Predicting safe driving behavior of professional bus drivers: Validation of psychometric tests using real driving performance

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Abstract

Human factors models of driving behavior often include psychomotor abilities, cognitive abilities and personality dimensions as key human attributes associated with safe driving. The present study evaluates the effectiveness of psychometric tests of these human attributes in predicting safe and effective driving performance by experienced bus drivers.

A test battery consisting of safety critical ability and personality tests was administered to 125 professional bus drivers during routine driver training. Participants drove a passenger bus under three real time driving scenarios: 1) typical road driving (without critical incidents), 2) a "dangerous situations" hazard course (involving traffic incidents), and 3) manoeuvring buses in confined spaces. Expert driving assessors scored the performance of drivers using objective and subjective criteria for each scenario (e.g. errors, speed, traffic cones moved and situational based grading).

Regression analyses of results indicate that the full psychometric test battery could predict driver performance (R=.62, p<.05), and that different combinations of ability and personality dimensions are relevant for different safe driving scenarios. For typical road driving situations, concentration, reaction time and safety relevant aspects of personality were significantly predictive of safe driving performance. For dangerous driving situations involving traffic hazards, measures of stress tolerance and visual situation awareness were most significant. For bus driving in confined spaces, logical reasoning skills which allow the planning and execution of complex driving manoeuvres were most significant. Overall, the results demonstrate the validity and utility of targeted psychometric testing in the recruitment and training of professional drivers.

Introduction

Beyond the human misery involved, traffic crashes create large direct and indirect costs for the community in general and the public transport industry in particular. For example, for the 5 year period between 2006 - 2011, there were 144 deaths from crashes involving buses in Australia (BTRE, 2012) with an estimated human cost of $2.4 million per fatality (BTRE, 2009). While travel by public transport is generally considered safer than travel by private vehicle (e.g. Risbey, Cregan & Silva, 2010; Bus Industry Confederation submission, 2003), strategies to improve safety on public transport are still important.

Road safety studies indicate that human error is a critical factor in more than 90% of road crashes (e.g. Gelau, Gasser, & Seeck, 2012; Smiley & Brookhuis, 1987), hence many road safety initiatives involve human factors interventions, such as defensive driving and fatigue management. An area less well researched is the use of psychometric tests of abilities and personality attributes to assess the safe driving capabilities of drivers. Schuhfried, an Austrian manufacturer of psychometric tests has recently completed a study into how psychological assessments can be used to predict safe driving behaviors of professional bus drivers.

Method

Professional bus drivers (n=125) from a large public transport company undertook ability and personality tests during routine safety training. Psychometric tests were chosen following an analysis of the underpinning human abilities and personality factors associated with professional bus driving. The analysis involved the GDE matrix of driver competencies (Hatakka, Keskinen, Gregersen, Glad, & Hernetkoski, 2002), which has a hierarchical approach to categorising driver behaviors in increasingly complex driving situations. This identified a set of safety critical abilities (i.e. concentration, reaction speed, situation awareness, stress tolerance, logical reasoning) and personality traits (i.e. risk taking, self-control, sense of responsibility, emotional stability) that are important for competent bus driving. Validated computer based psychometric tests assessing each of these factors were chosen from those available through the test publisher Schuhfried (schuhfried.com.au) and these became the independent variables for the study. Table 1 lists the 6 tests used.

Table 1: Ability and Personality Tests Used

Test Name	Attributes Assessed	Test Format
Cognitrone (COG)	Concentration	Speed and accuracy in completing a simple pattern matching task
Reaction Time Test (RT)	Reaction Speed	Responsiveness to visual and auditory signals
Adaptive Tachiscopic Traffic Perception (ATAVT)	Situation Awareness	Visual orientation and perception speed when recalling features from traffic photographs
Determination test (DT)	Stress Tolerance	Hand and foot pedal responses to rapidly changing visual and auditory signals
Adaptive Matrices Test (AMT)	Logical Reasoning	Abstract reasoning test involving extrapolating and completing complex patterns
Inventory of Driving Related Personality Traits (IVPE)	Risk Taking Self-Control Sense of Responsibility Emotional Stability	Questionnaire style personality assessment

The dependent variable for this study was each participant's bus driving competency, which was assessed by expert driving instructors during three driving scenarios: 1) typical road driving (without critical incidents), 2) a "dangerous situations" hazard course (involving traffic incidents), and 3) manoeuvring buses in confined spaces. Figure 1 depicts the three driving scenarios. A GPS-based G-Force-logging device was also used during the driving scenarios to measured physical vehicle dynamics including lateral and vertical jerking, acceleration speed, and cornering forces.

1. Typical road driving

- 30-minute bus drive in real life traffic
- Standardized route involving urban areas, highways and motorway
- No safety incidents or crashes
- Roundabouts, intersections, priority situations, etc.

