**
Extraversion-g	27.45	5.76	25.33	4.53	25.63	5.73	26.59	4.72	25.83	6.47	0.874	0.482
Extraversion-t	27.06	6.69	23.33	5.95	19.90	5.67	21.68	4.2	20.50	5.17	8.981	< 0.001
Neuroticism-g	28.73	4.66	29.96	4.85	31.44	4.82	25.82	5.27	25.88	4.90	5.776	< 0.001
Neuroticism-t	20.95	4.99	21.50	3.97	25.11	4.82	19.50	5.27	18.92	5.60	5.420	< 0.001
Conscientiousness-g	36.44	4.68	38.25	4.56	37.21	4.69	36.64	4.17	38.13	4.10	1.061	0.378
Conscientiousness-t	25.98	3.87	26.50	3.66	25.84	3.93	28.18	3.57	27.54	3.85	1.879	0.117
Openness-g	24.42	5.30	27.17	3.81	29.26	5.53	30.41	3.69	27.75	3.83	8.884	< 0.001
Openness-t	21.47	4.93	20.92	5.66	15.58	4.51	18.91	4.30	19.80	5.44	5.587	< 0.001
Agreeableness-g	24.86	3.70	24.92	4.40	27.68	1.70	27.96	4.19	27.88	3.79	5.665	< 0.001
Agreeableness-t	15.69	3.44	17.92	3.51	20.84	2.75	18.41	3.32	20.33	2.44	14.140	< 0.001
Disparagement-g	31.58	3.94	30.42	3.15	30.68	3.54	31.32	4.24	30.73	3.70	0.536	0.709

Disparagement-t	24.35	4.44	23.96	5.36	26.42	5.00	24.90	5.34	25.83	4.80	1.207	0.311

Post-hoc tests with Bonferroni correction were carried out in case of significant ANOVA results. Based on these, a difference between VŠLG students and all other groups except for ČVUT students was found in traffic-specific extraversion ($p < 0.01$ for each VŠLG-group comparison, except ČVUT, $p = 0.104$). In generic neuroticism, a difference exists between ČVUT students and seniors as well as experts ($p < 0.05$ each), and between UPOL students and seniors as well as experts ($p < 0.01$ each). In traffic-specific neuroticism, a difference was found between UPOL students and VŠLG students ($p < 0.05$), UPOL students and seniors and experts ($p < 0.01$ each). Further, a difference between VŠLG students and all other groups except for ČVUT students was found in generic openness ($p < 0.05$ for each VŠLG-group comparison, except ČVUT, $p = 0.146$). In traffic-specific openness, a difference exists between UPOL students and VŠLG and ČVUT students ($p < 0.01$ each). In generic agreeableness, a difference was found between VŠLG students and seniors as well as experts ($p < 0.05$ each), and a possible difference might exist between VŠLG and UPOL students ($p = 0.051$). Finally, a difference between VŠLG students and all other groups except for ČVUT students ($p = 0.052$) was found in traffic-specific agreeableness ($p < 0.01$ each), and there was a difference between ČVUT and UPOL students in this trait as well ($p = 0.035$).
Group differences in the reactance scale were examined using Kruskal-Wallis test (K-W = 41.220; $df = 4$; $p < 0.001$), with a difference found between VŠLG and UPOL students ($p < 0.001$), ČVUT students ($p = 0.012$) as well as experts ($p < 0.001$). Using Kruskal-Wallis test, no group differences were found in DBQ factor 2 (Dangerous Errors; K-W = 5.197; $df = 4$; $p = 0.268$) or factor 3 (Straying and Loss of Orientation; K-W = 1.592; $df = 4$; $p = 0.810$). The only difference between the groups was found in factor 1 (Dangerous Violations; K-W = 10.881; $df = 4$; $p = 0.028$), probably due to the difference between VŠLG and UPOL students (unadjusted $p = 0.018$) as well as experts (unadjusted $p = 0.009$); the adjusted p-values were, however, not significant in the post-hoc tests ($p = 0.178$ and $p = 0.089$ respectively). In the following paragraphs, individual hypothesis tests are reported.

