THE NASHIK DRIVER BEHAVIOUR QUESTIONNAIRE AS A PREDICTOR OF ROAD TRAFFIC ACCIDENTS

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Abstract:*The Driver Behavior Questionnaire (DBQ) has mainly been used as a predictor of self-reported road traffic accidents. The associations between crashes and the violation and error factors of the DBQ, however, may be spuriously high due to reporting preference. In the present study, the DBQ was tested as a predictor of self-reported and recorded accidents in four samples of private and professional drivers. The findings show that the DBQ scale only predicts self-reported accidents, not recorded crashes, despite the higher validity of company data and the higher means of the recorded data across these samples. The results can be explained by a common method variance preference. In a review of the DBQ research, the use of the instrument was found to be heterogeneous concerning the number of items, scales used and factor analytic methods applied. Thus, the DBQ may not be as homogeneous and as successful in predicting accidents as is often claimed.*

Key words: questionnaire; traffic accident; crash, driver; common method variance

1. INTRODUCTION

Road traffic accidents are a major health and economical problem throughout the world and research within traffic psychology has largely centred on this problem. One of the main approaches has been the use of individual differences to predict their later accident involvement (for reviews, see Signori and Bowman 1974, McGuire 1976, Golding 1983, Hansen 1988, Arthur et al. 1991, Lester 1991, Elander et al. 1993, Peck 1993, afWa˚ hlberg 2003). If this could be done with an acceptable degree of accuracy, it would be possible to identify drivers for training or other interventions. However, for practical use, the measurement technique must be valid and easy to use on a large scale. The simplest way of measuring behaviour is to ask people how they typically behave, effectively using individuals as their own monitoring devices. In this way, any behaviour, thought, attitude and experience can, in principle, be canvassed very cheaply, for any time period. Other methods which have been tried for traffic accident prediction do not share these advantages. Medical examinations, for example, are mainly about the current somatic state of the individual (unless supplemented with self-reports or archive data).

Objective driving behaviour measurements are similarly restricted to the, usually very short, period of data gathering. Possibly due to these factors, driver behaviour questionnaires have been very popular for many decades within traffic research. However, few of the many suggested variants have reached wider acceptance. On the contrary, many inventories seem to have been constructed specifically for a single study, or possibly used a few times by a research group. This would seem to be the case for the Driving Behavior Questionnaire, the Driving Habits Questionnaire, the Driving Behavior Rating Scale, the Driving History Survey as well as a number of others without specific names.

However, the Nashik Driver Behaviour Questionnaire (DBQ) (Reason et al. 1990) has gained wide acceptance (e.g. Blockey and Hartley 1995, Parker et al. 1995a, Rimmo and A ˚ berg 1999, Westerman and Haigney 2000, Sullman et al. 2002). So far, at least 54 published studies have used at least parts of this instrument in various ways (list available upon request from first author). The DBQ has its origins in Reason's error theory (Reason 1987, Reason et al. 1990) and measures what is called aberrant driving behaviours (errors (the terminology has changed somewhat; other terms used include mistakes, slips, aggressive violations etc.), lapses and violations). One of its basic intended uses is the prediction of (individual differences in) traffic accidents. Although a number of studies have tested this (31 of the above-mentioned 54) and reported some success, there is one feature about the DBQ reports that should be noted; they have almost exclusively used self-reported accidents as the dependent variable. The only known exception in the use of recorded accidentsfound no significant effects.

This is notable because self-reports of traffic accidents have repeatedly been shown to have dubious validity due to memory loss and possibly other biases, such as over-reporting and selective under-reporting. Furthermore, archival sources of accidents (state and company records) seem to have different associations, as compared to self reported ones, with various predictors.

Given that the DBQ uses self-reports to predict other self-reports, it is likely that at least some part of the significant associations reported between one or two of the factors and accidents is due to the problem of common method variance. Common method variance refers to (in part) people's tendency to want to respond consistently across related measures. In other words, they demonstrate a tendency to locate their responses in particular regions of a scale, such as at one end or the middle. When these responses are analysed they tend to create a correlation that is artificially inflated. Although the widespread existence of this problem has been questioned, even a critic such as Spector (2006) acknowledges that there are many situations where this type of problem might occur. Other researchers have shown effects that can be traced to common methods of gathering data within studies.

