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ORIGINAL PAPER

The Manchester driver behaviour questionnaire: self-reports of aberrant behaviour among Czech drivers

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Abstract
Purpose Considering the human contribution to car crashes, it seems necessary to make a distinction between different forms of aberrant driver behaviour and its different psychological origins. The aim of the present study was to determine the factors that affect driving behaviour, to prepare a factor model, to identify the role of age, gender, kilometres driven per year, and social status, and to examine the relationship between self-reported driver behaviour in DBQ and self-reported accident involvement and offences among Czech drivers.
Methods For this purpose the original 50-item version of DBQ was translated and adjusted to the Czech driver population. A total of 2,684 Czech drivers participated in the study, 1,791 men and 893 women. Responses to the 50 items were submitted to a principal components analysis with a varimax rotation.
Results Our research confirmed a three-factor approach as the most appropriate for the interpretation of data. In our case, the three-factor solution can provide an explanation for 31.75 % of the total variance.
Conclusions While Factor 1, "Dangerous Violations", and Factor 2, "Dangerous Errors", are consistent with the findings of other authors, Factor 3, interpreted as "Not Paying Attention to Driving, Straying, and Loss of Orientation", has been identified as a new one. In addition, predictors of (driver behaviour) factors defining the driver groups prone to engaging in specific types of driving behaviour are further discussed. Practical implications for the education, training, and assessment of drivers, preventive measures, and on-board assistance systems are addressed.

Keywords Driver behaviour questionnaire (DBQ) · Aberrant driver behaviour · Driving mistakes · Driving errors

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1 Introduction

DBQ (The Manchester Driver Behaviour Questionnaire) is a self-report questionnaire developed by Reason, Manstead, Stradling, Baxter, and Campbell in the United Kingdom in 1990 as a measure of aberrant driving behaviours [1]. The original version comprises 50 items referring to drivers' aberrations. Respondents are asked to rate on a six-point scale (1= never; 2=hardly ever; 3=occasionally; 4=quite often; 5= frequently; 6=nearly all the time) how often they experience specific types of aberrant driving behaviours. While the concept of aberrant behaviour implied in the DBQ scales has been used in the Czech setting, Reason's original 50-item questionnaire has not been translated into Czech and localized yet. The questionnaire primarily reflects the difference between two main types of aberrant driving behaviour: "errors" and "violations"). The main distinction between these two types involves the degree of planned action, or conscious decision. While errors are characterised by unplanned behaviour, the violation of traffic rules is an intentional aberration. Reason later added a "slips and lapses" scale characterised by attention and memory failures. Reason's taxonomy is applicable to Keskinen's Gadget model [2], where errors would pertain to the first two domains of the model (vehicle manoeuvring and mastering traffic situations), while violations would be associated with the other two domains (the goals and context of driving and goals for life and skills for living). This can be put to use with respect to young drivers, for example [3].

Different studies varied in their conclusions about the number of scales. Working with a sample of 135 drivers, Blockey and Hartley [4] confirmed the existence of three factors – general errors, dangerous errors, and dangerous violations. In a study involving 1,400 respondents, Aberg and Rimmö [5] showed two factors – violations and dangerous errors – while the third factor, harmless lapses, broke down into two new factors – inattention errors and inexperience errors. Sullman, Meadows, and Pajo [6] suggested four factors, namely errors, lapses, and aggressive and ordinary violations. In line with Reason's original propositions, Parker, Reason, Manstead, and Stradling [7] defined lapses, errors, and violations with a sample of 1,600 drivers. There are studies that even confirm five factors, for example, Parker et al. [8] who examined 1989 senior drivers (the study sample comprised drivers aged 50+).

There are many more studies dealing with this topic. The above review illustrates not only the inconsistency of researchers' opinions about the number and focus of the factors that are present in DBQ and that describe risky driving behaviour, but also that DBQ is an instrument that is commonly used to investigate driver behaviour. A comprehensive review of studies using DBQ was put together by Harrison [9], who also structured the changes in the questionnaire by subject and provided numerous examples.

DBQ is widely used to survey aberrant driving behaviour around the world [10]. While each translation and adaptation of the instrument involves modifications to the scales and the formulations and number of the items, the results and the prevalence of the use of this measure prove its usefulness. Gras et al. [11] adapted DBQ for use in the Spanish setting, which involved two translations into Spanish and one inverse translation into the original English version. Using factor analysis, they then demonstrated the existence of four factors, with one of them suggesting a mixture of lapses and errors. Noting the possibility of the meanings of some important items being lost in the translation of the original into another language, the authors suggest that a good-quality translation of the questionnaire is vital. The translation of DBQ is also addressed by Lajunen, Parker, and Summala [12], who demonstrated the reliability of the Finnish and Dutch version of DBQ as being comparable to that of the original UK version and the four-factor structure [13]. In China DBQ was modified into CDQ (Chinese Driving Questionnaire) [14]. A recently published new French version [15] demonstrated six factors: dangerous errors, inattention errors, inexperience errors, ordinary violations, aggressive violations, and positive behaviours. While DBQ is often used to assess aberrant behaviour among a certain group of drivers (e.g. young and novice drivers – see, for example, [16]), a recent Danish study suggests that the results across age categories are stable [17].

