

Reliability of the Driver Behaviour Questionnaire in a sample of novice drivers

Warren Harrison
Eastern Professional Services Pty Ltd

Abstract

The Driver Behaviour Questionnaire (DBQ) is a well-researched measurement instrument that is used widely to assess aspects of driver behaviour that reflect human error, lapses, and deliberate risky actions. The DBQ has been used in a range of cultural settings and is sometimes used as one of a number of outcome measures in road safety interventions. Its use as an outcome measure assumes that it is a reliable measurement instrument, but apart from evidence that the DBQ item scales are internally consistent there is little evidence about its reliability. This study investigated the factor structure, internal consistency, and test-retest reliability of the DBQ using a sample of 822 recently-licensed drivers who completed the DBQ and other questionnaire items on two occasions separated by about 6 months. The results suggest high levels of internal consistency for each of the four item scales and test re-test reliabilities between $r=.65$ and $r=.75$. The results support the use of the DBQ as a questionnaire outcome measure in evaluation studies.

Key Words

Novice drivers, Reliability, Driver Behaviour Questionnaire, Internet survey

Acknowledgments

The data reported here were collected as part of a larger, ongoing evaluation of aspects of the Victorian Graduated Licensing System. The data collection and analysis were funded by VicRoads. The author would like to acknowledge the assistance of Antonietta Cavallo, Sophie Oh, and Kelly Imberger in the development of the survey instrument and implementation of the recruitment and survey process.

Introduction

The Driver Behaviour Questionnaire (DBQ) was developed in the 1990s as a tool to assess aberrant driving behaviour (Parker et al., 1995; Reason et al., 1990). Its various forms generally have less than thirty behavioural items, with the participant required to respond to each item by indicating how frequently they behave as indicated. In typical items, for example, the participant is required to indicate on a six point scale (anchored at the ends by “never” and “nearly all the time”) how often they “Brake too quickly on a slippery road” or “Disregard the speed limit on a residential road”.

The DBQ has been discussed or used in studies concerning the following issues:

- The structure of aberrant driving behaviours (eg. Fernandes et al., 2007; Horswill & Coster, 2001; Lonczak et al., 2007; Rimmo, 2002)
- The relationship between self-reported aberrant driving behaviours and crash involvement (eg. Mesken et al., 2002)
- The relationship between self-reported aberrant driving behaviour and traffic offences or unsafe driving behaviours (eg. Charlton, 2004; Forward, 2006; Stradling, 2007)
- The broad relationship between psychological traits and states and crash involvement (eg. Arthur & Doverspike, 2001; Chliaoutakis et al., 2005; Iversen, 2004; Iversen & Rundmo, 2002, 2004; Nabi et al., 2007)
- Aberrant or risky behaviours in young or novice drivers (eg. Bianchi & Summala, 2002, 2004; de Craen et al., 2008; Delhomme & Villieux, 2005; Elliot & Baughan, 2004; Farand & McKenna, 2001; Laapotti et al., 2001)
- Older drivers (eg. Daigneault et al., 2002a, b; Schwebel et al., 2007)
- Bus and truck driver behaviour (eg. af Wåhlberg, 2004; Sullman et al., 2002)

- Motorcyclists (eg. Horswill & Helman, 2003)
- Drivers of four-wheel drive vehicles (eg. Bener et al., 2008)
- Aggressive and criminal driving behaviour (eg. Björklund, 2008; Corbett, 2007; Fong et al., 2001; Hennessy & Wiesenthal, 2002, 2005; King & Parker, 2008; Krahe & Fenske, 2002; Ross & Antonowicz, 2004; Schwebel et al., 2006; Van Rooy et al., 2006)
- Occupational health and safety issues as they relate to driver behaviour (eg. Caird & Kline, 2004; Darby et al., 2009; Davey et al., 2009)
- Aberrant driving behaviour in non-English speaking cultures (eg. Gras et al, 2006; Kontogiannis, 2006; Lajunen et al, 2004; Özkan & Lajunen, 2005; Özkan et al., 2006)

Some studies have used DBQ scores as evaluation tools where changes in responses to items are used as a surrogate measure for behaviour change (eg. McKenna et al., 2006).

Early interest focused on the factor structure of the instrument, with a consensus developing that DBQ responses could best be understood as reflecting three (earlier studies) or four underlying constructs. These are generally referred to as Errors, Violations, Lapses, and Aggressive Violations. The differentiation between Errors and Lapses (generally forgetful behaviours) reflects the early interest in human error that drove the development of the DBQ (eg. Reason, 1990). This theoretical basis for the original item set and DBQ structure may be a key limitation to the value of the test. The differentiation between Violations and Aggressive Violations (angry or aggressive behaviour towards other road users) has been contentious but now appears to have widespread acceptance, perhaps in part due to an increase in interest in aggressive driving behaviour.

The growth in reliance on the DBQ has taken place largely in advance of, or at least contemporaneously with growing understanding of the psychometric qualities of the test. Most studies have used exploratory factor analysis methods to identify four (or three) underlying constructs, but confirmatory factor analysis assessing the consistency of the four-factor structure of the DBQ was not undertaken until 2002 (Rimmö, 2002).

The broader issue of the reliability of the scales has had limited attention. Studies using exploratory factor analysis methods generally report reliability in the form of internal consistency measures for each scale or factor (using, for example, Cronbach alpha or related measures). Measures of internal scale consistency provide a general guide to the relative contribution of error variance and variance due to an underlying construct assessed at that point in time, but they do not provide information about the stability of the construct or instrument over time. Some understanding of reliability would normally precede the widespread use of a psychometric instrument, but the stability of the DBQ over time was not assessed until 2006 (Özkan, Lajunen, & Summala, 2006).

Özkan et al. (2006) reported the results of a study in which 622 participants completed the DBQ twice, with about three years separating the two data sets. They used a sample of car owners derived from registration records with a mean age of 43 years. The results suggested that participants responded consistently on the two test occasions and that the usual four factor solution was reasonably stable over time. A two-factor solution (using “errors” and “violations”) was more stable over time, suggesting that the distinction between the two types of errors (errors and lapses) and between the two types of violations are less stable. The authors reported test-retest reliabilities around 0.6 across the three years.