3.1. H1: The average risk perception of traffic situations is lower for males than for females

Descriptive characteristics are reported in Table 3. Normality assumption of average risk perception was retained (Shapiro-Wilk test, $p > 0.05$ for both groups), as well as the assumption of homogeneity of variances of both groups (Levene's test, $F = 0.553$, $p = 0.458$). Using the independent samples t-test, at the significance level of 0.05, a difference was found between males and females in their average risk perception (one-tailed $t_{142} = -2.766$, $p = 0.003$). On average, females perceive the risk of traffic situations as higher than males. Therefore, hypothesis H1 is accepted. In terms of practical significance (statistical power), the effect size is medium (Cohen's $d = 0.473$).

Table 3
Descriptive characteristics for testing of hypothesis H1, using Shapiro-Wilk (S-W) test

	N	Mean	*SD*	*SE*	S-W test	Sig.
Males	88	1.59	0.46	0.05	0.991	0.787
Females	56	1.81	0.47	0.06	0.984	0.647

3.2. H2: The average risk perception of traffic situations is lower for road users, who identify themselves as drivers, than for those identifying themselves as "other users"

Descriptive characteristics are reported in Table 4. Normality assumption of average risk perception was retained (Shapiro-Wilk test, $p > 0.05$ for both groups), as well as the assumption of homogeneity of variances of both groups (Levene's test, $F = 0.938$, $p = 0.334$). Using the independent samples t-test, at the significance level of 0.05, no difference was found between drivers and "other users" in their average risk perception (one-tailed $t_{141} = -0.053$, $p = 0.479$; Cohen's $d = 0.008$). Therefore, hypothesis H2 is rejected.

Table 4
Descriptive characteristics for testing of hypothesis H2, using Shapiro-Wilk (S-W) test

	N	Mean	*SD*	*SE*	S-W test	Sig.
Other users (pedestrians/cyclists)	50	1.67	0.42	0.06	0.978	0.457
Drivers	93	1.68	0.51	0.05	0.989	0.600

3.3. H3a: There is a positive association between perceived risk and age (the older the respondents, the higher their average risk perception)

Based on Pearson correlation coefficient, no association between perceived risk and age was found at $\alpha = 0.05$ level (one-tailed $r_{144} = -0.033$, $p = 0.348$). Therefore, hypothesis H3a is rejected.

3.4. H3b: There is a negative association between perceived risk and years of holding a driving licence (the more years, the lower the average risk perception)

Based on Pearson correlation coefficient, no association between perceived risk and years of holding a driving licence was found at $\alpha = 0.05$ level (one-tailed $r_{144} = 0.003$, $p = 0.486$). Therefore, hypothesis H3b is rejected.

3.5. H4a: There is a negative association between perceived risk and average monthly mileage (the higher the monthly mileage, the lower the average risk perception)

Graphs in Fig. 2 display the average perceived risk plotted against average monthly mileage (in kilometres). Based on Pearson correlation coefficient, initially, no significant association between perceived risk and average monthly mileage was found at $\alpha = 0.05$ level (one-tailed $r_{144} = -0.120$, $p = 0.076$). Upon closer inspection, there are 4 outliers in the sample (full dots in the left graph) – the drivers who reported driving 5800 km per month or more. After discarding these respondents, the correlation increases and becomes statistically significant (one-tailed $r_{140} = -0.157$, $p = 0.032$; restricting the hypothesis to drivers with an average monthly mileage < 5800 km). However, the association is still very weak (R^2 close to zero in both cases) and there are no further reasons for discarding the outliers (except that they have unusually high average monthly mileage in comparison with the rest of the sample). We therefore conclude, in compliance with the initial results, that there is no significant association between perceived risk and average monthly mileage and reject the hypothesis H4a.