The aim of this paper is to determine the factors that affect driving behaviour, to prepare a factor model, to identify the role of age, gender, kilometres driven per year, and social status, and to examine the relationship between self-reported driver behaviour in DBQ and self-reported accident involvement and offences among Czech drivers.

2 Material and methods

The original 50-item version of DBQ [1], translated and adapted to the Czech setting by permission of its author, was used to conduct the research. In methodological terms, the conversion of the English original of the questionnaire was carried out in following steps. The first step involved the questionnaire being translated into Czech by two independent translators. Following the review of these translations by Czech traffic psychologists, problematic items were identified (in terms of wording, ambiguity, and specific features of the Czech context), and these were then translated anew by another translator. On the basis of such consultations, the first Czech wordings of the items were defined. The next step of the adaptation involved a discussion with respondents.

The same version was used for a pilot survey carried out on a sample of $n=56$ drivers, during which the reliability of the scales was tested, in addition to the final wording of the items. The three steps thus revealed potentially misleading items, the wording of which was subsequently changed in order to eliminate the ambiguity while retaining their meanings and ensuring that they can still feed into the relevant scale. The greatest change concerned Item 6, which originally read: "Attempt to drive away without first having switched on the ignition", but was changed into "Attempt to drive away with the handbrake on." Item 34 was shortened for the sake of comprehensibility. The original version, "Overtake a single line of stationary or slow-moving vehicles, only to discover that they were queuing to get through a one-lane gap or roadwork lights", was changed into "Overtake a single line of stationary or slow-moving vehicles, only to discover that they were queuing to get through a one-lane gap".

The adaptation also concerned the six-point rating scale used to measure the frequency of behaviour. Six options were chosen for the sake of consistency with the original UK version. In the Czech setting frequency options are typically expressed on a five-point scale. Therefore, again, a translator, a methodologist, and the Institute of the Czech Language were consulted about this part of the translation. The final rating scale turned out to be in full accordance with its English equivalent. Another difference from traditional frequency differentiation scales was the absence of the "always" option, which had proved ineffective, as by nature the questionnaire addresses aberrant driving behaviour, which cannot be experienced at all times. Even the "nearly all the time" option is regarded as extreme enough to be used as the opposite of the "never" option. Respondents thus chose one of six options

(1=never, 6=nearly all the time) for each of the fifty items of the questionnaire.

The adapted DBQ was followed by a 22-item questionnaire enquiring about the respondent's driving history and sociodemographic information needed to process the data. In conclusion, the participants were asked two open-ended questions of a qualitative nature concerning their attitudes to driving and the role of a driver. The questionnaire was distributed via the internet. It was placed on an easy-to-remember domain and disseminated using social networks and web-based advertising. On average it took 20 min to complete. 2,684 respondents, 1,791 men and 893 women, participated in the online survey. Given that the Czech driver population comprises some 6.6 million people, the sample accounts for approximately 0.04 % of the total number of drivers in the Czech Republic. As for gender representation, 66 % of the respondents were men and 34 % women; these proportions are similar in the general population, as shown by the commonly stated male/female ratio of 60:40. The sample was not weighted in terms of age. Young drivers (under 27) accounted for 70 % of the respondents, with 41 % of the whole sample comprising drivers in the 18–22 age category. Drivers aged 28 to 42 accounted for 25 % of the sample. Thus only 5 % of the participants were aged above 42. The respondents' age structure corresponds to their occupational status: 44 % were students and 50 % were employees or freelancers.

3 Results

The aim of the present study was to determine the factors that affect driving behaviour, to prepare a factor model, to identify the role of age, gender, kilometres driven per year, and social status, and to examine the relationship between self-reported driver behaviour in DBQ and self-reported accident involvement and offences among Czech drivers.

3.1 Relative frequencies of the driver behaviour items

When the 50 items were ranked according to their rated mean frequencies, the five most frequently occurring behaviours were: "Check your speedometer and discover that you are unknowingly travelling faster than the legal limit" (Mn=2.49, SD=1.24), "Deliberately disregard the speed limits late at night or very early in the morning" (Mn=2.23, SD=1.59), "Drive with only "half an eye" on the road while looking at a map, changing a radio channel, etc." (Mn=1.65, SD=1.16), "Drive along country roads at night as fast with dipped lights as on full beam" (Mn=1.54, SD=1.56), and "Forget which gear you are currently in and have to check with your hand" (Mn=1.50, SD=1.30). Three out of the five most highly ranked items relate to behaviour connected to speed and speeding. The means and standard deviations for all 50 items are given in Table 1.