This paper reports some data concerning the stability of the DBQ over a six month period for a sample of younger drivers. It was anticipated that this information would help inform decisions to use the DBQ as an evaluation tool.

Method

Data were collected using an on-line survey, with a telephone survey (with the same items) used as a supplementary method when following up some participants. Participants completed the survey twice (see below). The on-line survey was developed and delivered using *phpSurveyor* software hosted on the author’s web server. This approach provided control over the presentation of items and branching within the survey based on prior responses, and stored participants’ responses to items in a SQL database.

The survey included items as follows.

- Demographic information – including birth year and month, sex, postcode of place of residence, household living arrangements, and employment and educational status.
- Learner experiences – including type of learner permit held, year and month permit was obtained, supervision arrangements during the learner period, estimated hours of driving experience as a learner, the pattern of learner driving experience, factors that interfered with gaining experience, and the number of professional lessons obtained.
- Experiences as a probationary driver – including the month and year of licensure, distance driven in the past week, number of attempts at the hazard perception test and the practical drive test, and information about car ownership.
- Driving exposure in the most recent two days – including for each day the number of trips, time spent driving, and driving conditions (light, presence of passengers, trip purpose, and whether the trip involved towing).
- Self-assessment of driving skill compared to peers in relation to hazard detection, safety, and driving in different driving contexts (such as at night, in unfamiliar situations, in wet conditions, etc).
- The 27-item Driver Behaviour Questionnaire (DBQ).
- Self-reported risk-related behaviours in the ten most recent driving trips – including speed-related behaviours, behaviours relating to mobile telephone use, and restraint use.
- Driving offences detected by Police or automated cameras in the last 6 months.
- Crash involvement and experiences of near misses in the last six months, including items relating to potential causal factors.
- Driving behaviours on the last ten driving trips in relation to the rules that apply to probationary drivers.
- Attitudes to the rules that apply to learner and probationary drivers.
- Contact with Victorian safety-related programs such as Keys Please, VicRoads resource materials for learner drivers, and professional driver training.
- Attitudes to the hazard perception test and the practical drive test.

The second survey included a subset of items from the first survey. Items concerning the following issues were not included in the second survey:

- Learner experiences (except the items concerning the total amount of experience).
- Contact with Victorian safety-related programs as these generally relate to learner drivers.
- Attitudes to the hazard perception test and the practical drive test.

A sample of 2,500 probationary licence holders was drawn randomly from the population of probationary licence holders in the Victorian licensing database. All potential cohort members were licensed in the most recent six-month period available in the database (between 4 November 2007 and 3 May 2007).

The cohort survey sample was representative of the relevant population in terms of sex, licence status, and place of residence. Sample membership was restricted to those who:

- obtained their learner permit at 16 years or older
- were 18 years or older when they got their probationary licence
- were 70 or younger at the time the Driver Licensing System dump occurred
- held a learner permit for at least 6 months (or 3 months if they are 25 or older) before getting their probationary licence
- had a “current” permit status
- don't hold multiple permits
- reside in the state of Victoria
- had known sex.

The data file included name, address, and telephone contact details (where known). An additional field was added (a participant number) to aid in tracking completion of the survey and to match participants' data between surveys.

A letter was sent from VicRoads to all potential survey participants. In the first survey these letters were sent to all potential sample members. In the second survey, the invitation letter was sent only to those who had completed the first survey. The letter was personally addressed, explained the purpose of the survey and how to participate. It included the URL for the on-line survey and the participant's participant number. It also included a telephone contact number for potential participants without internet access.

In both the first and second surveys, participants were offered a small reward (a \$10 gift card from a major retail chain) for participating in the survey, and were also given the opportunity to participate in a prize draw for one of ten \$500 gift cards. These rewards were only available to participants who completed the survey and provided a participant number.

The identity and confidentiality of participants was preserved as follows:

- VicRoads staff members were responsible for managing all aspects of the survey procedure that could identify participants. They managed the files drawn from the licensing database, arranged letters and contact with participants, and managed the reward system and prize draw at the end of the survey period. They also managed the provision of identifying information to the market research company responsible for supplementary telephone surveys (see below).
- The author was responsible for the on-line survey system. This system did not collect any identifying information. The participant numbers could not be used to identify participants without the VicRoads database, ensuring that the confidentiality of participants was maintained.

Reminder letters were sent to potential survey participants who had not completed the surveys about three weeks after the first letter was sent and then again after another three weeks in the case of the second survey. After another three weeks the names, addresses, and telephone numbers of potential participants who had not yet completed the survey were provided to a market research company contracted by VicRoads to provide the supplementary telephone survey. A search of relevant telephone number databases was conducted to locate telephone numbers for as many potential participants as possible, and the company then conducted the supplementary telephone survey using the on-line survey.

The two surveys each produced a data file with a number of response fields that should have remained constant between surveys. Each survey included:

- The participant number – a unique number issued to participants and printed on their invitation letter along with the survey URL address.
- The participant's sex and birth month and year.

Matching of the two sets of survey data was not a simple matter as any of these variables could be entered incorrectly during completion of the survey. The following approach was used to identify and correct possible problems in matching the two sets of survey responses, but it must be emphasised that it is possible that some data entry errors will be impossible to detect.

- Obvious errors in entering participant numbers resulted in the deletion of responses from 19 participants.
- The two data sets (the two surveys) were then matched using participant number as the matching variable.
- Matches based on participant number may still be incorrect as some errors in the entry of the participant numbers may not have been detected. The sex and birth month/year data were used to identify potential errors – matched data from the first and second survey where any one of these differed were identified. Thirty-six of the 867 matched cases in the two surveys had an inconsistency in sex, birth month, or birth year. Eight cases had inconsistent birth months, seven cases had inconsistent birth years, and fourteen cases had inconsistent entries for sex. Most of these errors appear to be data entry errors rather than matching errors. Only two of the inconsistent matched cases had inconsistent residential postcodes, and only two had more than one inconsistent variable. An additional nine matched survey cases had one or more of these variables missing. Although the differences may have related to typing errors, it was considered important to ensure that the matching was as accurate as possible and it was not possible to

determine which of the two different survey responses was correct. For this reason, forty-five cases were excluded from all further analysis.