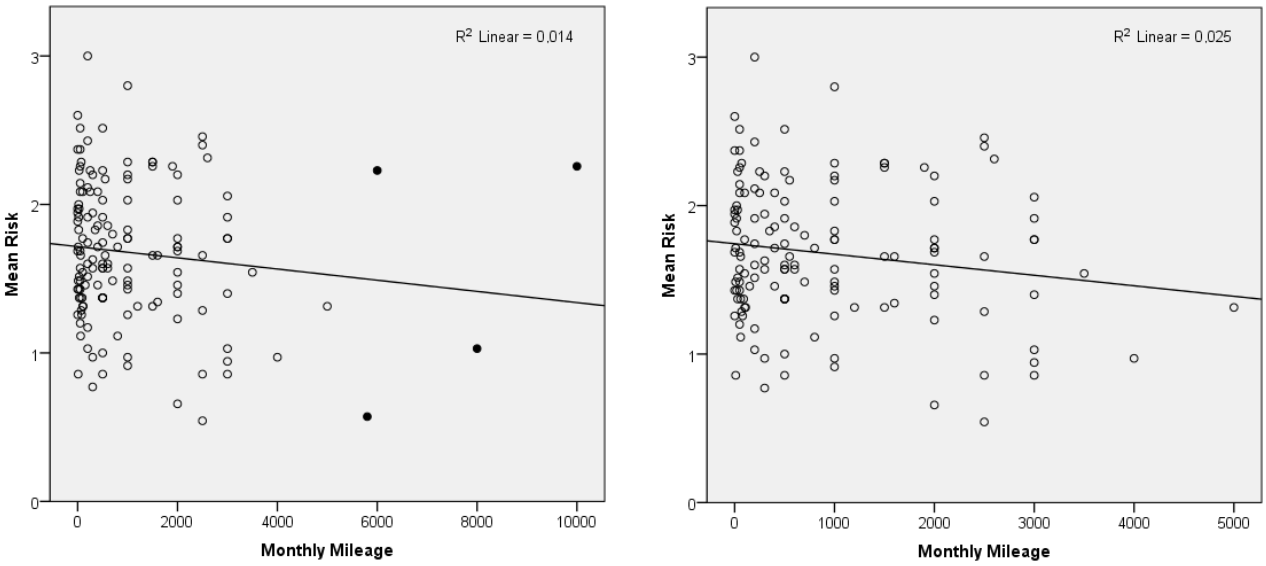

Fig. 2.
Relationship between average perceived risk and monthly mileage, with and without outliers (full dots)

3.6. H4b: There is a negative association between perceived risk and total accumulated mileage (the higher the total mileage, the lower the average risk perception)

Graphs in Fig. 3 display average perceived risk plotted against total accumulated mileage (in kilometres). Based on Pearson correlation coefficient, initially, a weak negative association between perceived risk and total accumulated mileage was found at $\alpha = 0.05$ level (one-tailed $r_{144} = -0.185$, $p = 0.013$). However, the R^2 is close to zero, and upon further inspection, there are 2 outliers in the sample (full dots in the left graph) – the drivers who reported having driven 1.4 and 1.5 million km. After discarding these respondents, the correlation decreases and becomes statistically insignificant (one-tailed $r_{142} = -0.123$, $p = 0.073$). Because the association between the two inspected variables is weak in both cases (R^2 close to zero), and probably influenced by the two respondents with unusually high total monthly mileage, we conclude that there is no association between perceived risk and total accumulated mileage and reject hypothesis H4b.

3.7. H5: There is a negative association between perceived risk and self-assessment of driving skills (the better the grade for the driving skills, the higher the average risk perception).

Based on Spearman correlation coefficient, no association between perceived risk and self-assessment of driving skills was found (one-tailed $\rho_{144} = 0.130$, $p = 0.060$). Therefore, hypothesis H5 is rejected.

3.8. H6: There is a negative association between perceived risk and population of city of residence (the higher the population, the lower the average risk perception)

Based on Pearson correlation coefficient, a significant weak negative association was found between perceived risk and population of city of residence (one-tailed $r_{144} = –0.233$, $p = 0.003$). Solely on these results, hypothesis H6 is accepted. No apparent outliers were identified in the data, however, the association is still low ($R^2 = 0.05$).

