ARIZONA TRANSPORTATION RESEARCH CENTER

RESEARCH NOTES:

Project 559(1)

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New, Improved, Comprehensive, and Automated Driver's License Test and Vision Screening System

Background

Non-automated tests tend to be subjective, time-consuming, costly, and heavily reliant on the experience of the examiner. Vision defines the fundamental way we perceive and respond to stimuli. Snellen acuity, the most widely used vision testing measure, accounts for less than 0.1% of the visual field. This measurement fails to quantify contrast sensitivity and color vision (Fink and Sadun, 2004), two of several visual parameters needed for both safe driving and comprehensive vision testing. Consequently, we seek to improve driver's license vision screening measures and methods in the State of Arizona due to the high collision, injury, and fatality rates of all drivers in the State of Arizona, and the disproportionate number of at-fault older drivers and collision risks in the States of Arizona and Florida.

Our findings span an eleven-year period from 1991 to 2001. These not only apply to Arizona and Florida, two states with some of the largest proportions of older individuals in the USA, but, as our global survey of Motor Vehicle Bureau Directors or their representatives of the USA, Commonwealth of Puerto Rico, United Kingdom, Canada, New Zealand, and Australia illustrate, any state, country, province, territory, commonwealth, or nation with an increasing number of older drivers. A pilot study, to follow, ultimately allows for the implementation of effective strategies for screening of visual impairment and eye disease in all Arizona drivers. This system may ultimately serve as a prototype of vision screening improvements for all other states, countries, and agencies (e.g., aviation, agriculture, rail, maritime, commercial driver's bureaus, etc.) to follow. This system may also be integrated into a larger automated system for additional screening mechanisms.

Approach

This report is divided into several core sections. These include comprehensive reviews of the literature; survey of driver's license bureau directors or their representatives; analysis of collision data; comparison of Relative Accident Involvement Ratio (RAIR) of collisions of Arizona and Florida drivers; descriptive statistics and calculated risks of violations and behavior-related Arizona collisions; comparison of average individual risks of collisions, injuries, and fatalities of Arizona and Florida drivers; and vision tests, driving simulators and possible aftereffects, and other automated tests. The literature review consists of an overview of older populations of Arizona and Florida; older drivers in the news; vision impairment; affected eye structures; visual acuity; contrast sensitivity; color vision; some diseases of the eyes; refractive error;

infectious disorders of the eye; nutritional and metabolic factors; Alzheimer's Disease, dementia, and driving; driver's license vision testing policies, self versus other vision testing; older versus younger drivers.

There are twenty- two appendices, A-V. Appendix A includes a horizontal section of the human eyeball and some common conditions that may affect it. Appendix B presents the results of the global survey of driver's license directors or their representatives. Appendices C-P show descriptive statistics based on calculations and analyses of collisions, injuries, and fatalities of Arizona and/or Florida drivers. Appendix Q provides a comparison of Average Individual Risks of collisions, injuries, and fatalities of Arizona and Florida drivers. Appendix R focuses on Arizona collision rates by restrictions, violations, and behaviors. Appendices S and T identify features of select national and international vision screening devices and driving simulators. Appendices U and V include all completed global surveys and sample survey forms.

Findings

This is the first study of its kind to present a new vision screening system and a fully and/ or partially automated driver's license test system. We offer global survey, literature review, statistical methods, and a thorough study of driving risks commonly associated with aging and disease in two states with significant proportions of older drivers. We determine that current U.S. Vision Standards for Driver's Licenses stem from antiquated 1937 visual standards, a 1925 report approved by the American Medical Association, and widespread implementations and modifications of the Snellen Eye Chart of the 1860s. New vision screening methodologies and standards are now needed to promote road safety, predict visual impairment, and evaluate possible restriction or confiscation of driver's licenses.