The result of this matching and culling process was a data set with matched responses from two surveys for a sample of 822 novice drivers.

Results

The sampling method described above resulted in:

- 2,500 invitations sent to potential participants by post, with follow-up reminder letters.
- Completion of the first survey in June-July 2008 by a total of 1,227 participants.
- 1,219 invitations sent to participants in the first survey, with follow-up reminder letters (some participant numbers provided in the first survey were incorrect and could not be used to identify participants).
- Completion of the second survey in February-March 2009 by 867 participants (after removal of some participants as outlined earlier).
- A final sample of 822 survey participants with matched data from the two survey waves.

This equates to a response rate of 49 percent in the first survey and 67 percent in the second survey – giving a final response rate of 33 percent. The analyses reported here are based on those participants with matched data from the two surveys (N = 822).

Although the focus of this paper is the data derived from the DBQ items in the two questionnaires, some background information from the survey may be useful (detailed analysis is in the project report):

- There were 363 male participants and 459 females. Males were younger (mean 20.3 years) than females (mean 21.2 years) ($F_{(1,820)} = 8.77, p = .003$).
- There was a bias towards participants living in suburbs with a higher level of socio-economic advantage. Sixty percent of respondents lived in advantaged suburbs, based on an ABS measure of socio-economic advantage/disadvantage derived from 2006 census data. The bias towards advantaged areas in the surveys samples appears to reflect an underlying bias in the place of residence of probationary licence holders rather than a sampling bias in the survey, and this most likely reflects the distribution of the population of young adults across the state rather than a specific response bias in this survey.
- Participants reported a mean of 117.1 hours of learner experience (in the first survey) and a mean of 12.1 professional lessons.
- Driving exposure in the two days preceding the survey was dependent on sex (males drove more than females), car ownership (in the expected direction), and learner experience (those with more experience had higher exposure estimates). Participants reported an average of 2.9 driving trips and 48 minutes driving time over the two preceding days, with 26 percent of their driving at night, 11 percent with two or more peer passengers, and 33 percent of trips for social purposes.
- Self confidence was related to learner experience, driving exposure, and sex – with more-experienced drivers, males, and drivers with higher exposure levels reporting higher levels of self confidence.

The 27 items of the DBQ were factor analysed using principle components analysis to identify the factors and oblique (varimax) rotation of the factors, and assuming a four-factor structure was appropriate given the result of a preliminary analysis of the first-survey data with a much larger sample of participants. The analysis was conducted twice – once with the data from the first survey, and then with the data from the second survey.

The two analyses suggested that the DBQ items and structure were consistent across the two surveys. The four factors accounted for 41.4 percent of item variance in the first survey, and for 41.3 percent of the variance in the second survey. Table 1 shows the factor loadings in the two surveys (labelled S1 and S2) after rotation, with loadings equal to or over .40 shown with a shaded background for emphasis. The similarities between the two sets of DBQ data are striking.

The four factors can be interpreted as follows, consistent with other research using the DBQ (eg. Lajunen et al (2004):

- Factor 1 is consistent with the 'Errors' factor reported in earlier research. Participants with high scores on items that load on this factor are more likely to make errors when driving.
- Factor 2 is consistent with the 'Ordinary violations' factor reported elsewhere. Participants with high scores on these items are more likely to report driving behaviours that are illegal or potentially illegal.
- Factor 3 is consistent with the 'Lapses' factor in earlier research. Participants with high scores on these items are more likely to report forgetful behaviour when driving or poor concentration.
- Factor 4 is consistent with the 'Aggressive violations' factor reported elsewhere. Participants with high scores on this factor are more likely than other participants to respond angrily to other road users.

Psychometric information about the four scales is shown in Table 2. The scale scores were calculated as the sum of scale responses for each item identified as loading on each of the four factors. The four scales had strong internal consistency in both surveys, with Cronbach alpha statistics over .65 in all cases. The mean scores on each scale were similar in the two surveys – but this is investigated more closely below.

The test-retest reliabilities were very high, indicating that participants maintained their relativities in responses to the four scales – those participants who had high "Lapses" scores in the first survey continued to have high "Lapses" scores in the second survey. The test-retest reliability was not as high for the "Errors" scale as it was for the other scales.

The pattern of responses to the DBQ items across the two surveys was analysed using repeated measures analysis of variance using the scale scores for the four scales in the two surveys as dependent measures, and survey, scale, age, learner experience, exposure, and sex as factors. The only results of interest are those that include "Scale" as a factor, as a dependent measure that averages across the four scales of the DBQ has no meaning.

Scale scores were affected by age ($F_{(3,2367)} = 9.08, p = .000$), sex ($F_{(3,2367)} = 17.68, p = .000$), and exposure (using the average time spent driving the day before the two surveys) ($F_{(3,2367)} = 4.68, p = .003$). There was an interaction between Scale and Survey indicating that responses to one or more of the Scales changed between the first and second survey ($F_{(3,2367)} = 3.14, p = .024$), and this interaction was in turn influenced by the amount of experience accrued as a learner ($F_{(3,2367)} = 4.00, p = .008$).

Figure 1 shows the change in mean DBQ scale scores between Survey 1 and Survey 2. The responses to the Errors and the Lapses items did not change significantly, and mean scale scores on the Violations and Aggressive Violations items increased. Participants were more likely to report behaviours represented in the Violations and Aggressive Violations scales in the second survey. This difference in the Violations and Aggressive Violations scales between the two surveys was only present for participants with relatively low levels of experience as learner drivers. The Violations and Aggressive Violations scale scores of participants with more than 100 hours of learner driver experience (about 50 percent of participants) did not increase between the two surveys.

Mean DBQ scale scores for male and female participants are shown in Figure 2. Males had significantly higher scores on the Violations and Aggressive Violations scales. Figure 3 shows the relationship between DBQ scale scores and age and exposure (using the amount of driving the day before the survey as a measure of exposure). In both cases there was no systematic variation in mean scores on the Lapses or Errors scales, but there were differences on the Violations and (less so) Aggressive Violations scales. Scores on these two scales were highest for younger participants and for participants who reported relatively high exposure levels.