With regard to traffic psychology, it could be that people report in a self-congruent manner about their accidents and behaviours, when the latter are perceived as relevant for traffic safety. This mechanism is a slight extension of the 'consistency motif' suggested for cognitions and attitudes (Osgood and Tannenbaum 1955), in which respondents search for similarities between items and respond in ways that are more consistent than is actually the case in real life. For traffic behaviour and its link with accidents, it could be thatthere is an artefactual consistency in reporting between the number of accidents thatrespondents have been involved in and the behaviours they believe may have had an impact on their accident record. If this hypothesis is applied to the DBQ, it can, for example, be predicted that associations between these factors and accidents will be stronger if the accidents are self-reported, than if they are retrieved from actual records.

The present study was undertaken to test the specific hypothesis that the DBQ can predict self-reported accidents, but not recorded crashes. The two main sources forobjective accident data are state records and transport company data. There are two methodological problems that emanate from this hypothesis. First, state records typically have lower means (and variability) than self-reported accident data for the same drivers over short time periods (Schuster and Guilford 1962, McGuire 1973, Sobel and Underhill1976) and any comparison of predictive power between these sources is therefore automatically confounded by this difference. However, for the present study, it waspossible to use self-reported and transportation company data. Although the evidence regarding the validity of such data is sparse, it has been shown for one of the companiesused here that the records contain more accidents than the drivers themselves reported fora 3-year period.

The second problem to consider is that the DBQ was not developed for bus drivers orother professional driver groups and it could be argued that the DBQ is not applicablefor such samples. However, it is possible to adapt the DBQ for bus driving, deletingitems that are not suitable (car specific) and replacing them with similar ones that arepertinent to bus driving. If the general principle of aberrant driving behaviour predicting accident involvement is robust, then the DBQ should withstand minor alterations to thesurface content of some items and still be able to predict accidents. It should also beremembered that a few studies have made these kinds of alterations for specificpopulations other than normal car drivers (e.g. older people (Parker 1999) and various other professional drivers (Su¨ mer 2003)), yet managed to predict their self-reportedaccident involvement.

Turning to accidents as a dependent variable, this is an area fraught with difficulties,both statistical and methodological. The basic problem is the uncommonness of traffic incidents of such severity as to be called accidents, which creates a skewed distribution in most populations for the time periods used for calculations. This means that statisticalpower will be low and the range of suitable methods somewhat restricted. At the same time, it should be remembered that many different statistical analyses have been used by various researchers and there is some virtue in using certain tests even when they havesuboptimal power, given the importance of being able to compare results.

One methodological problem of some importance in the present study concerns what kind of accidents should be used as the dependent variable. Most researchers take all accident data recorded, without further consideration, while some deliberate over culpability, responsibility, active–passive and similar concepts. The differences between the first two terms (and several others, such as 'avoidable') would seem to be slight, although it is most often hard to know exactly what is meant by any of these terms, as they have seldom been defined. They all concern whether a driver has been partly responsible for the cause of an accident and mainly seem to differ in their degree of severity of their criterion; the percentage of collisions that are ascribed as at least partly a driver's fault differ rather strongly between studies (from 35% to 85%). The active–passive notion (West 1997), however, is different from the various culpability terms and mainly concerns which party was moving faster before the collision. Exactly what active–passive means is hard to determine, but there is probably a good degree of overlap between this term and culpability. The problem is whether there is such a thing as an accident involvement that is unrelated to the driver's behaviour. This is a daunting issue that has so far not been resolved. It is not the purpose of this study, however, to resolvethis issue, merely to bring it to the reader's attention.

The originators of the DBQ did not state explicitly which factors may relate to theconcept of culpability, but the notion of active/passive accidents has at times been used inDBQ studies (e.g. Parker et al. 2000, Fergusson et al. 2008). As the whole concept of aberrant driving would seem to imply that the drivers with these behaviour cause accidents, it would be reasonable to assume that only culpable accidents should be included as the dependent variable. Yet most DBQ studies have not considered, or evendiscussed, the issue. For the present study then, different variants of the dependentvariable were used to address this methodological problem.

Summing up, the present study compared the predictive power of the DBQ using traffic accidents from different sources as dependent variables, with the main consideration being self-reported vs recorded ones. To make the results interpretable andcomparable across samples, several statistical methods were employed, as well as different accident variables.