3.2 Factor analysis

Responses to the 50 items were submitted to a principal components analysis with a varimax rotation. The scree plot (Fig. 1) indicated that the data were best fitted by a three-factor solution. The third factor (Not Paying Attention to Driving, Straying, and Loss of Orientation) is rather weak; the reason for its incorporation was rather well-based psychological interpretation. These three factors accounted for 31.75 % of the total variance. Factor 1 (Dangerous Violations) accounted for 18.07 % of the total variance, Factor 2 (Dangerous Errors) for 10.18 % of the total variance, and Factor 3 for 3.51 % of the total variance.

The items that loaded most highly for Factor 1 (Dangerous Violations) were:

- "Race" oncoming vehicles for a one-car gap on a narrow or obstructed road. (0.70)
- Get involved in unofficial "races" with other drivers. (0.69)
- Stuck behind a slow-moving vehicle on a two-lane highway, you are driven by frustration to try to overtake in risky circumstances. (0.69)
- Drive especially close or "flash" the car in front as a signal for that driver to go faster or get out of your way. (0.68)
- Deliberately disregard the speed limits late at night or very early in the morning. (0.65)
- Become impatient with a slow driver in the outer lane and overtake in places where it is not allowed (outside urban areas, for example). (0.63)
- Overtake a slow-moving vehicle in the inside lane or on the hard shoulder of a motorway. (0.60)

The highest loadings for Factor 2 (Dangerous Errors) were:

- Misjudge your crossing interval when turning right and narrowly miss a collision. (0.60)
- Fail to check your mirror before pulling out, changing lanes, turning, etc. (0.60)
- Fail to notice pedestrians crossing when turning into a side street from a main road. (0.58)
- Try to overtake without first checking your mirror, and then get hooted at by the car behind which has already begun its overtaking manoeuvre. (0.54)
- Ignore "give way" signs, and narrowly avoid colliding with traffic having the right of way. (0.54)
- Lost in thought or distracted, you fail to notice someone waiting at a zebra crossing, or a pelican crossing light that has just turned red. (0.53)

Table 1 Items from the driver behaviour questionnaire (DBQ) in descending order of mean score

Q no.	Item	Mean	SD
2	Check your speedometer and discover that you are unknowingly travelling faster that the legal limit.	2.49	1.24
21	Deliberately disregard the speed limits late at night or very early in the morning.	2.23	1.59
45	Drive with only "half an eye" on the road while looking at a map, changing a radio channel, etc.	1.65	1.16
5	Drive along country roads at night as fast with dipped lights as on full beam.	1.54	1.56
15	Forget which gear you are currently in and have to check with your hand.	1.5	1.3
13	"Wake up" to realise that you have no clear recollection of the road along which you have just travelled.	1.47	1.17
16	Stuck behind a slow-moving vehicle on a two-lane highway, you are driven by frustration to try to overtake in risky circumstances.	1.34	1.23
4	Become impatient with a slow driver in the outer lane and overtake in places where it is not allowed (outside urban areas, for example).	1.25	1.34
6	Attempt to drive away with the handbrake on.	1.15	0.93
33	Plan your route badly, so that you meet traffic congestion you could have avoided.	1.09	0.9
27	Have an aversion to a particular class of road user, and indicate your hostility by whatever means you can.	1.06	1.24
39	Fail to give way when a bus is signalling its intention to pull out.	1.05	1.08
47	Get involved in unofficial "races" with other drivers.	1.05	1.27
14	Miss your exit on a motorway and have to make a lengthy detour.	1.02	0.88
9	Distracted or preoccupied, realise belatedly that the vehicle ahead has slowed, and have to slam on the brakes to avoid a collision.	1.01	0.81
8	Forget where you left your car in a multi-level car park.	0.96	1.17
23	Lost in thought, you forget that your lights are on full beam until "flashed" by other motorists.	0.96	0.83
29	Park where it is not allowed and risk a fine.	0.96	1.11
34	Overtake a single line of stationary or slow-moving vehicles, only to discover that they were queuing to get through a one-lane gap.	0.85	1.06
18	Take a chance and go through lights that have turned red.	0.83	1.03
37	Get into the wrong lane at a roundabout or approaching a road junction.	0.8	0.82
46	Fail to notice pedestrians crossing when turning into a side street from a main road.	0.79	0.83
17	Intending to drive to destination A, you "wake up" to find yourself en route to B, where the latter is your more usual journey.	0.75	0.95
28	Lost in thought or distracted, you fail to notice someone waiting at a zebra crossing, or a pelican crossing light that has just turned red.	0.72	0.79
32	Fail to notice someone stepping out from behind a bus or parked vehicle until it is nearly too late.	0.72	0.76
31	Hit something when reversing that you had not previously seen.	0.69	0.75
30	Misjudge the speed of an oncoming vehicle when overtaking.	0.68	0.76
7	Drive especially close or "flash" the car in front as a signal for that driver to go faster or get out of your way.	0.67	1.07
12	Misjudge your gap in a car park and nearly (or actually) hit the adjoining vehicle.	0.63	0.82
38	Fail to read the signs correctly, and exit from a roundabout on the wrong road.	0.63	0.75
11	Turn left onto a main road into the path of an oncoming vehicle that you hadn't seen, or whose speed you had misjudged.	0.56	0.64
19	Angered by another driver's behaviour, you give chase with the intention of giving him/her a piece of your mind.	0.56	1
48	"Race" oncoming vehicles for a one-car gap on a narrow or obstructed road.	0.52	0.94
43	Deliberately drive the wrong way down a deserted one-way street.	0.48	0.82
35	Overtake a slow-moving vehicle in the inside lane or on the hard shoulder of a motorway.	0.45	0.87
36	Cut the corner at a right-hand turn and have to swerve violently to avoid an oncoming vehicle.	0.45	0.76
41	Fail to check your mirror before pulling out, changing lanes, turning, etc.	0.45	0.73
25	In a queue of vehicles turning left onto a main road, pay such close attention to the traffic approaching from the right that you nearly hit the car in front.	0.41	0.64
10	Intend to switch on the windscreen wipers, but switch on the lights instead, or vice versa.	0.38	0.74
1	Attempt to drive away from traffic lights in third gear.	0.37	0.57
20	Try to overtake without first checking your mirror, and then get hooted at by the car behind, which has already begun its overtaking manoeuvre.	0.33	0.59
49	Brake too quickly on a slippery road and/or steer the wrong way in a skid.	0.32	0.66
42	Attempt to overtake a vehicle that you hadn't noticed was signalling its intention to turn right.	0.28	0.56
26	Drive back from a party, restaurant, or pub, even though you realise that you have been drinking alcohol.	0.27	0.68

