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The Driver Behaviour Questionnaire as a predictor of accidents: A meta-analysis☆

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ABSTRACT

Introduction: Through a meta-analysis, this study investigated the relation of errors and violations from the Driver Behaviour Questionnaire (DBQ) to accident involvement. *Method:* We identified 174 studies using the DBQ, and a correlation of self-reported accidents with errors could be established in 32 samples and with violations in 42 samples. *Results:* The results showed that violations predicted accidents with an overall correlation of .13 when based on zero-order effects reported in tabular form, and with an overall correlation of .07 for effects reported in multivariate analysis, in tables reporting only significant effects, or in the text of a study. Errors predicted accidents with overall correlations of .10 and .06, respectively. The meta-analysis also showed that errors and violations correlated negatively with age and positively with exposure, and that males reported fewer errors and more violations than females. Supplementary analyses were conducted focusing on the moderating role of age, and on predicting accidents prospectively and retrospectively. Potential sources of bias are discussed, such as publication bias, measurement error, and consistency motif. *Impact on Industry:* The DBQ is a prominent measurement scale to examine drivers' self-reported aberrant behaviors. The present study provides information about the validity of the DBQ and therefore has strong relevance for researchers and road safety practitioners who seek to obtain insight into driving behaviors of a population of interest.

1. Introduction

It has long been documented that safe driving is not only accomplished by being able to drive in a relatively error-free manner. Intentional violations and risk taking are important determinants of road safety as well (Jonah, 1986; Robertson & Baker, 1975; Schuman, Pelz, Ehrlich, & Selzer, 1967). In 1990 Reason, Manstead, Stradling, Baxter, and Campbell introduced the Driver Behaviour Questionnaire (DBQ), which consisted of 50 items describing a variety of errors and violations during driving. Respondents had to indicate how often each aberration occurred to them during the last year on a scale between 0 (*never*) to 5 (*nearly all the time*). By conducting a principal component analysis on the results of 520 drivers, Reason et al. showed that errors were statistically distinct from violations, supporting the hypothesis that errors and violations are governed by different psychological mechanisms. Errors reflect performance limits of the driver such as those related to perceptual, attentional, and information processing abilities. Violations represent the style in which the driver chooses to drive and habits established after years of driving. The distinction between errors and violations is analogous to the distinction between driver performance and driver behavior (Evans, 2004), skills and safety motives (Lajunen & Summala, 1995), and driving skill and driving style (Elander, West, & French, 1993).

Since the work of Reason et al. (1990) the popularity of the DBQ has increased tremendously. Currently, at least 174 studies exist that have used the DBQ or a modified version (Fig. 1). The distinction between errors and violations has been found cross-culturally (Lajunen, Parker, & Summala, 2004; Özkan, Lajunen, Chliaoutakis, Parker, & Summala, 2006) and in special groups such as professional drivers, motor riders, traffic offenders, probationary drivers, parent-child pairs, young women, and older drivers (Bianchi & Summala, 2004; Brookland, Begg, Langley, & Ameratunga, 2008; Conner & Lai, 2005; Dobson, Brown, & Ball, 1998; Freeman, Wishart, Davey, Rowland, & Williams, 2009; Rimmö & Hakamies-Blomqvist, 2002; Schwebel et al., 2007; Steg & Van Brussel, 2009; Stevenson, Palamara, Morrison, & Ryan, 2001; Sullman, Meadows, & Pajo, 2002; Wallace, 2008). Furthermore, the DBQ errors and violations factors are strongly situated in a network of correlations with other questionnaires and tests such as Trait Anxiety, Driving Style Questionnaire, Big Five personality factors, Driver Attitude Questionnaire, Decision Making Questionnaire, Cognitive Failures Questionnaire, Propensity for Angry Driving Scale, Driver Perception of Pressure, Driving and Riding Avoidance Scale, Religious Orientation Scale, and Sensation Seeking Scale (Chapman, Ismail, & Underwood, 1999; Conner & Lai, 2005; Dobson et al., 1998; Lucidi et al., 2010; Maxwell, Grant, & Lipkin, 2005; Parker, Stradling, & Manstead, 1996; Schwebel, Severson, Ball, & Rizzo,

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2006; Shahar, 2009; Sümer, Lajunen, & Özkan, 2005; Taylor & Sullman, 2009; Van de Sande, 2008; Yildirim, 2007).

One of the most important applications of the DBQ is the prediction of individual differences in accident involvement. However, it is currently unclear to what extent the DBQ can predict accident involvement, because the results in the literature appear to be heterogeneous. For example, Freeman et al. (2009) and Sümer (2003) reported positive correlations (.16 and .18, respectively) between errors and accidents, whereas Stephens and Groeger (2009) found a negative correlation between lapses and accidents (−.16). Özkan and Lajunen (2005a) reported a correlation between ordinary violations and accidents of .35, whereas others found insignificant correlations, even pointing to the opposite direction (e.g., −.04 for highway code violations in Davey, Wishart, Freeman, & Watson, 2007). A review of Stradling, Parker, Lajunen, Meadows, and Xie (1998) stated that violations, not errors, predicted accidents. DeLucia, Bleckley, Meyer, and Bush (2003), on the other hand, found that errors, not violations, predicted accidents, and according to Blockey and Hartley (1995) neither errors nor violations were significant accident predictors. More recently, af Wåhlberg, Dorn, and Kline (in press) observed that in the literature "errors and lapses, taken together, have been significant predictors of accidents about as many times as the various violation factors" (p. 12).