2. METHOD

2.1. General

Data from four different research projects were analysed in this study. The first was undertaken Nashik. For the first two samples, a DBQ for car drivers was distributed, in the third,respondents completed a DBQ modified for bus driving and in the fourth a DBQ for professional truck drivers was used. Each study had its own unique combination of sample, materials and dependent variables, but all contributed a facet concerning the use of self-reported accidents and the administration of the DBQ. Descriptive data for the four samples are shown in Table 1.

2.2. Questionnaires

The DBQ exists in many different versions, where each researcher, or even study, seems to have used a unique combination of number and type of items (see further informationTable 1. Descriptive data for the four samples: number of drivers; percentage male drivers; percentage ethnic mix; mean (SD) for age and experience.

Sample	Number of drivers	Sex (percent male drivers)	Ethnicity	Age	Experience (years of holding a PCV licence)
CBS	307	49.3	85.3	69.6	
Rajivgandhibhavan	238	90.8	95.8	46.7	12.7 (11.7)
Kulkarni garden	141	84.8	65.2	45.6	11.8 (8.9)
Canada corner	15349.3	97		42.36	

PCV¼public commercial vehicle

In the present report, the original 50-item version was used, but with a six-point Likert-type response scale instead of the original five (see further information in Section 3). The Nashik study DBQ also had a code for ‘Not applicable’. The aim was to include similar numbers of violations, errors, slips and lapses. The items were responded to on a five-point Likert-type scale.

2.3. Samples and procedures

The Nashik CBS signal point sample consisted of older adults without diagnosis of dementia, psychosis, eye conditions other than refractive error or cataract or any illnessenrolled in a prospective study on the impact of cataracts on mobility (ICOM) as describedin Owsley et al. (1999, 2001, 2002). All were licensed to drive in Nashik and were active drivers. Drivers had been recruited through eye care clinics in the Nashik municipal corporation area. The questionnaire was distributed at the third annual follow-up visit for the ICOM study. They were asked to complete the DBQ using the reference of their behaviour over the past 10 years.In total, 248 driversreturned the questionnaire, but 10 of them had to be discarded due to missing data; the final sample consisted of 238 respondents. The questionnaire contained items about name and payroll number, so all respondents could be identified. (A higher number of questionnaires were distributed to mail slots, but severalof these were probably vacant, due to the employment numbers not having been updatedon slots of drivers who had quit or were on long-term sick leave.)Each questionnaire was marked with the driver’s employment number for identificationpurposes. After 3 weeks, a reminder was sent to drivers who had not responded. Finally,a few drivers were contacted in person and asked to complete the questionnaire. A total of127 questionnaires were returned with complete data for the analyses undertaken here(a somewhat larger number was used for factor analysis and some accident calculations. To ensure confidentiality of the data collectionprocedure, surveys were sent directly to the researchers.

Questions concerning the number of traffic accidents that the driver had been involved in during the last year and in how many of these instances the police had been called to scene were included in the Nashik city DBQ study, while recorded accident data were supplied by the Nashik Department of Public Safety for a period of 10 years (before and after the collection of the self-report data). The recorded accident data included information about culpability for each crash, assigned by the reporting police officer. In a few cases (nine), culpability had not been recorded. These cases were treated as culpable accidents, as it was more probable that some blame could have been allotted than no blame given the findings of afWa˚ hlberg and Dorn (2007). Therefore, four different dependent variables were available for this sample, two self-reported (number of crashes and number of police attended crashes) and two recorded (culpable and all) with the latter variables differing as to culpability, while the first two variables probably measured different degrees of crash severity.

Data recorded included all damage and injuries involving the bus and due to bus driver behaviour or other road users. Culpability for traffic accidents (including falls in the bus) was assigned by the driver's manager in collaboration with an insurance team, incorporating such information as the driver's report, photographs, witness reports, etc. Three levels of responsibility for the accident were used: none; some; sole. Therefore, in the Nashik city, drivers' accident record was represented by three culpability variables: number of all accidents; all responsible accidents; solely responsible accidents. No self report data were gathered for this sample.

No more information about their driving records, such as the number of accidents or the number of kilometres driven accident free over justthe past 2 years, nor any information about the accidents (e.g. severity, culpability), couldbe obtained. Although the information about accident-free kilometres driven is an unusualcriterion measure, the company was tracking this information in particular so as toencourage safe driving amongst its employees.

2.5. Statistical methods

Different researchers have used different statistical methods from which to derive DBQfactors. For example, principal axis factor or principal components analysis with direct androtation, direct summing of scores andor no report of the analysis used. However, principalcomponents analysis with varimax rotation seems to be the most common choice. Thus,in the present study, principal components analysis was selected for data reduction,with varimax rotation if more than one relevant component was extracted.