Table 1 (continued)

Q no.	Item	Mean	SD
24	On turning left, nearly hit a cyclist who has come up on your inside.	0.26	0.57
50	Misjudge your crossing interval when turning right and narrowly miss a collision.	0.26	0.53
44	Disregard red lights when driving late at night along empty roads.	0.25	0.72
22	Forget to pay/renew your statutory insurance and discover that you are driving illegally.	0.17	0.51
40	Ignore "give way" signs and narrowly avoid colliding with traffic having the right of way.	0.15	0.42
3	Lock yourself out of your car with the keys still inside.	0.13	0.43

– Misjudge your gap in a car park and nearly (or actually) hit the adjoining vehicle. (0.53)

The items that loaded most highly for Factor 3 (Not Paying Attention to Driving, Straying, and Loss of Orientation) were:

– Miss your exit on a motorway and have to make a detour. (0.64)
– Exit from a roundabout on the wrong road. (0.59)
– Plan your route badly, so that you meet traffic congestion you could have avoided. (0.56)
– Intending to drive to destination A, you "wake up" to find yourself en route to B, where the latter is your more usual journey. (0.54)
– "Wake up" to realise that you have no clear recollection of the road along which you have just travelled. (0.53)
– Forget where you left your car in a multi-level or large car park. (0.51)
– Get into the wrong lane at a roundabout or approaching a road junction. (0.50)

The next item (after the last one mentioned above) for Factor 3 has an intake of only 0.33, so we do not mention it here. It is necessary to note that the scores for all items are positively skewed (most respondents chose low values), which is a limiting factor for the factor analysis interpretations.

3.3 Predictors of factor scores

Using factor scores, multiple regressions were calculated to establish which of the sociodemographic indicators and self-reported accidents and offences provided the best predictors of the factors mentioned above (Factors 1, 2, and 3). The following indicators were used in the present study:

– Gender
– Age
– Education
– Type of driving licence (car, bus, truck etc.)
– Years of driving (since obtaining driving licence)