Schmidt (1992) and Gardner and Altman (1986) explained that individual studies contain only little information and that apparent inconsistencies in the effect sizes and *p*-values can usually be explained through sampling error alone. A meta-analysis is essential to cope with sampling error, to expose the consistency of the effects, and to aid in theory forming (Schmidt, 1992). This study used a meta-analysis to estimate the predictive correlations of the DBQ errors and violations factors with regard to self-reported and registered accidents. The effects of age, gender, and exposure (mileage and hours driven per week) were evaluated as well, as these variables are known confounders of accident involvement (Lourens, Vissers, & Jessurun, 1999; Massie, Campbell, & Williams, 1995).

2. Method

A literature search was conducted to recover published and unpublished studies that used the DBQ. The searches were conducted with Google Scholar, Web of Science, and Scopus, and by tracing the references of the retrieved documents.

Given the purpose of this meta-analysis to summarize as much of the empirical evidence of the DBQ-accident correlation as possible, all types of scientific studies, that is, journal articles, papers presented at scientific conferences, book chapters, reports, PhD dissertations, and Bachelor or Master theses, were eligible for inclusion. There exist many variants of the DBQ, such as translations or variants that include culture-specific aberrations (e.g., Xie & Parker, 2002), with diverse numbers of items (from 10 in Rowland, Davey, Freeman, & Wishart, 2009 up to 112 in Kontogiannis, Kossiavelou, & Marmaras, 2002), and different numbers of extracted factors (from one in e.g., Hennessy & Wiesenthal, 2005 to seven in Kontogiannis et al., 2002). In our meta-analysis, all DBQ variants including those for special groups such as professional drivers and motor riders were eligible for inclusion. However, studies that extracted neither a violations factor nor an errors factor (such as Furnham & Saipe, 1993, extracting five factors related to risk taking) were excluded. We identified a number of DBQ studies in languages other than English. These were excluded as well because of limited accessibility and the practical difficulties of translation. At this stage, our literature search had retrieved 174 DBQ studies.

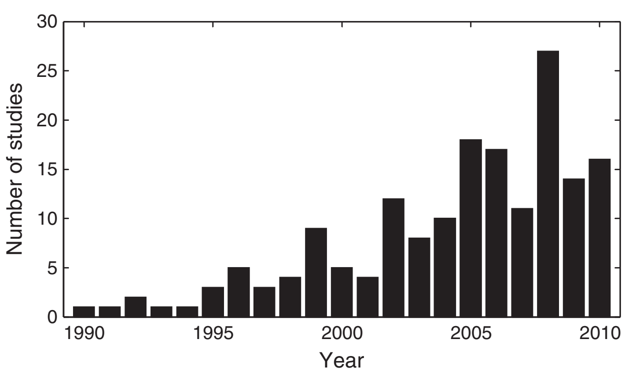

Fig. 1. Number of English-written studies per year using the original DBQ or a modified version of it.

Next, a selection was made among the retrieved DBQ studies. First, studies on children, pedestrians, and moped riders were excluded (Díaz, 2002; Elliott & Baughan, 2004; Mann & Sullman, 2008; Steg & Van Brussel, 2009). A substantial number of studies re-analyzed DBQ data from the same sample of respondents. If data were apparently re-used, we included only the study that reported the most comprehensive information on the relation between the DBQ factors and external criteria; the other studies using the same sample were excluded. It was also possible that the same sample was analyzed more than once within the same study as part of a longitudinal research (e.g., Conner & Lai, 2005). For these studies, we only used the available data from the first measurement instance and discarded the measurements that took place at a later phase. A number of studies included analyses on more than one separate sample of respondents (af Wåhlberg, 2010; af Wåhlberg et al., in press; Bener, Özkan, & Lajunen, 2008; Dobson et al., 1998). These samples were treated as independent.

Per sample, the correlations between the DBQ factor scores and the following six criteria were noted down, if available: self-reported number of accidents, recorded number of accidents (only in af Wåhlberg et al., in press), gender, age, mileage, and hours driven per week. If an effect size different than a correlation was reported (e.g., means and *SD*s, *F*-statistics between two groups, *t*-statistics, odds ratios), the effect size was converted into a correlation by using the equations reported in Borenstein, Hedges, Higgins, and Rothstein (2009). If correlations between DBQ factors and different types of accidents were reported, such as all accidents, culpable-only accidents, and passive/active accidents, we noted down only the correlation with all accidents. If the correlation with all accidents was not reported, we noted down the average of the available DBQ-accident correlations. In some cases, the effects were reported as an *F*-statistic of multiple groups (e.g., Analysis of Variance conducted on three or more age groups). In these cases, no correlation coefficient was calculated because we deemed that insufficient information was available for that. The DBQ-accidents correlations of Meadows (1994) and Mesken, Lajunen, and Summala (2002) were excluded due to uncertain reporting or data processing and because the observed effects were considered as outliers.

A number of DBQ studies used regression analysis, path analysis, structural equation modeling, or another multivariate technique, without reporting zero-order effects. In these cases we recorded the effect size from the multivariate analysis (typically standardized path coefficients or regression coefficients). The strength of a relationship between a predictor and a criterion variable obtained in a multivariate analysis depends on which predictors the authors included and therefore differs from the zero-order correlations. Furthermore, the corresponding standard errors are often unknown. Another issue was that some analyses did not report all relevant effects but only the statistically significant ones, or used stepwise regression analysis. Stepwise regression analysis uses an automatic procedure to select the strongest predictors to include in the meta-analysis and can distort the effect sizes because multiple hypotheses are tested, capitalizing on chance (Whittingham, Stephens, Bradbury, & Freckleton, 2006). To be able to investigate the zero-order effects separately from the more