



VALIDATION OF THE DRIVER BEHAVIOUR QUESTIONNAIRE OF DRIVERS IN BULGARIA

D. Iliev, D. Ilieva*

National Sports Academy "Vassil Levski," Sofia, Bulgaria

ABSTRACT

The Driver Behaviour Questionnaire (DBQ) is a widely used measure of driving behaviours that may increase a driver's risk of involvement in a crash. Purpose: The current research aimed to evaluate the validity of a 46-item questionnaire among Bulgarian drivers using confirmatory factor analysis. Method: Data on various attitudes towards road safety were gathered through an online survey. One hundred and sixty responses were obtained from licensed motor vehicle drivers, comprising 73.125% males and 26.875% females, aged between 18 and 61, with driving experience ranging from 1 to 5 years. Principal component factor analysis (with Varimax rotation) and confirmatory factor analysis (CFA with maximum likelihood estimation) were conducted to examine the underlying dimensions and model fit.

Results indicated that the seven-factor structure includes "lack of skills", "driver perception", "road aggression", "distracted driving", "neglected attitude", "arrogance" and "neatness". Confirmatory factor analysis supported the 46-item scale within the Bulgarian sample. **Discussion:** The models fit relatively well; all seven-factor structures effectively explain the data. The next step will be to identify which driver subgroups should be targeted in interventions and to determine the most suitable form of intervention to implement.

Keywords: Driver Behaviour; Factor structure, Construct validity; Model fit

INTRODUCTION

The Driver Behaviour Questionnaire (DBQ) is widely recognised as an effective measure of aberrant driving behaviours associated with an increased risk of experiencing motor vehicle crashes (1). The original DBQ by Reason and colleagues comprised 50 items, which were categorised into three descriptive factors: driving violations, driver error, and attentional lapses (1). Violations are distinct from mistakes and lapses, encompassing behaviours that deliberately contravene safe driving practices.

The number of items included has varied, leading to inconsistent measurement instruments. For instance, the original items suggested by Reason et al. were retained in a 24-item three-factor solution (2), a 28-item four-factor solution (3), and a 27-item four-factor solution based on data from Finland, Britain, and the Netherlands, which omitted one item

related to drinking alcohol and driving (4, 5). However, other researchers have discovered that different item and factor configurations better suit their data. For example, alternative forms of the DBQ include a 32-item, four-factor Swedish DBQ (6), a 22-item, four-factor Persian DBQ (7), and a 50-item, four-factor solution derived from data collected from drivers in Australia (8). The inconsistencies in factor structure suggest that respondents may interpret certain items differently. Some may view items perceived as deliberate errors as unintentional violations.

The DBQ has also been used to measure aberrant behaviours and potential crash risk of professional drivers or those who drive a company car.

This study is the first to utilise the DBS in a non-English-speaking country, making a unique contribution to the field. These findings will contribute to the growing body of research on the psychometric properties of DBS. They may also provide further support for its use as a

*Correspondence to: Desislava Ilieva, National Sports Academy "Vassil Levski," Sofia, Bulgaria, E-mail: desislava.ilieva@nsa.bg

measure of anxiety-induced driving behaviours in a non-clinical sample.

The current research aimed to assess the validity of a 46-item questionnaire among Bulgarian drivers using confirmatory factor analysis.

METHOD

2.1. Participants and procedure

The study included 160 drivers aged 18 to 60 years, all of whom possessed full driving licences. 73.125% of the respondents were male, while 26.875% were female. Age was also evenly distributed across the following age groups: 18–22, 22–35, 35–59, and 60 and above. Approximately 70% of the participants fell into the two older age groups, specifically those aged 35 and over 60 years. However, the youngest (18–22) and oldest (60+) drivers represented the smallest groups, each comprising 11,254% of the sample. 86,525% of drivers had more than 5 years of experience, 5,625% had 3 to 5 years, and 6,25% had 1 to 2 years of experience. Participants are instructed to consider their driving behaviour on a six-point scale (1 = never, 3 = occasionally, and 6 = nearly all the time).

2.2. Materials

2.2.1. Driver Behaviour Questionnaire (DBQ)

The 46-item questionnaire assessed self-reported driver behaviour (9).