The DBQ results suggest that the instrument is reliable – with a high level of internal consistency within the four scales that is stable over the six months between the surveys and a high level of test-retest reliability for the scales over the same period – and that mean scale scores did not change substantially. There are some interesting differences in the two violations scales. These are of interest given earlier research results concluding that the violations scale correlates with crash involvement.

Table 1: Factor loadings for DBQ items used in Surveys 1 and 2

Item	Factor 1		Factor 2		Factor 3		Factor 4	
	S 1	S 2	S 1	S 2	S 1	S 2	S 1	S 2
Miss seeing a Give Way" sign and just avoid colliding with traffic having the right of way"	0.70	0.64	0.11	-0.06	0.06	0.00	0.09	0.22
Go into an intersection so far that a driver with right of way has to stop and let you out	0.63	0.66	0.10	0.17	0.12	-0.01	0.14	0.08
When turning left, nearly hit a bicycle rider who has come up on your left	0.62	0.61	-0.02	-0.13	0.06	-0.09	0.08	0.22
Attempt to overtake someone that you had not noticed was signalling a right turn	0.48	0.44	0.12	0.12	0.17	0.15	0.06	0.29
Fail to notice that pedestrians are crossing when turning into a side street from a main road	0.48	0.43	0.16	0.25	0.22	0.27	0.09	0.04
Fail to check your rear-view mirror before pulling out, changing lanes, etc.	0.48	0.61	0.29	0.20	0.02	-0.04	-0.07	-0.09
Brake too quickly on a slippery road	0.47	0.57	0.25	0.23	0.25	0.16	0.06	0.07
Misread the signs and exit from a roundabout on the wrong road	0.47	0.48	0.09	0.16	0.38	0.23	-0.07	0.03
Queuing to turn left onto a main road, you pay such close attention to the traffic on the main road that you almost hit the car in front	0.46	0.47	0.10	0.08	0.27	0.28	0.21	0.13
Switch on one thing, such as the headlights, when you meant to switch on something else, such as the wipers	0.36	0.47	0.01	-0.14	0.45	0.30	-0.04	0.05
Hit something when reversing that you had not previously seen	0.25	0.46	0.04	0.03	0.34	0.10	0.05	-0.01
Attempt to drive away from traffic lights in the wrong gear	0.27	0.40	0.06	0.13	0.32	0.13	-0.03	-0.05
Disregard the speed limit on a freeway or rural highway	0.16	-0.09	0.76	0.48	-0.05	-0.03	0.13	0.17
Disregard the speed limit on a residential road	0.20	0.21	0.73	0.68	0.03	-0.06	0.13	0.25
Race away from traffic lights with the intention of beating the driver next to you	0.02	0.04	0.62	0.65	0.11	0.03	0.38	0.37
Enter an intersection knowing that the traffic lights have already changed against you	0.21	0.28	0.54	0.63	0.19	0.08	0.15	0.08
Overtake a slow driver on the left	-0.11	-0.07	0.53	0.46	0.16	0.18	0.35	0.39
Drive so close to the car in front that it would be difficult to stop in an emergency	0.23	0.31	0.48	0.58	0.22	0.07	0.09	0.08
Forget where you left your car in a car park	0.00	0.10	0.04	0.01	0.69	0.72	0.11	0.12
Having set out to drive to one place, you suddenly realise you are on the road to somewhere else	0.09	0.26	0.07	-0.07	0.66	0.57	0.08	0.23
Realise that you have no clear memory of the road you have been travelling on	0.13	0.28	0.25	0.37	0.63	0.47	0.01	-0.01
Get into the wrong lane approaching a roundabout or intersection	0.36	0.33	0.00	0.15	0.41	0.44	0.13	0.08
Underestimate the speed of an oncoming vehicle when overtaking	0.32	-0.03	0.36	0.00	0.40	0.46	-0.14	-0.06
Use your horn to indicate your annoyance to another road user	0.04	-0.01	0.09	0.17	0.10	0.06	0.74	0.68
Become angry at another driver and chase them with the intention of showing them how angry you are	0.19	0.20	0.23	0.21	-0.06	-0.01	0.71	0.72
Get angry at a certain type of driver and express your anger any way you can	0.08	0.08	0.36	0.28	0.10	0.08	0.64	0.72
Stay in a lane that you know will be closed ahead until the last minute before forcing your way into the other lane	0.35	0.32	0.31	0.35	0.02	0.15	0.39	0.46

Table 2: Psychometric characteristics of the DBQ scales

	Errors (Factor 1)	Violations (Factor 2)	Lapses (Factor 3)	Aggressive Violations (Factor 4)
Scale characteristics				
Survey 1:				
Mean	16.35	10.88	8.68	6.07
Standard deviation	4.35	4.38	3.14	2.62
Survey 2:				
Mean	16.64	11.44	8.69	6.34
Standard deviation	4.59	4.63	3.06	2.84
Internal Consistency (Cronbach alpha)				
Survey 1	.77	.77	.65	.69
Survey 2	.79	.79	.66	.73
Test-retest Reliability				
	.65	.75	.72	.72

Participants were asked to indicate on how many of the most recent ten driving trips they had engaged in specified risky behaviours. Scores on the Violations, Lapses, and Aggressive Violations scales of the DBQ were related to self-reported risky driving behaviour (see Figure 4). Participants with relatively high scores on these scales reported higher numbers of driving trips involving risky behaviours. This was so for most of the risky behaviours included in the survey, with some behaviours more strongly related to the DBQ scale scores. The strong relationship between risky driving and the Lapses scale is of some interest given the dominance of the Violations scale as a predictor of crash risk.