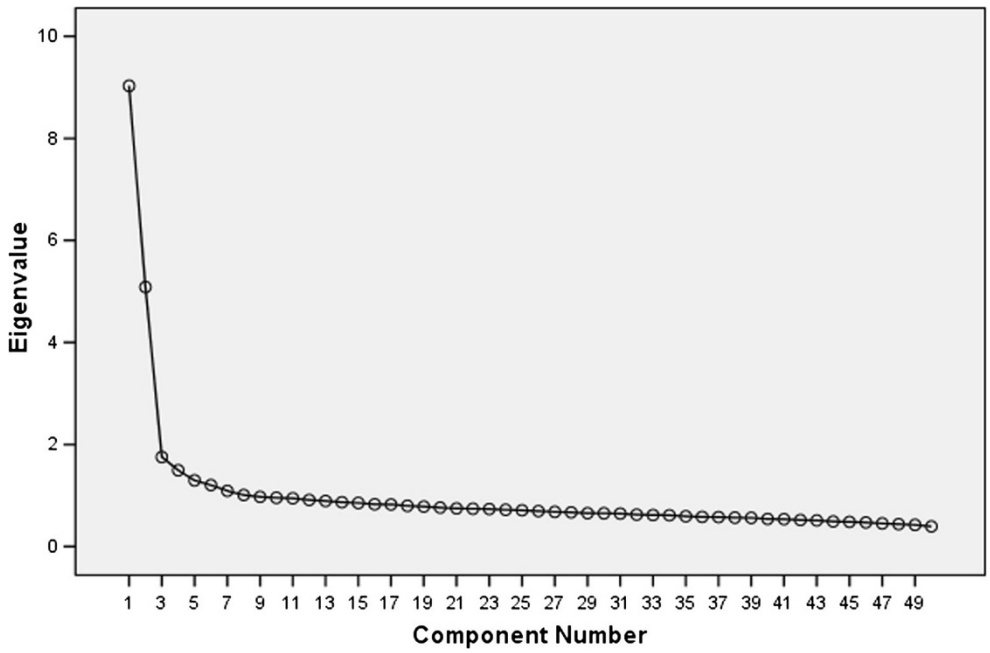

Fig. 1 The scree plot for three-factor solution

- Number of kilometres driven per year
- Occupation
- Partnership engagement
- Accident involvement and severity
- Offences and description
- Purpose of car trips
- Size of the place of residence

To provide multiple regression, the aforementioned indicators had to be modified and the number of categories was reduced (categories were merged in cases where there was no significant difference). The list below contains indicators (and categories) as significant predictors of Factors 1, 2, and 3:

- Gender
- Age
- Education (basic, secondary, university/college education)
- Occupation (student, employee, freelancer, unemployed)
- Size of the place of residence (up to 5,000 inhabitants, 5,000 to 50,000 inhabitants, more than 50,000 inhabitants)
- Partnership engagement (no engagement, with engagement)

In the case of the indicator "Number of kilometres driven per year", the extremely positive skewness of the data led us to use a data transformation. Data transformations are the application of a mathematical modification to the values of a variable. There are a great variety of possible data transformations (e.g. adding constants to multiplying, squaring or raising to a power, converting to logarithmic scales, inverting and reflecting). For our work we chose converting to logarithmic scales (logarithmic transformation). Many statistical procedures assume that the variables are normally distributed. A significant violation of the assumption of normality can seriously increase the chances of the researcher committing either a Type I or II error. Micceri [18] points out that true normality is exceedingly rare in education and psychology.

Using a common logarithm of the variables, we managed to adjust the data in such a way as to fit the histograms provided (Figs. 2 and 3).

3.3.1 Factor 1 (dangerous violations)

In line with the results of an original study by Reason et al. [1], our study confirmed Factor 1, which can be characterised as *Dangerous Violations*.

