Research Paper

To Study the Role & Benefits of Driving Simulators in Driver Training

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ABSTRACT:

Given that the beneficial effects of driver training on accident risk may not be an appropriate criterion measure, this study investigates whether professionally trained and experienced drivers exhibit safer driving behavior in a simulated driving task compared with drivers without professional driver training. A sample of 54 police trained drivers and a sample of 56 non-police trained drivers were required to complete two tasks. Firstly to overtake a slow-moving bus on a hazardous stretch of single-lane road with bends and hills and secondly to Follow a lead vehicle travelling at 55mph in a built-up section with a speed limit of 30mph. Results showed that in comparison with non-police trained drivers; police drivers were significantly less likely to cross the central division of the road at unsafe locations during the overtaking task and reduced their speed on approach to Pedestrians at the roadside in the following task to a greater extent. Police drivers also adopted a more central lane position compared with non-police trained drivers on urban roads and at traffic lights during the following task. Driver group differences in simulated driving performance are discussed with reference to the implications for driver training assessment and skill development.

KEYWORDS: Driving behavior, driving simulator, hazard perception, driver training.

1. INTRODUCTION

The effectiveness of driver training on road safety is a controversial issue. Early research has demonstrated improvements in accident risk (Anderson, Ford and Peck, 1980) but many more studies report no significant difference in crash risk post-training (Kaestner, 1968; Nichols, 1970; and Struckman-Johnson, 1989; Manders and Rennie, 1984; Lund and Williams, 1985). Whilst there may be some evidence for an initial improvement, road safety effects are not always long-lived (Stock, Weaver, Ray, Brink and Sadoff, 1983). Even specific skills training such as skid control and braking techniques have failed to find measurable improvements in slippery road accident rates (Lynam and Twisk, 1995; Gregersen, 1991; Katila, Keskinen, Hatakka and Laapotti, 2003). When considering the road safety benefits for accident-involved drivers, still no significant reduction on crash involvement post training has been found for at risk groups (Brown, Groeger and Biehl, 1987; Stuckman-Johnson, Lund, Williams and Osborne, 1989). Several studies have suggested that higher order skills such as hazard perception contribute more to reducing crash risk than advanced driving skills and knowledge per se (Lyman, 1995; McKenna and Crick, 1992) and greater emphasis on hazard awareness may improve the effect of training on road safety (Gregersen, 1995). Other studies suggest that accident reductions are possible provided a package of safety measures is in place (Gray 1990; Gregersen, Brehmer and Moren, 1996). Whilst one of the goals of driver training is to improve road safety, reduction in accident rates may not be a reliable indicator of driver training effectiveness. Firstly, there are well-established problems in the reliability of accident records that lead to difficulties in using accident rates as a criterion measure (Wahlberg, 2003). Secondly, an accident may be the result of several events that might be due to factors not considered during the driver-training course under study. Thirdly, accident frequency is an unreliable criterion given the fact that accidents are comparatively rare events when considering the prevalence of everyday risk taking. Perhaps a more fruitful avenue would be to consider whether post-test professional driver training leads to reduced risk taking behaviour which may ultimately improve road safety whilst not necessarily influencing individual accident risk.

2. NEED FOR THE STUDY

The purpose of this study is primarily to determine if a driving simulator can be used to accurately and efficiently measure driving performance as compared to an on-road evaluation, and additionally, to identify differences between road and simulated driving. In order to properly evaluate drivers using a driving simulator in place of currently used driving evaluations, the following question must be answered: Can a simulator serve the purpose of an on-road evaluation? Using a driving simulator for

evaluation purposes may assist OTs to be more efficient in their client evaluation work, allow more people to continue to drive in a safe manner, and maximize the effectiveness of the transportation system of our society. By assessing the skills and abilities of drivers with a simulated driver evaluation as compared to an on-road evaluation, it can be determined if a simulator could be used effectively by OTs in place of an on-road evaluation. For this study, a low-cost interactive simulation was used. This driving simulator is completely interactive in that actions of the subject or failures to act in certain situations influence the visual display that closely reflects experiences of actual driving (Janke, 1994). Various versions of this driving simulator have been used for a variety of experimental and pragmatic applications. The current study hopes to expand upon previous and on-going work in yet another application of such technology. While flight, driving, and other simulators have been and are being used extensively, questions remain as to the appropriateness and validity of their application. Can a simulator be used for longer, whole-task driver evaluation or assist part-task assessment? Most applications thus far have been limited to either short scenarios or jumps (e.g., 3-5 minutes) or for longer sessions (10-30 minutes) with very limited maneuvers, such as with straight road or highway driving (e.g., McGehee, Dingus, Papelis, & Bartelme, 1995; Sexton, 1994). This is not to say that useful findings have not been obtained, but this study attempts to assess driving in a realistic, whole task setting such as one would encounter when driving on the road, utilizing a low-cost, interactive driving simulator.