2.3. Statistical analysis

No data was missing for the DBQ items. Before analysis, the distribution of each DBQ item was checked for normality using the Shapiro-Wilk W Test ($p \leq 0.1$). A comprehensive statistical analysis was performed, including principal component factor analysis (PCA with Varimax rotation) and confirmatory factor analysis (CFA with maximum likelihood estimation), to examine the underlying dimensions and model fit using 46 questionnaire items. The PSA enables the exploration of the internal validity of the questionnaire. For each axis, a label was created for the corresponding factor. Seven factors were identified. Additionally, a CFA with a forced seven-factor solution was conducted.

RESULTS

3.1. Factor structure in the current sample

The first analysis used principal component analysis (PCA) with Varimax rotation. The seven-factor structure was found to be most interpretable. The seven factors explained 48.72% of the variance (**Table 1**). Loadings less than 0.3 were omitted for clarity. The unexplained variance exceeds 50%.

Table 1. Factor loading and explained variance.

Component	SS Loadings	% of Variance	Cumulative %
1	4.46	9.48	9.48
2	4.40	9.37	18.85
3	3.74	7.96	26.81
4	3.11	6.62	33.43
5	2.59	5.51	38.95
6	2.35	5.00	43.95
7	2.24	4.77	48.72

The factor loadings of the seven-factor structure are presented in **Table 2**.

Table 2. Seven-factor factor structure.

ITEMS	FACTORS						
	1	2	3	4	5	6	7
LACK OF SKILLS							
10. Do you misjudge your parking space and almost hit a neighbouring vehicle?	0.600						
1. Do you ever start moving from a traffic light in third gear?	0.598						

18. Do you ever start overtaking without checking your mirror first and get honked at by the car behind you, which has already started an overtaking manoeuvre?	0.587						
26. Do you ever, lost in thought, fail to notice that someone is waiting on the crosswalk to cross or to go through a red light that has just turned red?	0.571						
44. Do you ever overlook pedestrians? Do you ever pull away from a traffic light in third gear?	0.522						
46. Do you ever mistake the right-of-way light interval while making a right turn and narrowly miss an accident?	0.515						
39. Do you ever forget to use your mirror before merging into traffic, changing lanes, or turning?	0.499						
37. Do you ever fail to yield to a bus signalling its intention to merge into traffic?	0.437						
16. Do you ever risk crossing an intersection where the traffic light has just turned red?	0.378						
DRIVER PERCEPTION							
29. Have you ever hit something you did not see before while reversing?	0.685						
32. Do you ever overtake a line of stopped or slow-moving vehicles, only to find they were waiting to pass a road repair?	0.641						
41. Do you intentionally pull into a one-way street next to an empty parking space?	0.542						
38. Do you ever ignore a no-right sign and almost have an accident with someone coming from the right-of-way?	0.510						
35. Do you ever choose the wrong lane when entering a roundabout or approaching a multi-lane intersection?	0.506						
31. Do you ever plan your route poorly and end up in a traffic jam you could have avoided?	0.500						
27. Do you ever park incorrectly and get a ticket or have your car impounded?	0.485						
12. Do you ever miss your motorway exit and must take a long detour?	0.458						
40. Do you ever try to overtake a car without seeing its left-turn signal?	0.449						
28. Do you ever mistake the speed of an oncoming car while overtaking?	0.447						
36. Do you ever fail to see the signs correctly and take the wrong exit from a roundabout?	0.400						
22. Do you ever turn right and almost hit a cyclist coming from behind you?	0.336						