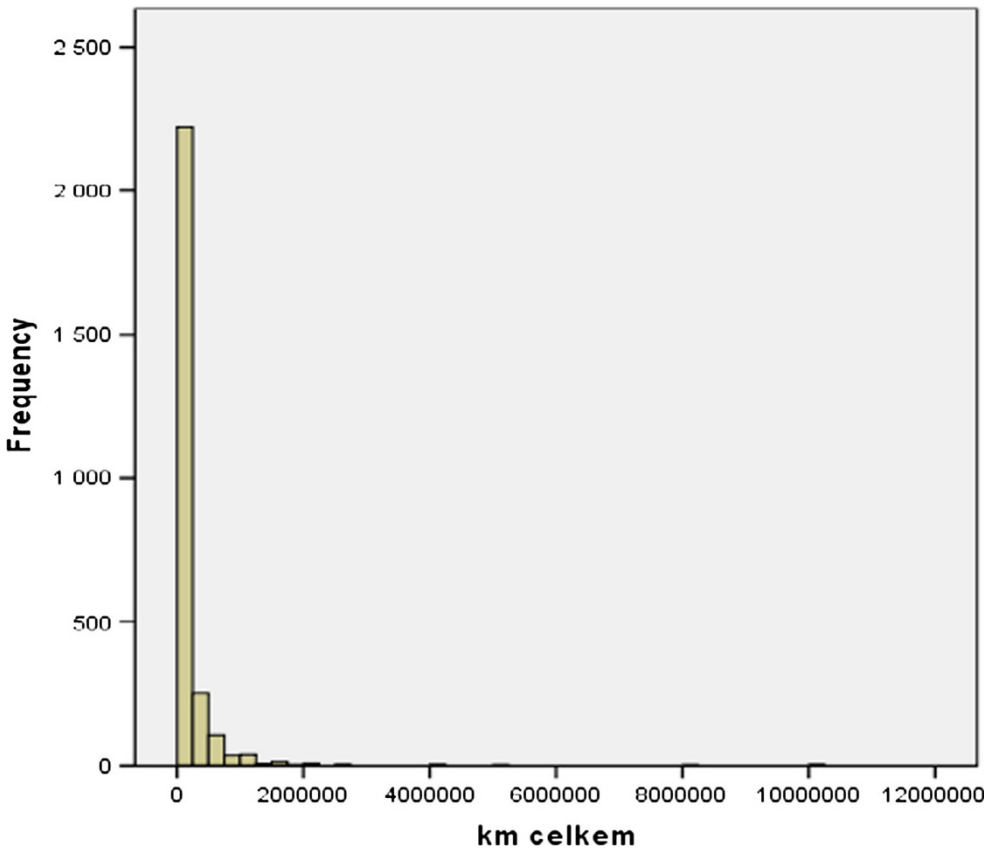

Fig. 2 Histogram for "Number of kilometres driven per year" before adjustment

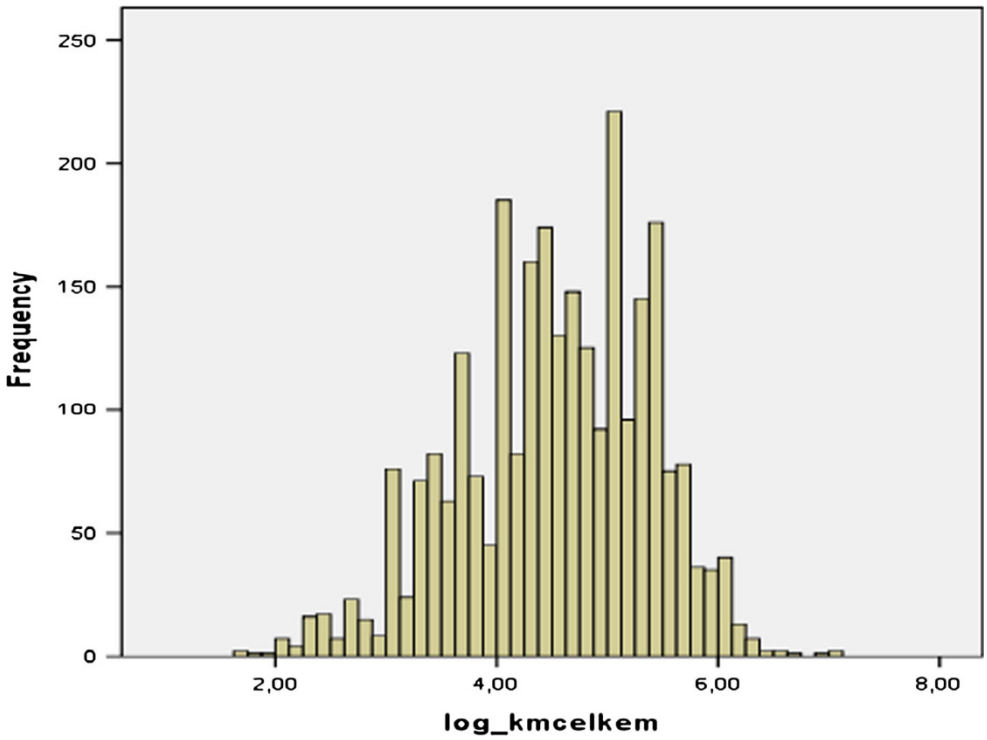

Fig. 3 Histogram for "Number of kilometres driven per year" after adjustment

When attempting to anticipate the result of Factor 1 using all the predictors that we followed, we can explain up to 25.6 % of the variance of this variable. It is evident that all the variables except Partnership Engagement play a role of their own (Table 2).

However, when we look into category variables to see the degree of difference between the categories, we note that in education, the size of the place of residence, and occupation the difference is always due to a single deviating group. The model could thus be considerably simplified as follows (regression analysis with indicator variables has been used this time) Table 3:

The significance of the model is $F(7.2675)=130.75$; $p<0.001$; $R^2=0.255$ (although a number of predictors were removed, the difference from the original value prior to the adjustment of predictors $R^2=0.256$ is minimal).

Table 2 Predictors of factor 1 dangerous violations

Source	F	Sig.	Partial Eta Squared
Gender	85.471	0.000	0.031
Education	6.183	0.002	0.005
Partnership engagement	1.451	0.228	0.001
Size of the place of residence	13.793	0.000	0.010
Occupation	8.657	0.000	0.013
Age	96.535	0.000	0.035
Log Mileage per year	5.615	0.018	0.002
Log Mileage (lifetime)	52.239	0.000	0.019

To summarise, the rules appear to be deliberately violated mainly by *younger men who travel many kilometres per year*, *are experienced drivers*, *have not completed university-level education*, *live in big cities*, *and are entrepreneurs*.

3.3.2 Factor 2 (dangerous errors)

The second factor, which we can call *Dangerous Errors*, is – similarly to Factor 1 and as envisaged – in line with the study of Reason et al. [1].

When attempting to anticipate the result of Factor 2 using all the predictors that we followed, we can explain 13.5 % of the variance of this variable. It is evident that the following variables play a role of their own: gender, the size of the place of residence, and the total number of kilometres driven in the driver's lifetime (Table 4).