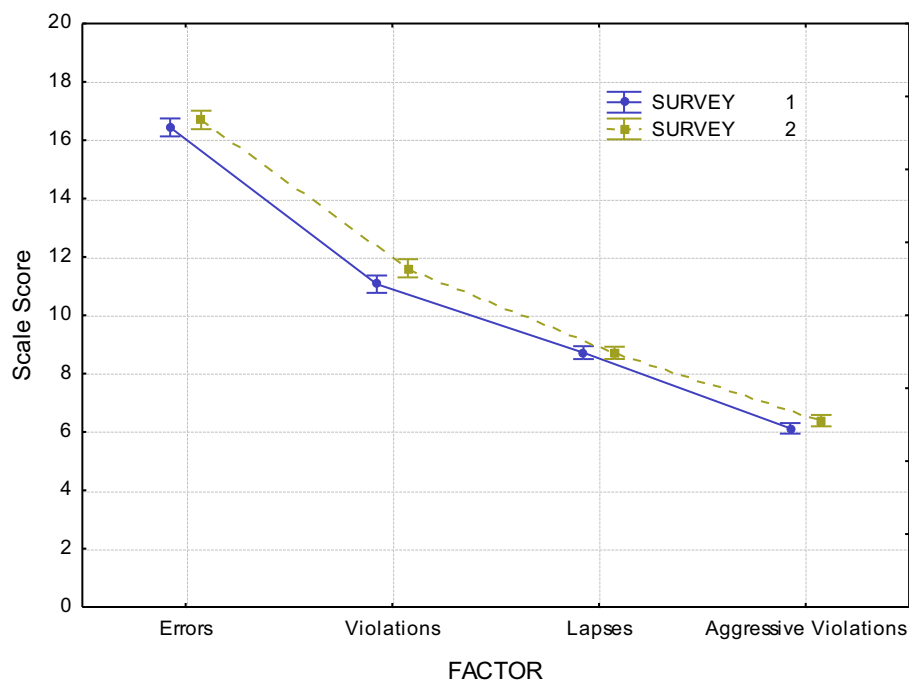


Figure 1: Mean DBQ scale scores for Survey 1 and Survey 2, with 95% confidence intervals

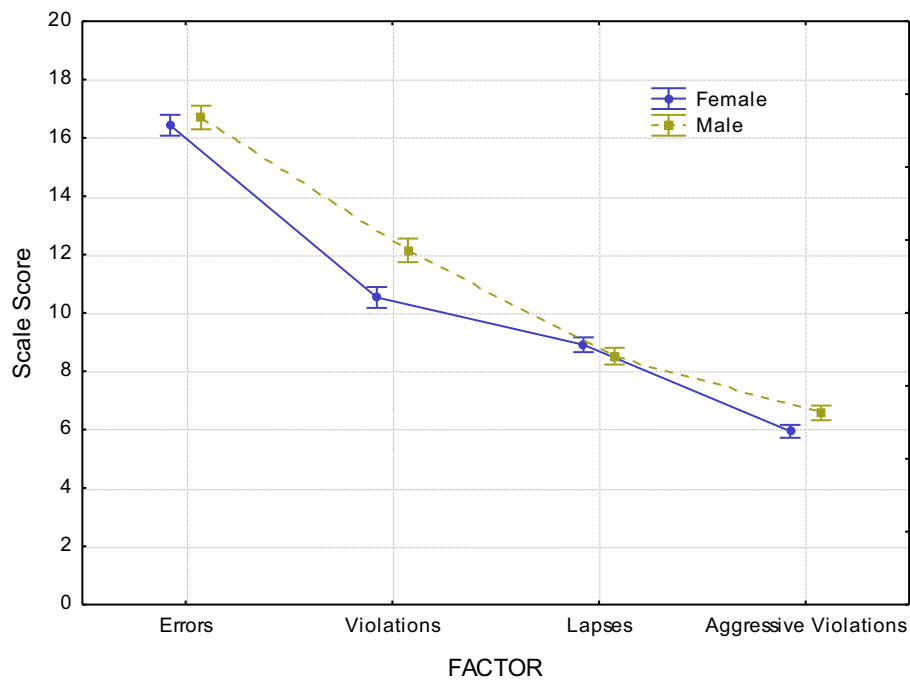


Figure 2: Mean DBQ scale scores for males and females, with 95% confidence intervals

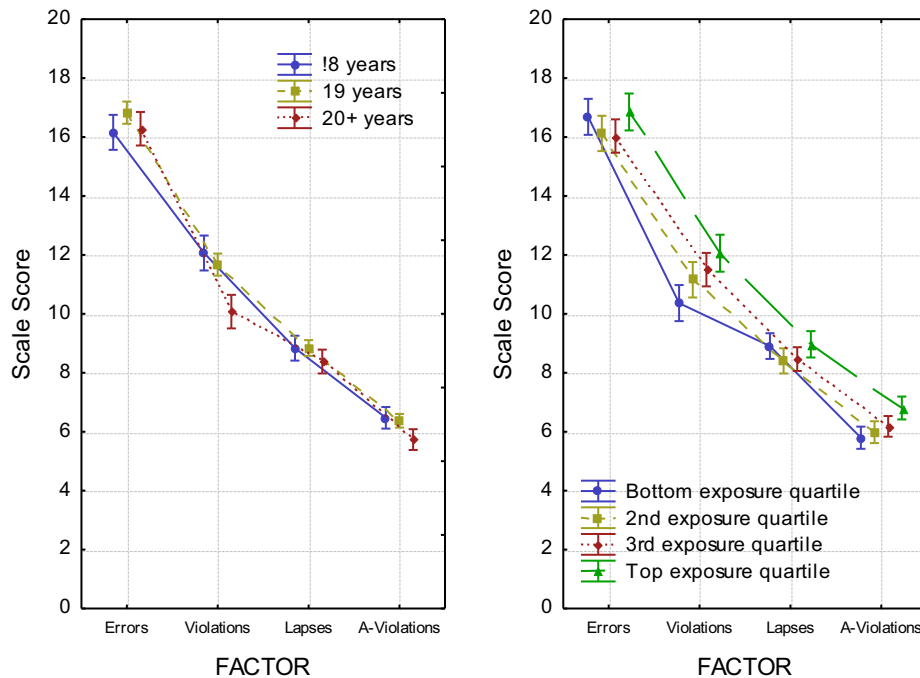


Figure 3: Mean DBQ scale scores by age (left) and exposure (right), with 95% confidence intervals