ROAD RAGE							
33. Do you ever overtake a slow-moving car on the highway from the right or through the emergency lane?			0.734				
17. Do you chase other drivers, angry at their behaviour, intending to "teach" them?			0.718				
25. Do you ever feel disgust towards a particular group of road users and show this hostility in every possible way?			0.708				
14. Do you ever try to overtake in risky circumstances, provoked by nervousness when driving behind a very slow vehicle on a two-lane road?			0.548				
30. Do you ever fail to notice someone jumping out in front of a stopped bus or between parked cars and almost have an accident?			0.543				
3. Do you get impatient when driving behind a slow driver in the left lane and overtaking him on the right?			0.402				
DISTRACTED DRIVING							
13. Do you sometimes forget which gear you are in and have to check with your hand?			0.631				
8. Do you turn on your windshield wipers instead of your turn signals and vice versa?			0.582				
21. Do you ever drive while lost in thought and forget that you have your high beams on until the oncoming driver signals you?			0.542				
9. Do you ever make a left turn on a main road, crossing the lane of an oncoming vehicle you did not see or whose speed you did not judge correctly?			0.532				
11. Do you ever drive and suddenly realize you have no clear memory of the road you just moved on?			0.461				
6. Do you forget where you left your car in a multi-level parking lot?			0.441				
7. Do you ever realize too late that the car in front of you is slowing down and you must slam on the brakes to avoid a collision?			0.435				
NEGLECTED ATTITUDE							
42. Do you ever run a red light when driving late at night on deserted roads?			0.577				
24. Do you ever drive after drinking alcohol, even though you realize that you may be over 0.5 per mille?			0.535				
43. Do you ever drive with only half an eye open while using your phone, the radio, or looking at the map on your GPS?			0.531				
34. Do you ever enter the center line of a left turn and have to swerve sharply to the right to avoid an oncoming vehicle?			0.454				

19. Do you deliberately ignore speed limits late at night or early in the morning?					0.436		
ARROGANCE							
46. Do you brake too hard on a slippery road and/or turn the wrong way to intentionally skid?						0.680	
4. On country roads at night, do you drive at the same speed with low and high beams?						0.585	
45. Do you engage in "unregulated" races with other drivers?						0.579	
5. Do you ever drive very close to the car in front of you or flash your lights to signal the driver to drive faster or move to the right lane?						0.514	
NEATNESS							
20. Do you sometimes forget when your road tax or insurance expires and end up driving illegally?							0.759
2. Do you ever look at your speedometer and find yourself driving faster than the speed limit without meaning to?							0.509
23. Do you ever pay close attention to traffic approaching from the left in a line of cars turning right on a main road, and almost hit the car in front?							0.408
15. Do you set off for one place but end up somewhere else, which is on your usual daily route?							0.373

The first factor (F1) concerns “lack of skills” and accounts for 9.48% of the variance. The second factor, primarily covering “driver perception,” accounts for 9.37% of the total variance. The third factor, “road aggression”, accounts for 7.96% of the variance. The fourth factor, “distracting driving”, accounts for 6.62% of the variance. The fifth factor is “neglected attitude,” with an accounted variance of 5.51%. The sixth factor is “arrogance”, with an accounted variance of 5.00%, while the seventh factor, “neatness,” has an accounted variance of 4.77%.

A CFA was conducted to examine the model's fit established in the PSA (**Figure 1**). In line with Hu and Bentler (1999) and Byrne (2012), the fit of the models can be evaluated using the Comparative Fit Index (CFI) and the Standardised Root Mean Square Residual (SRMR). A good-fitting model should have a 2:1 or 5:1 χ^2 /degree of freedom ratio, CFI > 0.90 (preferably > 0.95), RMSEA < 0.08 or 0.10 (preferably < 0.05), and SRMR < .08 (preferably < .05) indexes (10-12).

Table 3. Test for Exact Fit.

Test for Exact Fit		
χ^2	df	p
1523	967	<.001

Table 4. Fit model.