Table 3 Predictors of Factor 1 Dangerous Violations – revised model

	Beta	t	p
Gender	0.17	9.43	0.00
Age	−0.27	−12.04	0.00
Log Mileage per year	0.09	2.36	0.02
Log Mileage (lifetime)	0.31	7.26	0.00
Education (university)	−0.06	−3.45	0.00
Size of the place of residence (50,000+)	0.09	5.14	0.00
Occupation (freelancer)	0.10	5.79	0.00

Table 4 Predictors of Factor 2 Dangerous Errors

Source	F	Sig.	Partial Eta Squared
Gender	31.765	0.000	0.012
Education	2.488	0.083	0.002
Partnership engagement	0.145	0.704	0.000
Size of the place of residence	7.451	0.001	0.006
Profession	0.443	0.778	0.001
Age	0.179	0.672	0.000
Log Mileage per year	2.030	0.154	0.001
Log Mileage (lifetime)	24.878	0.000	0.009

The aforementioned three predictors can account for 13.5 % of the variance. Again, we can disregard a number of variables, or categories of variables, to arrive at the following lightened regression model Table 5:

The significance of the model is $F(4.2679)=102.57$; $p<0.001$; $R^2=0.133$ (although a number of predictors were removed, the difference from the original value prior to the adjustment of predictors $R^2=0.135$ is minimal).

Our model thus suggests that driving errors are mainly made by *women with not much driving experience*, *who come from small towns or villages*, *and have completed only basic education* (this is a rather simplistic interpretation – the individual variables may be connected with a logical "or" rather than "and").

3.3.3 Factor 3 (Not paying attention to driving, straying, and loss of orientation)

The third factor is somehow different from what we envisaged and from what is known from the literature [1, 4–8]. This factor can be referred to as "s*traying and loss of orientation*".

When attempting to anticipate the result of Factor 3 using all the predictors that we followed, we can explain 7 % of the variance of this variable. It is evident that the following variables play a role of their own: gender, education, the size of the place of residence, occupation, and the total number of kilometres driven in the driver's lifetime (Table 6).

Table 5 Predictors of Factor 2 Dangerous Errors – revised model

	Beta	*t*	*p*
Log Mileage (lifetime)	−0.30	−15.64	0.00
Gender	−0.12	−6.23	0.00
Size of the place of residence (up to 5,000)	0.07	3.64	0.00
Education (basic)	0.04	2.20	0.03

Table 6 Predictors of Factor 3 Not Paying Attention to Driving, Straying, and Loss of Orientation

Source	F	Sig.	Partial Eta Squared
	15.509	0.000	0.070
Gender	64.617	0.000	0.024
Education	6.162	0.002	0.005
Partnership engagement	0.038	0.846	0.000
Size of the place of residence	12.301	0.000	0.009
Profession	3.021	0.017	0.005
Age	2.084	0.149	0.001
Log Mileage per year	2.537	0.111	0.001
Log Mileage (lifetime)	8.279	0.004	0.003

Again, we can disregard a number of variables, or categories of variables, to arrive at the following lightened regression model Table 7:

The significance of the model is $F(6.2677)=32.02$; $p<0.001$; $R^2=0.067$ (although a number of predictors were removed, the difference from the original value prior to the adjustment of predictors $R^2=0.07$ is minimal).

The interpretation of this factor is rather difficult. It appears that the biggest problems with orientation are experienced by older drivers (low effect), women, those who have considerable lifetime driving experience, and those who are from a large city. The older driver predictor can be interpreted as a generally poorer sense of orientation and a longer reaction time on the part of older drivers. The lifetime mileage predictor can be interpreted rather easily – drivers who spend a lot of time on the road are more likely to get lost (greater exposure). Moreover, some items refer to driving on a motorway, which in itself is a predictor of a larger number of kilometres travelled. A similar interpretation can be made in relation to the big city drivers predictor, where the assumption of driving around a large city allows for a greater chance of getting lost or losing one's orientation (exposure). The interpretation of the gender predictor (women) may be associated with Factor 2 (Dangerous Errors) and may be related to different driving styles in men and women. The education and occupation

Table 7 Predictors of Factor 3 Not Paying Attention to Driving, Straying, and Loss of Orientation – revised model

	Beta	*t*	*p*
Age	0.06	2.47	0.01
Gender	−0.17	−8.29	0.00
Size of the place of residence (50,000+)	0.10	5.18	0.00
Log Mileage (lifetime)	0.08	3.28	0.00
Education (basic)	−0.07	−3.75	0.00
Occupation (student)	−0.06	−2.34	0.02

(student) predictors involve more complicated interpretations which require further research.

4 Discussion

The DBQ is a prominent measurement scale to examine drivers' self-reported aberrant behaviors. Self-reports can be a very useful and efficient means for studying aberrant driving behavior. Anonymous surveys can provide reliable in-depth information about behavior, as well as about the motives and attitudes leading to risky driving. DBQ has been used in several studies in many countries and despite minor cultural nuances, the distinction between errors as unintentional mistakes and violations as deliberate acts has been supported by all international studies, including the one presented in this paper.

