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Cognitive and personality determinants of safe driving performance in professional drivers

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ABSTRACT

Large truck and bus crashes still cause a high rate of fatalities and costs. Considering that the human factor plays an important role it is obvious that there is great interest in predicting safe driving performance in professional drivers, especially with new technologies emerging to assist drivers. This study uses a modern theoretical framework to assess which psychometric tests are still able to predict safe driving performance in today's professional drivers under these new circumstances.

126 male professional bus drivers completed a standardized digital test battery and three driving exercises. The test battery was used to assess reaction time, concentration, ability to gain an overview, reactive stress tolerance, logical reasoning, and safety-related personality traits. The exercises consisted of an on-road driving test, an obstacle course, and a maneuvering course.

The study yielded satisfactory indicators of criterion related validity. It also showed that different tests were relevant for the prediction of safe driving performance in different driving exercises. Contrary to previous research, logical reasoning showed significant effects. The results indicate that in order to assess safe driving performance in professional drivers, a comprehensive assessment with psychometric tests should be recommended.

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1. Introduction

According to the Federal Motor Carrier Safety Administration (FMCSA) there were a total of 4161 fatalities and 132,000 injuries in crashes involving large trucks and busses in the United States of America in 2014. Large truck crashes that involve fatalities cost, on average, a staggering $3.6 million per crash; those that cause injuries cost almost $200,000 per crash. Eurostat reports 1357 road accident fatalities in the category busses and coaches as well as goods vehicles in 2013. Considering that the human factor plays an important role in over 90 percent of these accidents (Gelau et al., 2012; Smiley & Brookhuis, 1987), it is obvious that there is great interest in predicting safe driving performance in professional drivers.

There is a long tradition of using psychometric tests to predict safe driving performance in various countries around the world. Tests are used in medical-psychological examinations to assess cognitive requirements (e.g., in Austria, Spain and Hungary) or in transport companies to select the best applicants. The concepts and theoretical background underlying these

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psychometric tests have remained basically unchanged for several decades, whereas the technology used in trucks and busses as well as road safety infrastructure in general has changed substantially (American Trucking Association, 2016; Dong, Hu, Uchimura, & Murayama, 2011; Sayed, Saunier, Lovegrove, & de Leur, 2010). The current study examines whether psychometric tests are still able to predict safe driving performance in professional drivers under these new circumstances and if so, which determinants are most important. In the light of the results, we also discuss the benefits a company can expect from using psychometric tests in its selection process.

2. Cognitive and personality determinants of safe driving performance

Traffic psychological research has a long tradition and has evolved considerably since the human factor was identified as one of the main reasons for traffic accidents. This research can be divided into two main fields: first, research examining cognitive functions and personality traits relevant to safe driving performance, and second, research which aims to define models of driving performance. Findings of both fields are described in the following sections, with a special focus on the implications for the selection of tests for the present study.

2.1. Empirical findings on determinants of safe driving performance

Numerous studies focus on identifying relevant cognitive and personality traits as valid predictors of safe driving performance. While some studies focus on the predictive validity of ability tests (e.g., Bukasa, Christ, Ponocny-Seliger, Smuc, & Wenninger, 2003; Bukasa, Wenninger, & Brandstätter, 1990; Karner & Neuwirth, 2000; McKnight & McKnight, 1999; Myers, Ball, Kalina, Roth, & Goode, 2000; Piersma et al., 2016), others investigate the predictive validity of personality measures (e.g., Burns & Wilde, 1995; Cellar, Nelson, & Yorke, 2000; Dahlen, Martin, Ragan, & Kuhlman, 2005; Dahlen & White, 2006; Iversen & Rundmo, 2002; Jonah, 1997; Jonah, Thiessen, & Au-Yeung, 2001; Oltedal & Rundmo, 2006).

Consistent evidence has been found for cognitive determinants such as visual perception and orientation, concentration and attention, reaction behavior, and sensorimotor functions (for an overview see Sommer et al., 2008). While these dimensions can be considered as "classics" among determinants of driving performance, more recent studies focus on the shift in requirements as a result of technical advancements in the automotive sector (e.g., Asimakopulos et al., 2012). New technical solutions like GPS navigation devices or communication tools facilitate many aspects of driving, but make operation of the vehicle itself increasingly difficult, which is why the relevance of higher cognitive and executive functions appears to be increasing.

With regard to relevant personality traits, evidence was found for a multitude of determinants. The most important key factors include emotional stability, social responsibility, and subjectively accepted level of risk key factors (Sommer et al., 2008).

Based on these research findings, an increasing number of countries introduced legal frameworks for driver assessments that specifically define the psychological dimensions to be tested (Schubert, Schneider, Eisenmenger, & Stephan, 2002).

2.2. Theoretical models of safe driving performance

While there are numerous studies demonstrating the criterion validity of single determinants, they are usually restricted in their validity with regard to multi-causal and complex behavior such as driving. It would therefore seem more appropriate to use theoretically based models of safe driving performance as a basis for validation. Only by considering the complex interaction of different abilities and personality traits it is possible to use psychological assessment for capturing the multi-causal criterion of safe driving performance.

Several models of safe driving behavior were considered as a basis for the present validation study and were evaluated in terms of their scientific and practical benefits. From a historical perspective, ability-based system models of driving behavior (Klebelsberg, 1982) represented the first attempt to introduce a more holistic approach to the modeling of safe driving performance to replace the use of single determinants. A shortcoming of this approach, however, is its exclusive focus on cognitive abilities. This is despite the fact that personality traits have been considered as an aspect of the psychological assessment of safe driving performance since the early 20th century (for example Marbe's theory of "accident proneness", 1923). Later insights from social psychology and the psychology of learning have also influenced the prediction of driving behavior and encouraged the inclusion of personality traits. System models with a focus on ability determinants were therefore succeeded by hierarchical models such as that of Michon (1985), which incorporated personality traits as an aspect of driving behavior. More recent models (e.g., Groeger, 2000) feature process-oriented pillars of driving performance that allow for a more direct link to real driving behavior. Even more importantly, these models facilitate the assessment of relevant skills, since they are defined by anchors in driving behavior.

One such model that takes particular account of actual behavior is the "Goals for Driver Education" (GDE) framework. The basis for the GDE framework was the EU GADGET project (Christ et al., 1999; Hatakka, Keskinen, Gregersen, & Glad, 1999). The GDE framework – first postulated by Hatakka, Keskinen, Gregersen, Glad, and Hernetkoski (2002) – incorporates four hierarchical levels. Decisions and behavior at lower levels are influenced by traits and abilities as well as by failure and success at higher levels. The lowest of the four levels involves vehicle maneuvering; the next two levels focus on mastery of traffic situations and on driving goals and context, while the highest level involves goals for life and skills for living. In addition, there

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