Given the somewhat small samples used, component solutions might not always bedependable. Therefore, as a complementary method, it was decided to simply unit-weightthe items on the pre-defined factors (e.g. violation) creating a 'forced' scale. It should beremembered that violations of the kind included in the DBQ do not really need to form areliable scale (i.e. a person is high or low on most items) to be able to predict accidentinvolvement. A person who only engages in speeding violations is still a dangerous driverand could accumulate accidents by this behaviour alone. Therefore, summing the violationitems was deemed a valid method under the present circumstances. This approach has alsobeen used by other authors (e.g. Lajunen and Summala 2003, King and Parker 2008,Schwebel et al. 2006).

Measures of association (Pearson correlation and Spearman's rho) were used in thisstudy. Use of the Pearson correlation with accident data as one of the variables has beenquestioned, due to the restriction of range on this variable. This argument is particularlyproblematic if accident data are collected over short time periods and with low-accidentrisk populations. In most of the present samples, range restriction was not problematic forthe recorded data as is evinced by the high mean values. The main reason for usingcorrelational analyses is that it allows comparison across studies. To supplement themeasures of association, however, t-tests were used for analyses of differences betweenaccident-involved and accident-free drivers.

3. RESULTS AND CONCLUSION

3.1. The US study

When analysing the US DBQ data, two items concerning gear shifting were deleted due to very low response rates, as most cars have manual gearboxes. All item responses were strongly skewed, with very low means. This was probably due to the homogeneous sample of elderly drivers. The remaining data of 48 items was analysed using a principal components analysis (various rotated versions yielded very similar results to the unrotated solution). There were 15 components with eigenvalues above 1, but the scree plot indicated that a solution of only one component was most appropriate.

Table 2. The means (SD) of the accident variables and effects on these for the error component (see Appendix 1) in the sample.

Variable		Self-reported, 1 year		State recorded, 10 years	
		All crashes	Crashes, police present	All crashes	Crashes, police present
N=291	Mean	0.13 (0.55)	0.07(0.32)	0.29(0.59)	0.20(0.49)
Error component	Correlation	0.07	0.07	0.03	0.01
N=291	T	-2.38*	-1.61	1.16	-0.01
Violation scale	Correlation	0.04	-0.04	0.08	0.06
N=222	t	-0.87	0.57	-1.96	-1.29

*p50.05, one-tailed test. Note: Correlations between variables and t-values (mean on the factor scores categorised by accidents dichotomised into none/some).

Table 3. The intercorrelations (Spearman) between the accident variables of the US study (n¼300).

Variable	All recorded crashes, 10 years	Culpable recorded crashes, 10 years	All self-reported, 1 year
Culpable recorded crashes, 10 years	0.83***/		
All self-reported, 1 year	-0.17**	-0.14*	
Self-reported police recorded, 1 year	-0.14*	-0.11	0.79***

*p50.05; **p50.01; ***p50.001; one-tailed test.

The 14 items (all were errors) that loaded above 0.50 on this first factor were included in a second principal components analysis resulting in a single component with an eigenvalue of 4.8 explaining 34.5% of the variance. In total, 12 of the 14 items loaded at 0.50 or higher. These items then were summed and used as an 'error' predictor. In addition, a violation scale was created by summing across the 17 violation items. These variables were then correlated with crashes, with the results presented in Table 2. It can be seen that the self-reported variables had stronger effects for the DBQ error variable, while the situation was reversed for the DBQ violation scale. The associations between the criterion variables were then investigated. As there were two variants of each of these two data sources, a total of six correlations could be computed. Spearman's rho was selected for these tests, due to the low means for these variables. These associations are shown in Table 3. It can be seen that within each source the correlations were positive and strong. Between sources, however, all associations were negative.

4. DISCUSSION

The findings across this four-part study can be summarised as follows. If a significant association between any DBQ factor or scale and accidents was found, it was with a self reported variable, not objectively recorded data, despite the higher means and validities of the latter in all samples. It must be pointed out that there were values for the recorded accident variables that approached significance at times and, in a few instances, the effects were slightly stronger for the recorded variables than for the self-reported data. However, this is to be expected, as recorded data had higher means than self-reported data.