3. OBJECTIVES AND SCOPE

- To study the role of driving simulators in Driver Training.
- To study the advantages and disadvantages of Driving Simulators.
- To study the impact of Driving Simulators on Novice and experienced drivers.
- To analyze the effectiveness of this study.

4. METHODOLOGY

In the present experiment specific driver information was collected through self-reported Driver History and Cognitive Failure questionnaires from a range of licensed drivers between the ages of 18 and 75. In addition, a driver reaction time test was administered to all participants. Finally, both on-road and simulated OT driving evaluations were administered in a counterbalanced fashion.

Design A 2 X 2 mixed factorial design was employed with driving Environment (Road and Simulator) varied within subjects and Age (Younger < 45 years, Older > 45 years) varied between subjects.

Participants The 19 participants in the study were licensed drivers (age 18-75). All participants had normal or corrected-to-normal vision and valid California drivers licenses. The participants were recruited through newspaper and posted advertisements that offered $5.00 per hour to healthy drivers for participation in an experiment involving an on-road evaluation and a driving simulator Participants were recruited through a local university, a hospital, and a local senior center. Of the 14 participants who completed all sessions of the study, 10 were in the Younger group and four were in the Older group.

Apparatus and Stimulus

Orientation. Upon arrival, verification of both a current driver's license and proof of automobile insurance was carried out. The first portion of each session included an orientation in which the purpose of the study was explained (see Appendix A) and various forms were completed as required by the Santa Clara Valley Medical Center. Also, the Driving Questionnaire, shown in Appendix B, was used to determine basic driving information. An additional questionnaire, the Cognitive Failures Questionnaire (CFQ) (Broadbent, Cooper, FitzGerald, & Parkes, 1982), was also completed (see Appendix C). The CFQ asks questions of participants about minor mistakes, lapses of attention, or instances of forgetting that occur from time to time. This questionnaire, previously utilized in a driver study by Andre (1991), was used to assess self-reported failures in perception, memory, and motor function in drivers.

Driving Reaction Time Test. The reaction time test was administered to determine simple reaction time, utilizing the Instructo-Clinic Testing Apparatus (Bumpa-Tel¨, Inc., 1973). This apparatus is for testing depth perception, visual acuity, peripheral vision, color determination, and simple and complex reaction time, and was used to test and measure simple reaction times in this study. The unit consists of simulated gas and brake pedals with a series of red, yellow, and green lights to test reaction time. The task involved depressing the gas pedal to illuminate a green light. When the red light was activated, the participant was to brake as quickly as possible by stepping on the brake pedal. After a series of practice trials, three trials were given; the average of these three trials was reported.

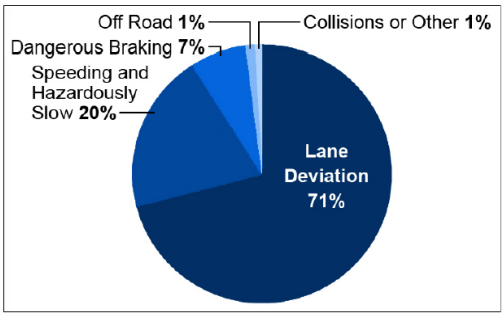

Figure 8. Pie chart. Percentage of driving errors observed by type.

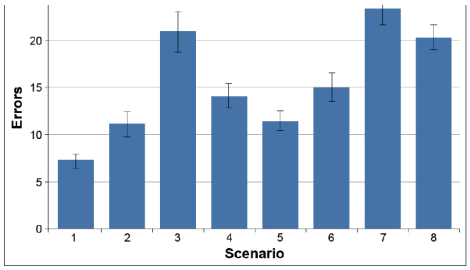

Figure 7. Bar chart. Average total errors per scenario.

5. RESULTS AND DISCUSSIONS

The purpose of this study was to determine if a driving simulator can replace an on-road evaluation in the context of an Occupational Therapist Driver Assessment. Specifically, this study set out to compare the differences between the two environments. The benefits of using a simulator to perform driver assessment are many-fold and include: 1) a more time- and cost-efficient method for evaluations (e.g., weather concerns would be eliminated), 2) the ability to evaluate drivers under complex conditions where failures are likely to occur, and 3) the safety of both the evaluator and driver would be improved. Unfortunately however, the data from this initial study does not show clear promise for replacing the current on-road assessment procedure with simulator assessment for OTs. This is based on the lack of statistically significant positive correlation between Road and Simulator, and the high drop out rate due to simulator discomfort.

By looking at the sub-components that make up Overall Performance (Steering, Braking, Acceleration, Caution/Safety, and Additional Skills) for each environment, one can better learn when and why road and simulator evaluations are associated. While both Acceleration and Additional Skills were not significantly correlated, a fairly positive relationship does exist.