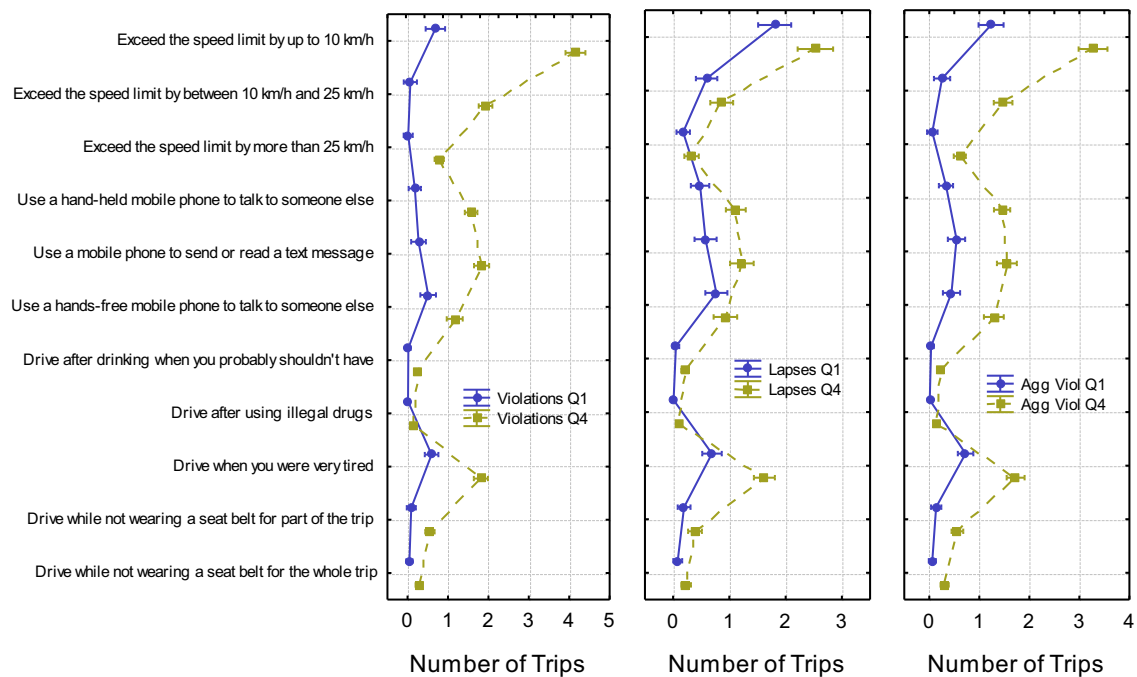


Figure 4: Mean number of trips (of last ten) involving unsafe or risky driving behaviours averaged across surveys disaggregated by DBQ scores on the Violations, Lapses, and Aggressive Violations scales (lowest and highest quartiles) with 95% confidence intervals

Participants indicated how many times they had been detected committing a range of traffic offences. A loglinear analysis conducted to analyse the survey data set more generally indicated that:

- There was a significant interaction between item, DBQ Violation scale score, and sex. Participants with DBQ Violations scale scores in the top quartile had more traffic offences than those in the bottom quartile (validating the DBQ Violations scale), but this was more so for male participants than for female participants. The effect of Violations scale scores on the number of offences for female participants was limited to speeding and signal-related offences.
- There was a significant interaction between DBQ Violation score, exposure, and sex. The relationship between the DBQ Violations scale score and the number of traffic offences was most pronounced for male participants with relatively high exposure levels. Males in the top DBQ Violations quartile and in the top two exposure quartiles comprised 9.6 percent of the sample but accounted for 28 percent of the offences reported by participants. The effect of exposure on offences (and its interaction with the DBQ Violations score) was independent of offence type.

Analysis of the relationship between DBQ items and self-reported crash involvement suggested the following interactions were statistically significant:

- Crash involvement and DBQ Lapses scale. Thirty-three percent of participants with Lapses scale scores in the highest quartile reported involvement in a crash, compared to 16 percent of participants in the lowest Lapses quartile.
- Crash involvement and DBQ Aggressive Violations scale. Thirty-four percent of participants with Aggressive Violations scale scores in the top quartile reported involvement in a crash, compared to 19 percent of those in the lowest quartile.

Discussion

The data discussed here were used to assess the psychometric characteristics of the DBQ. Key results were as follows:

- The DBQ's factor structure was remarkably consistent in the two surveys and in each case the four factors accounted for about 41 percent of the item variance.
- The DBQ factors had high internal consistency with Cronbach alphas over .65 in both surveys, and test-retest reliabilities were high – between .65 and .75 for the four scales. This suggests that the DBQ is highly reliable and well suited to assessing changes in self-reported driving behaviours. This result is important because there is little research concerning the application of the DBQ in Australia, its use as an on-line instrument, or its reliability beyond the common assessment of internal consistency for the scales.
- The mean scores on the DBQ scales did change between surveys, suggesting that some aspects of driver behaviour changed. There were no statistically significant changes in scores on the Lapses and Errors scales, but Violations and Aggressive Violations scale scores increased significantly in Survey 2 for participants with low levels of experience as learner drivers. This suggests that early experience as a solo driver might influence low-experience learners differently – increasing the likelihood that they will behave in ways that are potentially dangerous or illegal. The reason for this is uncertain – it may not relate directly to the level of learner driver experience but may instead relate to some personal characteristics that are associated with participants who had low levels of experience as learner drivers. This is an issue that may benefit from further research.

Analysis of the relationship between DBQ responses and other measures suggested the following:

- Scale scores on the Violations and Aggressive Violations scales were influenced by personal characteristics of the participants. Males had higher scores on both scales than did females, as did younger participants (compared to older participants) and those with high levels of driving exposure (compared to those with lower levels of current driving exposure). The higher risk associated with males, youthfulness, and high levels of driving exposure is a theme that was repeated throughout the results of the two surveys.
- Higher levels of risk taking behaviour were associated with higher scores on the Lapses, Violations, and Aggressive Violations DBQ scales. Lapses scores were not correlated to high level speeding, however, unlike Violations and Aggressive Violations scores.
- The Violations scale in the DBQ was related to the likelihood of a traffic offence. This was especially so for males where it was true for most offence types. For females, this relationship held only for speeding and signal offences.
- The link between the Violations score and offences for males was especially pronounced for males with high levels of recent driving exposure.
- Crash involvement was correlated with scores on the Lapses and Aggressive Violations scales.