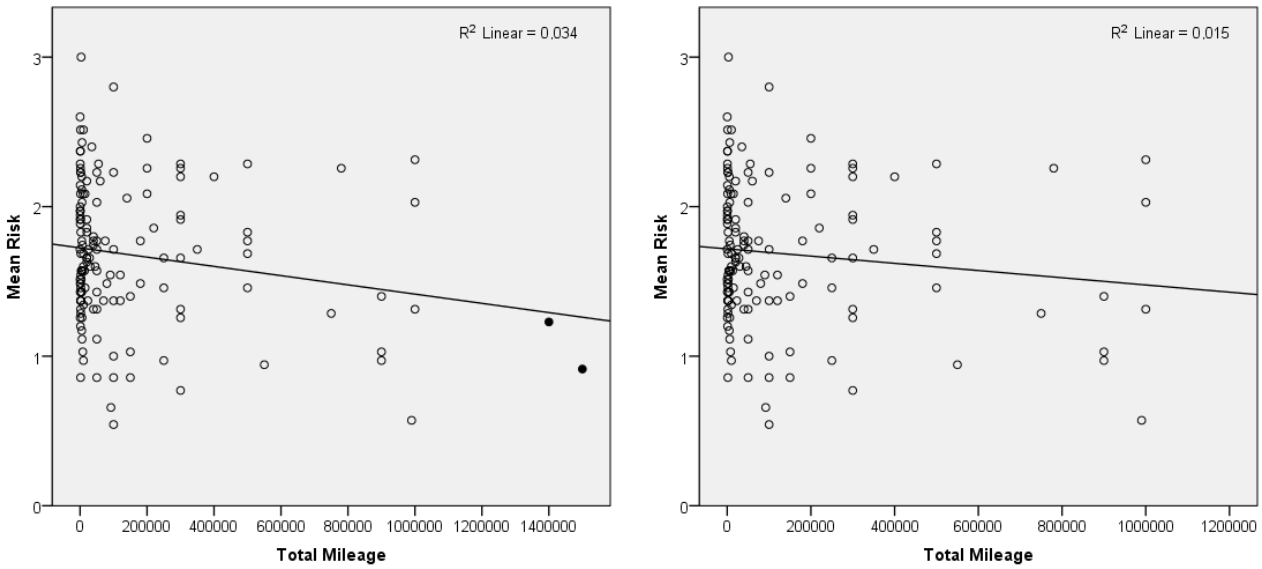

Fig. 3.
Relationship between average perceived risk and total mileage, with and without outliers (full dots)

3.9. H7: There is a difference in average risk perception between the student groups UPOL, VŠLG, ČVUT, the expert group and the group of seniors

Descriptive characteristics are reported in Table 5. Normality assumption of average risk perception was retained for all groups (Shapiro-Wilk test, $p > 0.05$ each), as well as the assumption of homogeneity of variances (Levene's test, $F_{4, 139} = 1.429$, $p = 0.228$). Using the one-way analysis of variance, at the significance level of 0.05, no difference was found between the student groups UPOL, VŠLG, ČVUT, the expert group and the group of seniors ($F_{4, 139} = 1.765$, $p = 0.139$; see Fig. 4). Therefore, hypothesis H7 is rejected.

Table 5
Descriptive characteristics for testing of hypothesis H7, using Shapiro-Wilk (S-W) test

	N	Mean	*SD*	S-W test	Sig.
VŠLG	55	1.79	0.50	0.986	0.754
ČVUT	24	1.56	0.38	0.976	0.819
UPOL	19	1.51	0.39	0.960	0.572
Seniors	22	1.64	0.57	0.975	0.831
Experts	24	1.70	0.43	0.946	0.219

