Accident Analysis and Prevention 48 (2012) 379–396

Contents lists available at SciVerse ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Investigating the factorial invariance of the 28-item DBQ across genders and age groups: An Exploratory Structural Equation Modeling Study

Markus Mattsson*

Traffic Research Unit, Institute of Behavioural Sciences, University of Helsinki, PO Box 9 (Siltavuorenpenger 1 A), FI-00014 University of Helsinki, Finland

ARTICLE INFO

Article history:
Received 28 July 2011
Received in revised form
26 November 2011
Accepted 12 February 2012

Keywords:
Driver Behavior Questionnaire
DBQ
Factorial invariance
Exploratory Structural Equation Modeling
ESEM

ABSTRACT

The Driver Behaviour Questionnaire (DBQ) is perhaps the most widely used questionnaire instrument in traffic psychology with 174 studies published by late 2010. The instrument was developed based on a plausible cognitive ergonomic theory (the Generic Error Modeling System, GEMS), but the factor structure obtained in the original study (Reason et al., 1990) did not mirror the theory's conceptual structure. This led to abandoning GEMS and adopting the obtained factor structure as a starting point for further DBQ research. This article argues that (1) certain choices in the original study, concerning statistical methodology and the wording of individual question items, may have contributed to the ways the obtained factor structure deviated from the underlying theory and (2) the analysis methods often used in DBQ studies, principal components (PC) analysis and maximum likelihood (ML) factor analysis, are not optimal choices for the non-normally distributed categorical data that is obtained using the instrument. This is because ML produces biased results when used with this type of data, while PC is by definition unable to uncover latent factors as it summarizes all variation in the measured variables. (3) Even though DBQ factor scores have been routinely compared in subgroups of men and women and respondents of different ages, DBQ's factorial invariance in these groups has not been rigorously tested. These concerns are addressed in this article by framing the results of certain previous DBQ studies as a structural equation model (SEM) and an Exploratory Structural Equation Model (ESEM) and testing measurement model fit in subgroups of respondents. The SEM analyses indicate that the model does not fit data from the whole sample of respondents as it stands, while the ESEM analyses show that a modification of the model does. However, the ESEM analyses indicate the DBQ measures different underlying latent variables in the different subgroups. Based on the analyses and a review of recent advances in attention and memory research, an update to the theory underlying the DBQ is suggested.

1. Introduction

Traffic psychology is a field that provides a fertile testing ground for the ecological validity and generalizability of psychological theories. Theories of human error are one much researched example of this – for instance Reason et al. (1990) state that: "The road environment makes an excellent natural laboratory for observing aberrant behaviors". One influential view of human error, presented in Reason (1990) differentiates the possible kinds of human error based on whether the error was due to the action sequence not proceeding as planned (*slips* and *lapses*) or to the chosen action not being appropriate for the context in which it was executed (*mistakes*). *Slips* and *lapses* are skill-based errors, related to the execution of a motor plan, the former being especially related to attention and/or execution of movements, the latter to retrieval from memory. *Mistakes* are caused by an unsuccessful choice of means to attain an end – or, in plain English, by bad planning. In addition to these types of error that Reason (1990) deems definable in relation to the cognitive processes of the individual, the category of *violations* (of social rules and/or norms) are defined as "deliberate ... violations from those practices deemed necessary ... to maintain the safe operation of a potentially hazardous system". The ideas presented in Reason (1988) and Reason (1990) were adapted to the traffic context by Reason et al. (1990) who developed the Driver Behavior Questionnaire (DBQ) to measure these different types of human error that may occur on the roads. The original 50-item version of the questionnaire was based on the conceptual framework of the Generic Error Modeling System developed in Reason (1990).

These categorizations of errors are not rigid: *mistakes* can be further divided based on whether they are rule- or knowledge-based while *slips* and *lapses* can be combined into one category as, for instance, Reason et al. (1990) do, calling the resulting category *silly errors*. A further, higher-level categorization combines *slips*, *lapses* and *mistakes* into a single category of *unintentional errors*,

* Tel.: +358 40 7689406; fax: +358 91 9129422.
E-mail address: markus.mattsson@helsinki.fi

0001-4575/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
doi:10.1016/j.aap.2012.02.009