The DBQ appears to have a reasonable level of stability across time when used with younger drivers in an on-line survey format. Although the instrument suffers from limitations imposed by its theoretical background and consequent failure to assess the broad range of factors associated with safety, the data reported here do suggest that the instrument can reasonably be used as part of a battery of assessment tools in an evaluation context.

References

- af Wählberg, A. (2004, January). The stability of driver acceleration behavior, and a replication of its relation to bus accidents. *Accident Analysis & Prevention*, 36(1), 83-92.
- Arthur, W., & Doverspike, D. (2001). Predicting motor vehicle crash involvement from a personality measure and a driving knowledge test. *Journal of Prevention & Intervention in the Community*, 22(1), 35-42.
- Bener, A., Al Maadid, M., Özkan, T., Diyaab, K., Lajunen, T., & Al-Bast, D. (2008, September). The impact of four-wheel drive on risky driver behaviours and road traffic accidents. *Transportation Research Part F: Traffic Psychology and Behaviour*, 11(5), 324-333.
- Bener, A., Özkan, T., & Lajunen, T. (2008, July). The Driver Behaviour Questionnaire in Arab Gulf countries: Qatar and United Arab Emirates. *Accident Analysis & Prevention*, 40(4), 1411-1417.
- Bianchi, A., & Summala, H. (2002, December). Moral judgement and drivers' behavior among Brazilians students. *Psychological Reports*, 91(31), 759-766.
- Bianchi, A., & Summala, H. (2004, July). The 'genetics' of driving behavior: Parents' driving style predicts their children's driving style. *Accident Analysis & Prevention*, 36(4), 655-659.
- Björklund, G. (2008, May). Driver irritation and aggressive behaviour. *Accident Analysis & Prevention*, 40(3), 1069-1077.
- Caird, J., & Kline, T. (2004, December). The relationships between organizational and individual variables to on-the-job driver accidents and accident-free kilometres. *Ergonomics*, 47(15), 1598-1613.
- Charlton, S. (2004, September). Perceptual and attentional effects on drivers' speed selection at curves. *Accident Analysis & Prevention*, 36(5), 877-884.
- Chliaoutakis, J., Koukouli, S., Lajunen, T., & Tzamalouka, G. (2005, November). Lifestyle traits as predictors of driving behaviour in urban areas of Greece. *Transportation Research Part F: Traffic Psychology and Behaviour*, 8(6), 413-428.
- Corbett, C. (2007, June). Vehicle-related crime and the gender gap. *Psychology, Crime & Law*, 13(3), 245-263.
- Daigneault, G., Joly, P., & Frigon, J. (2002, April). Executive functions in the evaluation of accident risk of older drivers. *Journal of Clinical and Experimental Neuropsychology*, 24(2), 221-238.
- Daigneault, G., Joly, P., & Frigon, J. (2002, March). Previous convictions or accidents and the risk of subsequent accidents of older drivers. *Accident Analysis & Prevention*, 34(2), 257-261.
- Darby, P., Murray, W., & Raeside, R. (2009, March). Applying online fleet driver assessment to help identify, target and reduce occupational road safety risks. *Safety Science*, 47(3), 436-442.
- Davey, J., Wishart, D., Freeman, J., & Watson, B. (2007, January). An application of the driver behaviour questionnaire in an Australian organisational fleet setting. *Transportation Research Part F: Traffic Psychology and Behaviour*, 10(1), 11-21.
- de Craen, S., Twisk, D., Hagenzieker, M., Brookhuis, K., & Elffers, H. (2008, July). The development of a method to measure speed adaptation to traffic complexity: Identifying novice, unsafe, and overconfident drivers. *Accident Analysis & Prevention*, 40(4), 1524-1530.
- Delhomme, P., & Villieux, A. (2005, September). Adaptation française de l'échelle de colère au volant D.A.S.: Quels liens entre colère éprouvée au volant, infractions et accidents de la route déclarés par de jeunes automobilistes?. *European Review of Applied Psychology/Revue Européenne de Psychologie Appliquée*, 55(3), 187-205.