CFI	TLI	RMSEA	RMSEA 90% CI	
			Lower	Upper
0.733	0.714	0.0603	0.0545	0.0660

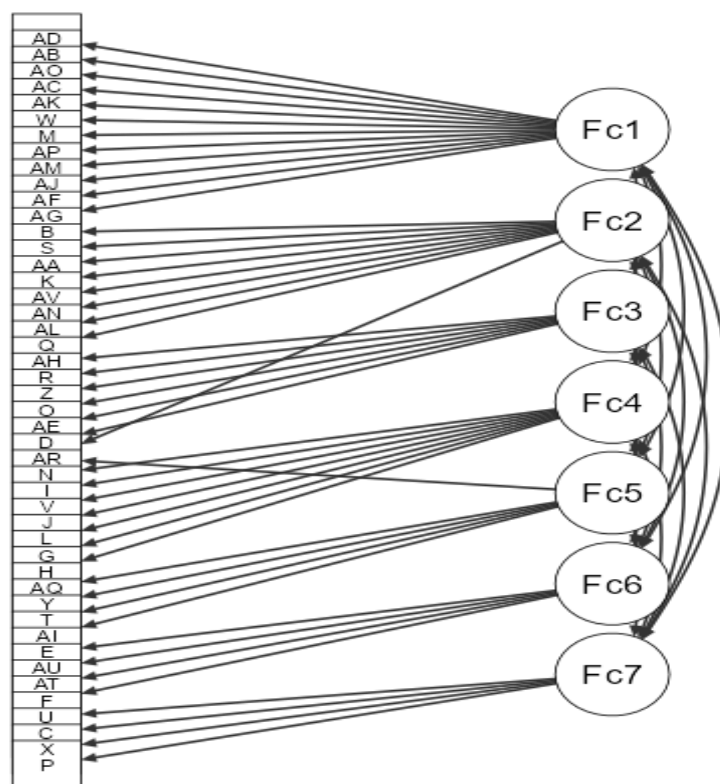


Figure 1. Path Diagram.

The primary test for the general adequacy of the tested model, χ^2 , is applicable to nearly all types of discrepancy functions. The data in the table above show an exceptionally high value for this statistic ($\chi^2 = 1523$, $df = 967$) and a low probability associated with it ($p = 0.001$), (Table 3).

Another group of goodness-of-fit indicators for the tested model is the classical one-sample criteria, the results of which are presented in **Table 4**. The first two goodness-of-fit tests—GFI and the Tucker–Lewis index (TLI)—reveal a discrepancy between the tested univariate model and the actual data.

A third group of indicators, which are increasingly used to assess the general correspondence of the tested model with the data, displacing the chi-square and one-sample criteria, is based on the estimate of the population's non-centrality parameter. The concept was developed by Steiger and Lind (13 - 15) because, according to J. Steiger, “the classical approach to hypothesis testing is inappropriate due to insufficient power of the chi-square test”. With this concept, the authors make a fundamental change in the approach to assessing the adequacy of the tested model.

Instead of testing the null hypothesis of complete adequacy of the model, they propose an alternative approach: to examine the extent to which it is inadequate, how far the model deviates from the general population, and how accurately this inadequacy is determined based on the sample data.

The Steiger and Lind RMSEA (Root Mean Square Error of Approximation) criterion is directly based on the population non-centrality index. This criterion addresses one of the shortcomings of single-sample methods by compensating for the simplicity (parsimony) of the model. All else being equal, a model with fewer parameters fits less well than a more complex one. Therefore, fit indices that do not take this into account may more frequently lead to the rejection of the tested model. In this case, neither the point estimate of the above ratio (0.054) nor the values within the two confidence interval limits provide grounds for assuming that the tested univariate model is adequate for the data.

The reason can be sought in the design of the assessment instrument itself, which is not intended to reveal the identified latent ability structures.

3.2. Descriptive statistics

The six most frequently occurring behaviours were: get impatient when driving behind a slow driver in the left lane and overtaking him on the correct drive very close to the car in front of you or flash your lights to signal the driver to drive faster or move to the right lane; overtake a line of stopped or slow-moving vehicles, only to find they were waiting to pass a road repair; ever miss your exit on the highway and have to

make a long detour; turn on your windshield wipers instead of your turn signals and vice versa and forget when your road tax/insurance expires and find yourself driving illegally. The most common behaviours are connected with road rage, arrogance, driver perception, and distracted driving.

Table 5 gives the means and standard deviations for all 47 items.

Table 5. Items of DBQ arranged in descending order of mean score.