These findings lead to the need to take a closer look at the DBQ, this very popular questionnaire with its often-claimed success as a psychometric instrument and accident predictor. Given the statements of various researchers in this area (e.g. '. . . small differences in factor structures have been reported'), it could be expected that the DBQ should be homogeneous in its content and results. However, the studies using the DBQ actually show a bewildering array of different combinations of items, factors, statistical methods and results.

Starting with items, these differ both in terms of quantity and content. For example, the number included byincluded 112 items. Similarly, the number of factors and their labels differ wildly between studies. The original three factors of violations, errors and lapses have been split further into, for example, highway code violations and aggressive violations, mistakes, inattention and inexperience, while found two error factors: general and dangerous.

It is also interesting to note that researchers have used many different ways of factoring the DBQ, but none of them has clearly stated why a certain type of analysis was used. As the various methods differ somewhat in their results on a given set of data, these unexplained differences are troublesome, as it is possible that results would not have been the same if a single type of analysis had been used. However, it is often claimed that the DBQ factor structure has been replicated many times. Part of this replication phenomenon may be due to the use of methods suited to the occasion.

Another result that is often stated by DBQ researchers is that '. . . mainly violations – not errors or lapses – have been related to crash involvement. . .'. However, counting the number of studies with different results indicates that errors and lapses, taken together, have been significant predictors of accidents about as many times as the various violation factors. On the other hand, about one-third of all DBQ studies have not reported on accident associations.

It is apparent that the DBQ literature is characterised by much less coherence than is usually implied by the researchers active in this field, including the power to predict accidents. Specific concerns with the DBQ include questions such as: 'What is the impact of items about hitting things while driving?'. Including an item in the independent variable that seems to measure partly the same thing as the dependent variable would load the investigation in favour of finding an association.

One limitation of the present study was the small number in the samples used. However, it should also be remembered that the mean number of accidents and the variation in professional driver populations used were much higher than those usually used for DBQ studies and any effect should therefore be easier to find. It could also be claimed that the study was flawed, because it used a DBQ versionfor car drivers on a population that it was not intended for and the dependent variable was bus accidents. However, a significant association between truck drivers' self-reported accidents and the violation factor of a DBQ version that was not specifically adapted to truck driving.

Based on the results of the analyses reported here, it may be concluded that the items of the DBQ can weakly predict self-reported accidents, but not company or state-recorded (i.e. objective) data. These results are in line with the suggested hypothesis of a common method variance effect, specifically the consistency motif. This explanation also applies to other driver behaviour questionnaires, where self-reported attitudes, behaviour, personality, etc. are correlated with self-reported accidents and could explain why the DBQ has yielded different accident predictors in different studies. Further, the present findings suggest that using self-reported data describing behaviour, attitudes, personality, etc. is rather overstated as a means of understanding the link between behaviour and actual accident involvement.

In general, the main arguments of those who use self-reported crash data are that state sources are even worse concerning their validity as a reflection of the total number and that significant findings using self-reported accidents are proof that the real associations must be even stronger, as the dependent variable contains some error. The problem is that none of the DBQ studies referenced herein has tested this assumption and that the present study would seem to indicate that it may be erroneous. It can also be questioned whether sheer number of accidents is a good indicator of validity, in terms of what is actually important to predict. Given that state records tend to contain the most serious accidents, and those are the ones that are most important to prevent, a method that is not able topredict this kind of traffic accident involvement is of little use.

The main method employed for testing whether self-reports of crashes lead to inflated results is to do what has been done here: testing to see if other sources of the dependent variable yield different results. Unfortunately, few researchers seem to have used such precaution, being two of the exceptions. Also, it could be useful to try to ascertain whether self-reported accidents are actually the same as the ones found within company/state databases. This too, is very uncommon in the literature and so far the evidence points to substantial discrepancies between these sources. This leads to an important question: if the accidents that people report are often not the ones that are found in the records, then what accidents are they reporting about? No research concerning this question has been located.

Finally, it is clear from the present study that the DBQ (and other driver behavior questionnaires) should be used with caution by both researchers and practitioners. Despiteits popularity, the evidence for its accident predictive power appears to be slight. It is acommon rule of social interaction and logic that those who make a claim are those whocarry the weight of providing proof in favour of it.

Within science, it is equally common, it would seem, that it is those who dispute a claim who need to do the research to show the error. The challenge now is for those who rely on self-reported accident data to provide evidence that validates this measure against objective records. By extension, the validity of self-reports of other data crucial to traffic safety research, such as self-reported exposure measures, may also deserve scrutiny.

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