- Elliott, M., & Baughan, C. (2004, November). Developing a self-report method for investigating adolescent road user behaviour. *Transportation Research Part F: Traffic Psychology and Behaviour*, 7(6), 373-393.
- Farrand, P., & McKenna, F. (2001, September). Risk perception in novice drivers: The relationship between questionnaire measures and response latency. *Transportation Research Part F: Traffic Psychology and Behaviour*, 4(3), 201-212.
- Fernandes, R., Job, R., & Hatfield, J. (2007). A challenge to the assumed generalizability of prediction and countermeasure for risky driving: Different factors predict different risky driving behaviors. *Journal of Safety Research*, 38(1), 59-70.
- Fong, G., Frost, D., & Stansfeld, S. (2001). Road rage: A psychiatric phenomenon?. *Social Psychiatry and Psychiatric Epidemiology*, 36(6), 277-286.
- Forward, S. (2006, November). The intention to commit driving violations - A qualitative study. *Transportation Research Part F: Traffic Psychology and Behaviour*, 9(6), 412-426.
- Gras, M., Sullman, M., Cunill, M., Aymerich, M., Font-Mayolas, S., & Planes, M. (2006, March). Spanish drivers and their aberrant driving behaviours. *Transportation Research Part F: Traffic Psychology and Behaviour*, 9(2), 129-137.
- Hennessy, D., & Wiesensthal, D. (2002, December). The relationship between driver aggression, violence, and vengeance. *Violence and Victims*, 17(6), 707-718.
- Hennessy, D., & Wiesensthal, D. (2005, January). Driving Vengeance and Willful Violations: Clustering of Problem Driving Attitudes. *Journal of Applied Social Psychology*, 35(1), 61-79.
- Horswill, M., & Coster, M. (2001, February). User-controlled photographic animations, photograph-based questions, and questionnaires: Three internet-based instruments for measuring drivers' risk-taking behavior. *Behavior Research Methods, Instruments & Computers*, 33(1), 46-58.
- Horswill, M., & Helman, S. (2003, July). A behavioral comparison between motorcyclists and a matched group of non-motorcycling car drivers: Factors influencing accident risk. *Accident Analysis & Prevention*, 35(4), 589-597.
- Iversen, H. (2004, May). Risk-taking attitudes and risky driving behaviour. *Transportation Research Part F: Traffic Psychology and Behaviour*, 7(3), 135-150.
- Iversen, H., & Rundmo, T. (2002, December). Personality, risky driving and accident involvement among Norwegian drivers. *Personality and Individual Differences*, 33(8), 1251-1263.
- Iversen, H., & Rundmo, T. (2004, April). Attitudes towards traffic safety, driving behaviour and accident involvement among the Norwegian public. *Ergonomics*, 47(5), 555-572.
- King, Y., & Parker, D. (2008, March). Driving violations, aggression and perceived consensus. *European Review of Applied Psychology/Revue Européenne de Psychologie Appliquée*, 58(1), 43-49.
- Kontogiannis, T. (2006, September). Patterns of driver stress and coping strategies in a Greek sample and their relationship to aberrant behaviors and traffic accidents. *Accident Analysis & Prevention*, 38(5), 913-924.
- Kontogiannis, T., Kossivelou, Z., & Marmaras, N. (2002, May). Self-reports of aberrant behaviour on the roads: Errors and violations in a sample of Greek drivers. *Accident Analysis & Prevention*, 34(3), 381-399.
- Krahé, B., & Fenske, I. (2002). Predicting aggressive driving behavior: The role of macho personality, age, and power of car. *Aggressive Behavior*, 28(1), 21-29.

- Laapotti, S., Keskinen, E., Hatakka, M., & Katila, A. (2001, November). Novice drivers' accidents and violations—A failure on higher or lower hierarchical levels of driving behaviour. *Accident Analysis & Prevention*, 33(6), 759-770.
- Lajunen, T., Parker, D., & Summala, H. (2004, March). The Manchester Driver Behaviour Questionnaire: A cross-cultural study. *Accident Analysis & Prevention*, 36(2), 231-238.
- Lonczak, H., Neighbors, C., & Donovan, D. (2007, May). Predicting risky and angry driving as a function of gender. *Accident Analysis & Prevention*, 39(3), 536-545.
- McKenna, F., Horswill, M., & Alexander, J. (2006, March). Does anticipation training affect drivers' risk taking?. *Journal of Experimental Psychology: Applied*, 12(1), 1-10.
- Mesken, J., Lajunen, T., & Summala, H. (2002, June). Interpersonal violations, speeding violations and their relation to accident involvement in Finland. *Ergonomics*, 45(7), 469-483.
- Nabi, H., Salmi, L., Lafont, S., Zins, M., Lagarde, E., & Chiron, M. (2007, February). Attitudes associated with behavioral predictors of serious road traffic crashes: Results from the GAZEL cohort. *Injury Prevention*, 13(1), 26-31.
- Özkan, T., & Lajunen, T. (2005). Why are there sex differences in risky driving? The relationship between sex and gender-role on aggressive driving, traffic offences, and accident involvement among young Turkish drivers. *Aggressive Behavior*, 31(6), 547-558.
- Özkan, T., & Lajunen, T. (2005, July). A new addition to DBQ: Positive Driver Behaviours Scale. *Transportation Research Part F: Traffic Psychology and Behaviour*, 8(4), 355-368.
- Özkan, T., Lajunen, T., & Summala, H. (2006, March). Driver Behaviour Questionnaire: A follow-up study. *Accident Analysis & Prevention*, 38(2), 386-395.
- Özkan, T., Lajunen, T., Chliaoutakis, J., Summala, H., & Parker, D. (2006, May). Cross-cultural differences in driving behaviours: A comparison of six countries. *Transportation Research Part F: Traffic Psychology and Behaviour*, 9(3), 227-242.
- Parker, D., Reason, J.T., Manstead, A.S.R., & Stradling, S.G. (1995) Driving errors, driving violations and accident involvement. *Ergonomics*, 38, 1036-1048.
- Reason, J.T. (1990) *Human Error*. Cambridge: Cambridge University Press
- Reason, J.T., Manstead, A.S.R., Stradling, S.G., Baxter, J.S., & Campbell, K. (1990) Errors and violations on the road: A real distinction? *Ergonomics*, 33, 1315-1332.
- Rimmö, P. (2002, June). Aberrant driving behaviour: Homogeneity of a four-factor structure in samples differing in age and gender. *Ergonomics*, 45(8), 569-582.
- Ross, R., & Antonowicz, D. (2004). *Antisocial drivers: Prosocial driver training for prevention and rehabilitation*. Springfield, IL US: Charles C. Thomas Publisher.
- Schwebel, D., Ball, K., Severson, J., Rizzo, M., Viamonte, S., & Barton, B. (2007). Individual difference factors in risky driving among older adults. *Journal of Safety Research*, 38(5), 501-509.
- Schwebel, D., Severson, J., Ball, K., & Rizzo, M. (2006, July). Individual difference factors in risky driving: The roles of anger/hostility, conscientiousness, and sensation-seeking. *Accident Analysis & Prevention*, 38(4), 801-810.
- Stradling, S. (2007, August). Car driver speed choice in Scotland. *Ergonomics*, 50(8), 1196-1208.

Sullman, M., Meadows, M., & Pajo, K. (2002, September). Aberrant driving behaviours amongst New Zealand truck drivers. *Transportation Research Part F: Traffic Psychology and Behaviour*, 5(3), 217-232.

Van Rooy, D., Rotton, J., & Burns, T. (2006, March). Convergent, discriminant, and predictive validity of aggressive driving inventories: They drive as they live. *Aggressive Behavior*, 32(2), 89-98.