Items	Mean	Std. Deviation
3. Do you get impatient when driving behind a slow driver in the left lane and overtaking him on the right?	3,2	1,0
5. Do you ever drive very close to the car in front of you or flash your lights to signal the driver to drive faster or move to the right lane?	3,1	1,5
32. Do you ever overtake a line of stopped or slow-moving vehicles, only to find they were waiting to pass a road repair?	2,7	0,7
12. Do you ever miss your exit on the highway and have to make a long detour	2,4	1,1
8. Do you turn on your windshield wipers instead of your turn signals and vice versa?	2,3	0,7
20. Do you ever forget when your road tax/insurance expires and find yourself driving illegally?	2,2	1,0
44. Do you ever overlook pedestrians? Do you ever pull away from a traffic light in third gear?	2,2	1,0
14. You drive behind a very slow vehicle on a two-lane road and, overcome with nervousness, you try to overtake in risky circumstances	2,2	0,8
36. Do you ever fail to see the signs correctly and take the wrong exit from a roundabout?	2,1	0,7
4. On country roads at night, do you drive at the same speed with low and high beams?	2,1	1,0
38. Do you ever ignore a no-right sign and almost have an accident with someone coming from the right-of-way?	2,1	0,8
22. Do you ever turn right and almost hit a cyclist coming from behind you?	2,1	0,8
7. Do you ever realize too late that the car in front of you is slowing down and you must slam on the brakes to avoid a collision?	2,0	1,0
37. Do you ever fail to yield to a bus signalling its intention to merge into traffic?	2,0	0,7
15. Do you set off for one place but end up somewhere else, which is on your usual daily route?	1,9	0,9
45. Do you engage in "unregulated" races with other drivers?	1,9	0,7
6. Do you forget where you left your car in a multi-level parking lot?	1,9	1,0
28. Do you ever mistake the speed of an oncoming car while overtaking?	1,9	0,7
13. Do you ever forget which gear you are in and have to check with your hand?	1,9	0,8
21. Do you ever drive while lost in thought and forget that you have your high beams on until the oncoming driver signals you?	1,8	0,9
29. Do you hit something you did not see beforehand while reversing?	1,8	0,7
30. Do you ever fail to notice someone who pulls out in front of a stopped bus and between parked cars, and almost have an accident?	1,8	0,7
47. Do you ever mistake the right-of-way light interval while making a right turn and narrowly miss an accident?	1,8	0,9
42. Do you ever run a red light when driving late at night on empty roads?	1,8	0,9

27. Do you ever park incorrectly and get a ticket or have your car impounded?	1,7	0,7
10. You misjudge a parking space in a parking lot and almost hit a neighbouring vehicle	1,7	0,7
11. You are driving, and at one point, you realize that you have no clear memory of the road you just drove on	1,7	0,7
31. Do you ever plan your route poorly and end up in a traffic jam you could have avoided?	1,7	0,8
41. Do you intentionally pull into a one-way street next to an empty parking space?	1,6	0,7
33. Do you ever overtake a slow-moving car on the highway from the right or through the emergency lane?	1,6	0,7
40. Do you ever try to overtake a car without seeing its left-turn signal?	1,6	0,7
16. Do you ever risk crossing an intersection where the traffic light has just turned red?	1,6	0,8
35. Failing to see the signs correctly and taking the wrong exit from the roundabout?	1,6	0,7
19. Do you deliberately ignore speed limits late at night or early in the morning?	1,6	0,6
9. Do you ever make a left turn on a main road, crossing the lane of an oncoming vehicle you did not see or whose speed you did not judge correctly?	1,5	0,8
26. Do you ever, lost in thought, fail to notice that someone is waiting on the crosswalk to cross or to go through a red light that has just turned red?	1,5	0,8
17. Do you chase other drivers, angry at their behaviour, intending to "teach" them?	1,5	0,7
24. Do you ever drive after drinking alcohol, even though you realize that you may be over 0.5 per mille?	1,5	0,7
39. Do you ever forget to use your mirror before merging into traffic, changing lanes, or turning?	1,4	0,6
46. Do you brake too hard on a slippery road and/or turn the wrong way to intentionally skid?	1,4	0,8
18. Do you ever start overtaking without checking your mirror first and get honked at by the car behind you, which has already started an overtaking manoeuvre?	1,4	0,8
34. Entering the wrong lane at a roundabout or while approaching an intersection	1,3	0,7
2. Do you ever look at your speedometer and find yourself driving faster than the speed limit without meaning to?	1,3	0,5
23. Do you ever pay close attention to traffic approaching from the left in a line of cars turning right on a main road, and almost hit the car in front?	1,2	0,4
25. Do you ever feel disgust towards a particular group of road users and show this hostility in every possible way?	1,1	0,4
43. Do you ever drive with only half an eye open while using your phone, the radio, or looking at the map on your GPS?	1,1	0,4

DISCUSSION

The current study examined the validity of the Driver Behaviour Questionnaire (DBQ) construct among Bulgarian drivers. The findings, particularly concerning the suitability of the 46-item questionnaire, have significant implications for psychology and transportation safety.