Driver behaviour is a very complex matter that is influenced by one's knowledge, abilities, and skills on the one hand and personality traits (such as volition, values, and motives) on the other. Last but not least, there are situational variables (such as mood, stress, and the overall mindset at the moment) that come into play. Therefore, different research methods must be used to describe such behaviour and identify its predictors. The present study focuses on the assessment of (aberrant) driving behaviour using self-report questionnaires administered to drivers. It thus seeks to describe the behaviour in itself rather than its causes. As in the original study [1] and other similar research projects [4–8, 10–17], our study also confirmed the division of aberrant behaviour into two major categories – Dangerous Violations and Dangerous Errors. In comparison to the above studies (including the original one), a new factor, which may be referred to as "Not Paying Attention to Driving, Straying, and Loss of Orientation", was identified among Czech drivers. This factor could also be labelled as *non-dangerous errors* (cf. [1]). What is noteworthy and new with respect to the previous studies is the specific nature of statements that feed into this factor, such as those associated with absent-mindedness, not paying attention to driving, straying, and losing orientation. Given the driver characteristics (gender, age, education, occupation, size of the place of residence, partnership engagement), the results of our research generally correspond with the original study [1] and other studies mentioned above.

5 Conclusions

The results of our research suggested the three-factor solution as the most appropriate approach to interpreting data collected by means of the DBQ questionnaire. While these findings are in agreement with the previous ones arrived at by other authors [1, 4, 5, 7], they also contradict the results of some other studies that propose different arrangements [6, 8]. In our case, the three-factor solution makes it possible to account for 31.75 % of the total variance. Factor 1 accounted for 18.07 % of the total variance, Factor 2 for 10.18 % of the total variance, and Factor 3 for 3.51 % of the total variance.

In accordance with the original study by Reason et al. [1], Factor 1, which is characterised by mostly intentional violations, could be referred to as Dangerous Violations. These involve preconceived deliberate behaviour that is in breach of the regulations. Again in line with Reason's original study [1], Factor 2 may be referred to as Dangerous Errors. These mostly involve driving behaviour which is characterised by mistakes and errors made by drivers without obvious intent or purpose. These may generally result from actions that are inappropriate in a given situation or are appropriate but executed in a wrong manner. Both cases involve behaviours which, although not intentionally planned and executed in violation of the rules, pose a danger to traffic safety. In contradiction with the findings of the author of the questionnaire [1] and other authors [4–8], we interpret Factor 3 as Not Paying Attention to Driving, Straying, and Loss of Orientation. First and foremost, this factor builds upon statements pertaining to orientation in traffic environment and aberrations resulting from absent-mindedness or insufficient attention paid to driving.

As part of our research we sought to establish the most salient predictors for each of the factors using the respondents' sociodemographic data. We looked for the following variables (adjusted for the purposes of statistical processing): gender, age, education, occupation, size of the place of residence, and partnership engagement.

In Factor 1 (Dangerous Violations), we can account for 25.5 % of the variance using the predictors under scrutiny. The predictors suggest that the rules are intentionally violated especially by young men who travel many kilometres per year, are experienced drivers, have not completed university-level education, live in big cities, and are entrepreneurs.

As regards Factor 2 (Dangerous Errors), our model and predictors can account for 13.3 % of the variance of this variable. It is apparent that the following variables play a role of their own: gender, the size of the place of residence, and the total number of kilometres driven in the driver's lifetime. Our model thus suggests that driving errors are mainly made by women with not much driving experience, who come from small towns or villages, and have completed only basic education.

As for Factor 3, using all the predictors that we followed, we can account for 6.7 % of the variance of this variable. It is apparent that the following variables play a role of their own: gender, education, the size of the place of residence,

occupation, and the total number of kilometres driven in the driver's lifetime. It seems that the biggest problems with orientation are experienced by older drivers, women, those who have considerable lifetime driving experience, and those who are from a large city. Given this factor's weak loading, however, the interpretation potential is limited.

The main implications of our research for practical measures aimed at increasing traffic safety include a better understanding of drivers' risk behaviour as an entity broken down into three distinct classes which are likely to involve different underlying psychological processes. Deliberate violations are believed to stem mainly from drivers' personality traits, motivation, values, and volition. Effective measures targeted at drivers engaging in this type of aberrant behaviour may include rigorous enforcement, counselling (rehabilitation programmes), and training programmes aimed at self-reflection and feedback, and, in general, a focus on higher levels of the Gadget model – GDE matrix [2]. Effective measures for drivers characterised by committing Dangerous Errors may include those focused on education and training in driving (the lower and middle levels of the Gadget model). The class of drivers who are absent-minded, confused, or show poor orientation in the traffic environment (Factor 3) may benefit from measures involving training in multifaceted driving situations (such as booster driving lessons) or, in the case of older drivers, those aimed at training and the maintenance of cognitive capacities.

Other possible implications include the utilisation of onboard assistance systems and the modification of the design of the traffic infrastructure in general. Different groups of drivers (categorised according to the types of aberrant driving behaviour) are likely to show different needs (in terms of traffic safety improvements) that the systems under consideration may meet. Assistance systems (and infrastructure designs) that focus on the provision of feedback and law enforcement may be more useful for the class of drivers who commit deliberate traffic violations, while error-prone, absent-minded, and confused drivers may benefit more from systems that facilitate orientation and provide general support in dealing with driving as a multifaceted task.

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