2. Hazard course

- A driving obstacle course involving critical driving situations
- Breakdowns, pedestrian crossings, narrow roadways, serpentines, concealed turns, reversing

3. Manoeuvring

- Time-critical manoeuvring
- Narrow roadway, bends and slalom driving, height monitoring situation, parking sideways and backwards, driving onto verge

Figure 1: Bus driving scenarios

Assessment of the dependent and independent variables were undertaken at a driver testing track in Vienna Austria in January 2015. Figure 2 overviews the study design and primary outcomes.
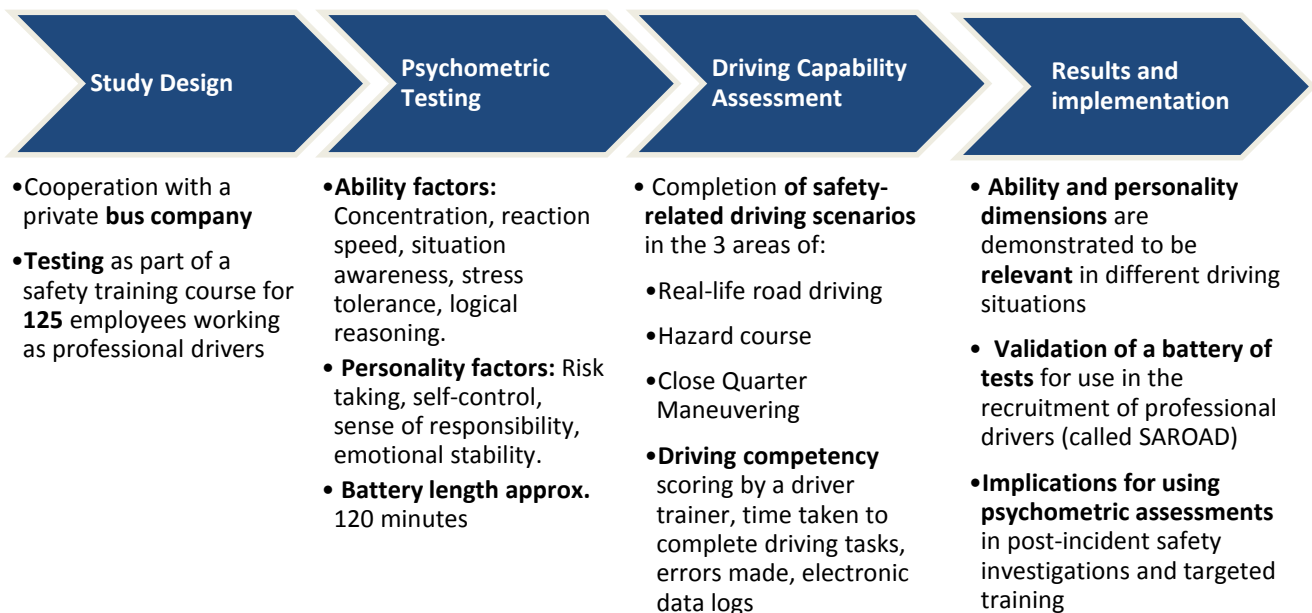
Study Design	Psychometric Testing	Driving Capability Assessment	Results and implementation
•Cooperation with a private **bus company** •**Testing** as part of a safety training course for **125** employees working as professional drivers	•**Ability factors:** Concentration, reaction speed, situation awareness, stress tolerance, logical reasoning. • **Personality factors:** Risk taking, self-control, sense of responsibility, emotional stability. • **Battery length approx.** 120 minutes	• Completion **of safety-related driving scenarios** in the 3 areas of: •Real-life road driving •Hazard course •Close Quarter Maneuvering •**Driving competency** scoring by a driver trainer, time taken to complete driving tasks, errors made, electronic data logs	• **Ability and personality dimensions** are demonstrated to be **relevant** in different driving situations • **Validation of a battery of tests** for use in the recruitment of professional drivers (called SAROAD) •**Implications for using psychometric assessments** in post-incident safety investigations and targeted training

Figure 2: Bus driver study design and primary outcomes

Analysis & Results

Results from psychometric testing and driving performance were evaluated using regression analyses. Driver competency was determined through the expert driver trainer ratings and error/mistakes ratings in the 3 driving scenarios. Those ratings were aggregated into driving scenario scores and correlated with the psychometric test results. If the tests are predictive of driver competency then better performance in the driving scenarios should be associated with higher test results, which was found to be the case. In this analysis the correlation for the combined battery of tests was found to be R =.62 (p < .05) for the typical driving scenario. Therefore, results from the complete battery of 6 tests were able to predict around 38% of the variation in driver competency under standard driving conditions. The full test battery correlations with the hazard course scenario and manoeuvring scenarios were found to be R =.52 (p < .05) and R =.502 (p < .05) respectively, accounting for approximately 25% of the variance in driving competence in these scenarios.

The analysis also found that different attributes more strongly predicted performance for each of the 3 driving scenarios. Table 2 summarises the strongest test predictors for each driving scenario.

Table 2: Abilities and personality traits associated with different driving scenarios

	Driver Competency Assessments (driving scenarios)		
	Typical Road Driving	**Hazard Course**	**Manoeuvring**
Relevant Abilities:	Reaction speed Concentration	Situation awareness Stress tolerance	Logical reasoning
Relevant Personality Traits:	Risk taking Self-control Sense of responsibility Emotional stability	-	-
Correlation (R):	0.54	0.38	0.28
Tests Used:	COG (Concentration) RT (Reaction) IVPE (Personality) *	ATAVT (Adaptive Tachistoscopic Traffic Perception Test) * DT (Determination Test) *	AMT (Adaptive Matrices Test) *

* significant at p < .05

Discussion

This study has demonstrated that psychometric tests assessing ability and personality factors, can successfully predict the driving competency and safe driving performance of bus drivers. This group of 6 tests has since been combined into a commercially available test battery called Safety Assessment Road (SAROAD).

The finding that different tests can predict performance in different driving situations indicates that test results can also be used to identify specific driver competency gaps. This diagnostic approach may be useful in assessing ability deficits related to driving incidents or crashes, as well as assessing driver competencies to inform driver training needs. In summary,

the findings from this study indicate that psychometric testing can be a useful tool for recruiting, assessing potential driving deficiencies and the targeted training of safe and competent bus drivers.

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