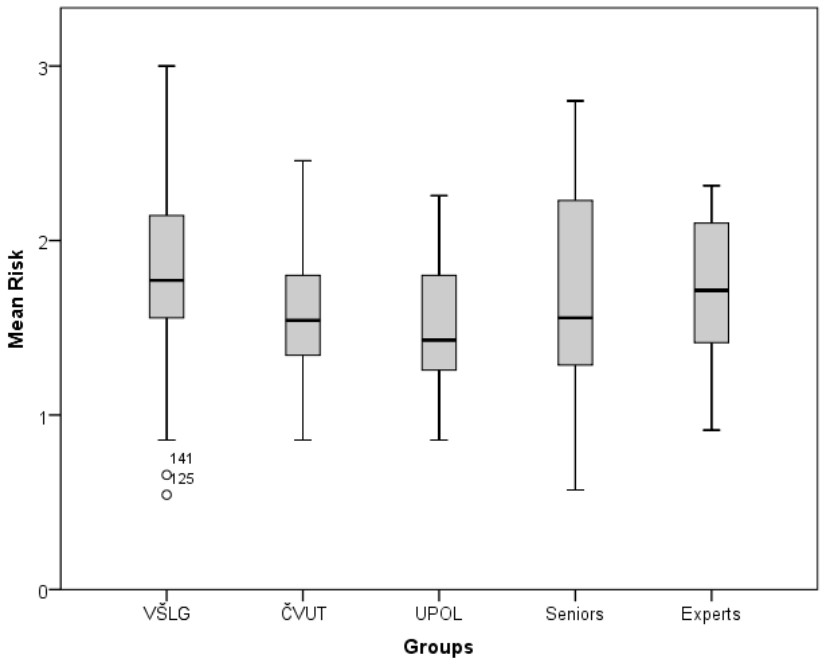

Fig. 4.
Average perceived risk of traffic situations for individual respondent groups

4. Discussion

The results of previous hypotheses testing are summarized and discussed in the following paragraphs:

– *(H1) On average, females perceive the risk of traffic situations as higher than males*. This finding is consistent with earlier studies, which indicated that males tend to be more optimistic regarding their driving skills and perceive the behaviours as less serious and less likely to result in accidents (DeJoy, 1992; Farrand and McKenna, 2001; De Craen et al., 2011).

– *(H2) No difference was found between drivers and "other road users" (pedestrians/cyclists) in their average risk perception.* While it appears as surprising, this may be caused by the fact that most of video clips displayed interactions between vehicles. It means that the respondents, who identified themselves as primarily pedestrians or cyclists, may perceive the risk as related to vehicle drivers rather than to themselves. Nevertheless this is not supported by theory, since neither cyclists' risk perception nor comparisons to drivers' risk perceptions have been sufficiently studied so far, as indicated e.g. by Chaurand and Delhomme (2013) or Lehtonen et al. (2016).

– *(H3a) No association was found between perceived risk and age* and *(H3b) No association was found between perceived risk and years of holding a driving licence*. These findings are not consistent with general knowledge that hazard perception is related to age and experience (Finn and Bragg, 1986; Sagberg and Bjørnskau, 2006; Borowsky et al., 2009), which both contribute to over-involvement of young drivers in accidents. This might be caused by research sample bias, as the sample is rather small and consists mainly of students (younger participants) and traffic experts (older participants). Hypothesis then might be, that both groups perceive traffic risk at the same or similar level, but due to different reasons: young people because of their age (they are known to rather underestimate risk) and traffic experts (older drivers) because of their experience (belief that they can handle such a situation).

– *(H4a) There is no association between perceived risk and average monthly mileage* and *(H4b) There is no association between perceived risk and total accumulated mileage*. Similarly to hypotheses H3a and H3b, we did not find sufficient evidence for the association of driving experience and risk perception in traffic situations in our sample. This could be the result of the aforementioned sample bias – most participants (85%) in our sample reported driving 2000 km or less on average per month and having driven 35000 km or less in total. A less restricted sample in terms of driving experience (i.e., including more professional drivers) might yield different results and become more consistent with existing literature.