Factor-analytic procedures identified seven dimensions of potentially problematic behaviour: driver perception, lack of skills, road rage, distracted driving, neglected attitude, arrogance, and tidiness.

Associations between skills deficits and perceptions of driving skill suggest that skills-based interventions may facilitate treatment for a subset of anxious drivers. Noting that driving performance depends on a relatively complex skill set, Taylor et al. suggest that skills training may enhance driving competence and confidence in anxious drivers, thereby improving overall treatment efficacy (16, 17). The relationship between performance deficits and accident, panic, and social/interpersonal concerns suggests that skills-based interventions may be beneficial irrespective of the specific focus of driving fear.

The DBQ has been used in numerous studies of driving behaviour, and various factor structures have been proposed. Traditionally, the DBQ encompasses 50 individual behaviours that fall into three broad behaviour patterns: violations, errors, and lapses. Violations are defined as deliberate behaviours that directly contravene road laws, such as exceeding the speed limit or failing to obey red traffic light signals. Errors are behaviours that do not directly violate road laws but, like violations, are considered to increase a driver's crash risk. In contrast, lapses are minor mistakes that are not deemed associated with crash involvement (1). The DBQ has been employed in several countries across various target groups. Rimmö and Hakamies-Blomqvist have categorised lapses into inattention and inexperience errors, while Mesken et. al have divided violations into aggressive and ordinary types (6, 18). Comparisons between the results obtained in these studies are challenging due to cultural differences and methodological variations. The number of items has varied significantly between versions used in different studies. Sampling strategies, target populations, and statistical analyses may also differ. Some studies have employed either Principal Component Analysis (PCA) with varimax rotation (1, 2, 6, 8, 19, 20) or PCA with oblimin rotation (5, 18, 21, 22). A cross-cultural study conducted by Lajunen et al. (2004) suggests that, despite cultural nuances, the distinction between errors, such as unintentional mistakes, and violations, such as deliberate acts, remains robust, as supported by all international studies. According to the authors, the DBQ can be used confidently, and the scales can be compared at least among Western European countries, provided that cultural factors are taken into account and the translation procedures are carried out meticulously.

The original DBQ was validated for drivers aged 20 to 56 (1) and has primarily been used for drivers within this age range (23). Stephens et al. demonstrated that a four-factor version of the DBQ, based on the findings of Parker et al. and incorporating a factor for aggressive violations, is suitable for a broad range of drivers; however, its applicability is less pronounced when specifically examining older drivers (21, 24).

The French version of DBQ validation reveals a six-factor structure: “dangerous errors”, “inattention errors”, “inexperience errors”, “ordinary violations”, “aggressive violations” and “positive behaviours” (25).

The DBQ studied by Stanojevic et al., which compares three countries—Bulgaria, Romania, and Serbia—produced a two-factor solution: violations and errors, aligning with numerous previous studies (26-28).

An examination of the strengths and limitations of the current research is pertinent for the ongoing validation of the DBQ.

Participants in the current study completed the questionnaires via an elaborate online survey at their own convenience and were assured of the confidentiality of their responses. Consequently, the impact of social desirability on responses is expected to be minimal.

CONCLUSION

The current research takes steps towards operationalising and assessing driving behaviour. The models fit relatively well, and all seven-factor structures provide a good explanation of the data. The next step will be to identify which driver subgroups should be targeted in interventions and to determine the specific interventions that ought to be implemented. The Driving Behaviour Questionnaire can assess traffic violations and errors among drivers, considering their specific task-related conditions (which qualitatively differ from other groups of drivers), with potential implications for the enforcement of occupational and road safety research.

Conflict of Interest

The authors declare that they have no conflict of interest.

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