Only one component, Steering, showed a positive and significant correlation between the environments of Road and Simulator. It is suspected that these findings are largely due to the differences in fidelity and feedback between the two environments examined here. Braking and Caution/Safety however, showed very low correlations. While the Braking was discussed previously (see the Braking Sub-Component Scores section), the low correlation for Caution/Safety seems to indicate that differences are readily apparent for each environment, such as where to look for traffic, how the vehicle (actual or simulated) responds, etc.

6. CONCLUSIONS & RECOMMENDATIONS

The purpose of this study was to determine if a driving simulator can replace an on-road evaluation in the context of an Occupational Therapist (OT) Driver Assessment. The benefits of using a simulator to perform driver assessment include: 1) a more time- and cost-efficient method for evaluations (e.g., weather concerns would be eliminated), 2) the ability to evaluate drivers under complex conditions where failures are likely to occur, and 3) the safety of both the evaluator and driver would be improved.

This article presents eight logical and six research-based reasons to introduce simulator training into fleet driver training. Fleet managers who invest in simulator training may receive additional benefits from the enhanced positive image and greater public prestige given to organizations that demonstrate a tangible commitment to greater environmental responsibility, e.g. with eco-drive training and zero fuel consumption during driver training. In addition, simulator training may also help a fleet comply with mandatory health and safety requirements.

Given the historic and non-controversial acceptance of simulator-based training by the military, the aviation industry and the medical profession as well as the increasing quality of affordable driving simulator hardware and software, there is a high probability that an increasing percentage of future driver training and evaluation for fleet drivers will be done on driving simulators. The logic and the evidence support the adoption of the simulator training. Moreover, the benefits of simulator training can be greatly enhanced if sufficient attention is paid to all aspects of the integration of driving simulators into driver-training programs, especially the quality of courseware. Research cited in this article indicates that well-planned improvements in driving simulator courseware are able to cut learning time in half.

REFERENCES

1. Bellavance, F. & Hirsch, P. (2013). Novice Learner Driver Perceptions of the Efficiency of Driving Simulator-Based Training in Quebec. Proceedings of the 23rd Canadian Multidisciplinary Road Safety Conference. Montreal, Quebec, May 26-29, 2013. Bédard, M.B., Parkkari, M., Weaver, B., Riendeau, J., & Dahlquist, M. (2010). Assessment of driving performance using a simulator protocol: Validity and reproducibility. The American Journal of Occupational Therapy 64, 336-340. De Winter, J. C. F., De Groot, S., Mulder, M., Wieringa, P. A., Dankelman, J., & Mulder,
2. J. A. (2009). Relationships between driving simulator performance and driving test
3. results. Ergonomics 52, 137-153.Eco-Driving (2011). http://www.ecomobile.gouv.qc.ca/en/proven_savings_potential.php
4. Haworth, N., & Symmons, M., (2001). The Relationship between Fuel Economy and Safety Outcomes. Monash University Accident Research Centre, Victoria, Australia
5. (Report No 188; pp. 1-67).
6. Hirsch, P. & Bellavance, F. (2013). [Transfer-of-Training Efficiency Study]. Unpublished raw data.
7. Hirsch, P., Bellavance, F. & Pignatelli, S. (2011). An Evaluation of the Effectiveness of
8. Simulator-Based Training on the Acquisition of Gear-Shifting Skills for Learner Truck
9. Drivers. Proceedings of the 21st Canadian Multidisciplinary Road Safety Conference,
10. May 8-11, 2011. Halifax, Nova Scotia.
11. Lee, H-C., Lee, A. H., Cameron, D., & Li-Tsang, C. (2003). Using a driving simulator to
12. identify older drivers at inflated risk of motor vehicle crashes. Journal of Safety
13. Research 34, 453-459.
14. Lee, H-C., Cameron, D., & Lee, A. H. (2003). Assessing the driving performance of older adult

drivers: on-road versus simulated driving. Accident Analysis and Prevention
15. 35, 793-803.
16. Lew, H. L., Poole, J. H., Lee, E. H., Jaffe, D. L., Huang, H-C. & Brodd, E. (2005).
17. Predictive validity of driving- simulator assessments following traumatic brain injury: A preliminary study. Brain Injury. 19, 177-188.
18. Lindsey, J. T. & Barron, A. E. (2008). Effects of simulation on emergency vehicle
19. drivers' competency in training. Prehospital Disaster Medecine. 23(4) 361–368.
20. Morgan, J. F., S. Tidwell, et al. (2011). "On the training and testing of entry-level
21. commercial motor vehicle drivers." Accident, Analysis and Prevention. 43(4): 1400.