– *(H5) No association between perceived risk and self-assessment of driving skills was found.* This finding is not surprising, since literature is mixed on this topic: some studies reported positive correlations, some negative, some none (e.g. Hattaka et al., 1997; Lund and Rundmo, 2009). We expected negative correlation between self-assessment of driving skills and level of risk perception: the better the grade drivers give themselves (with "1"

meaning "excellent"), the higher the average risk perception (i.e. the more aware the drivers are of the traffic risk). One of the reasons why this relationship is so unclear might be the fact that most of the studies (including ours) did not distinguish between risk perception ("if I can identify risk, I can see the risk") and ability to handle the risk ("I perceive risk, but I believe I know how to handle it and so I don't consider this situation as risky").

- *(H6) A negative association between perceived risk and population of city of residence was found*. This finding may relate to possible differences in traffic performance and patterns in less vs more inhabited areas. Previous analyses, based on place of residence (as opposed to place of accident) shown that the risk is lower for city population compared to suburban and rural population (Blatt and Furman, 1998; Scheiner and Holz-Rau, 2011). These differences may have been translated to driving behaviour and skills, and in turn to hazard perceptions of users living in cities. However, we should keep in mind that the association in our sample was still rather weak.

- *(H7) No difference was found between the student groups UPOL, VŠLG, ČVUT, the expert group and the group of seniors in terms of average risk perception.* This hypothesis was originally formulated with the idea of checking the anticipated value of expert judgment, which is applied by certified auditors during road safety inspections. Lack of difference may be surprising; however there were previous studies aiming in the same direction. For example Sivak et al. (1989) did not find any differences in risk ratings of professional vs non-professional drivers; also Kouabenan (2002) found similar hazard perception patterns across various occupation and experience groups. In another study (Kruysse and Wijlhuizen, 1992), experts and lay persons were found equally reliable in judging hazardous traffic situations. These features may influence the expert judgments, in addition to already known biases, such as reliability between experts, confirmation of expectancies or skewed descriptive analyses, which are all important elements in road safety inspections and investigations. Although solutions were proposed (Melcher et al., 2001; Cafiso et al., 2006; Elvik, 2006; Washington et al., 2009; Brenac et al., 2012; Park and Sahaji, 2013; Classen et al., 2015), they have not yet become a standard practice.

It should also be noted that the presented study had limitations, which may influence the results and their interpretation:

- Sample size was low, which limited possibility of validation; in addition distribution was skewed towards students. In three of five groups males were overrepresented compared to females.
- The questionnaires were not designed to distinguish between risk perception and ability to handle the risk.
- Video clips of traffic scenes were taken "off-road", which may reduce comparability with previous studies that were typically from the driver perspective. In other words: in the present study, respondents assessed the risk to others, while most studies dealt with risk to respondents themselves. Perceived risks in these perspectives may differ, as noted for example by Sjöberg (2000).
- Pearson correlation coefficients for H3, H4 and H6 were rather low.

5. Summary and conclusions

The study objective was to reveal the links between subjective risk assessment and personality traits – the authors wanted to find an answer to the question *How do we perceive traffic risk?* To this end an on-line test was prepared, consisting of general questionnaire, risk perception assessment, personality questionnaire, and Driver Behaviour Questionnaire. Several groups of respondents filled in the test and their data were analysed.

Some of the identified relationships provided expected results, consistent with previous studies: for example high risk perception of females compared to males or lack of differences between students (non-professionals) and experts (professionals). Other findings were less expected, for example lack of relationships of risk perceptions to age and experience. These could have been influenced by small size of respondent sample or the fact that video clips, used for risk perception assessment were "off-road", as opposed to typical "on-road" design, which could limit comparability to past research.

Nevertheless the idea of the "off-road" video clips was to mimic the view of traffic experts, who conduct road safety inspections, i.e. "ordinary periodical verifications of the characteristics and defects that require maintenance work for reasons of safety" (European Directive 2008/96/EC). The inspections involve survey and reporting with use of check lists, optionally including traffic conflict observations, speed measurements or accident analyses. All these task are to some extent subjective, i.e. possibly influenced by risk perceptions. In this regards the identified differences, based for example on gender or city population, should be considered. Future improved studies may lead to implementation of these aspects in order to improve road safety auditors' or traffic conflict observers' training procedures.

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