Based on our analyses, the following observations are highlighted:

- Environmental factors and manner of collisions increase in collision involvement between ages 50 to 59 years in both Arizona and Florida drivers.
- Drivers age 80 to 89 years in both states are most likely at-fault in collisions compared to all other age cohorts. These results are consistent among drivers cited for collision involvement due to visual defects.
- The ages 75 years and over cohorts constitute the Arizona driver age groups with the greatest Average Individual Risk of Fatalities (6.65E-04).
- Drivers ages 80 to 89 years are about twice as likely to be at-fault when compared to the cohorts ages 16 to 19 years in the following categories of collisions: angle manner of collisions (Arizona, Florida), clear weather-related collision (Arizona, Florida), cloudy weather-related collision (Florida), darkness-related collision (Arizona, Florida), daylight-related collision (Arizona, Florida), fog-related collision (Arizona, Florida), head-on manner of collisions (Arizona, Florida), rain-related collision (Arizona, Florida), rear end collision (Arizona), sideswipe manner of collision (Arizona, Florida). ·

  These drivers are also are about three times as likely to be at-fault in left-turn manner of collisions compared to the drivers age 16 to 19 years.
- Florida drivers age 90 years and over are, according to the highest RAIR values, seven times as likely to be at-fault in collision involvement due to corrective lenses restrictions than drivers age 16-19 years.

We find that many of our results follow reliability engineering principles based on bathtub curves that are generated when we graphically represent RAIR. RAIR allows us to quantify millions of collisions in both states through the Accident Location Identification and Surveillance System (ALISS) of Arizona and the

Florida Department of Highway Safety and Motor Vehicles (FHSMV) databases of two-vehicle accidents. These RAIR results, in conjunction with other preceding visual impairment studies conducted on various populations, suggest that driver's license renewal policies also need to be modified in order to screen drivers as soon as they reach the age of 50 years**.**

Our global survey reveals the following information:

- No automated vision screening systems exist in any state, county, province or territory Motor Vehicle Division (MVD) we surveyed.
- Most MVD officials in the USA and in other countries acknowledge that their current vision testing methodologies are either inadequate or inaccurate.
- No vision tests at MVDs in the USA and other countries include a screening component for Glaucoma or Age-Relate Macular Degeneration (AMD), two of the fastest growing diseases that can result in vision loss.

The ESRA Dynamic Vision Assessment for Transportation (ESRA DVAT ™), as envisaged, provides a fully automated, comprehensive, and cost-effective approach through the testing of vision function, vision condition, and vision status. It expands and improves existing technology. The ESRA Vision Assessment Procedure for Transportation (ESRA VAPT™) complements the NHTSA "Model Driver Screening and Evaluation Program" (Staplin *et al.*, 2003a) for a fitness to drive determination.

The ESRA Dynamic Assessment for Transportation™ (ESRA DAT ™,) offers the potential for automation of other driver's license tests, such as cognition, knowledge (written), and operation skills.

Recommendations

Our study underscores the significance of vision testing methods and the need for revised vision measures to complement standard visual acuity for assessing at-risk drivers and, in particular, older drivers. It is recommended that at-risk and older drivers in Arizona are tested for vision through a system of measures provided by two automated tests (to test vision condition and function) and one driving simulator (to assess eye status) once safety studies and potential liability issues are addressed. This system shall provide instant scoring, short and effective on-site testing, and computer automation score reports and records linked by network to the MVD.

Components, such as the following, are recommended as part of this new driver's license vision testing system: B1Max ™ VACS (high and low contrast visual acuity testing), Modified 3-D Amsler Grid Test (Dr. Wolfgang Fink, California Institute of Technology with Sandy Straus, ESRA Consulting Corporation) (test for possible visual diseases, injuries, and tumors (conditions) that may impair driving abilities); and Systems Technology, Inc. STISIM Drive™ Model E Series Driving Simulators (test for visual status through ambient poor visibility conditions and to screen at-risk drivers, in particular, patients with dementia once possible aftereffects, among other unresolved safety, management, and ergonomic issues, are adequately addressed).

At a minimum, we call for the adoption of a computer automated visual acuity test for implementation. The vision condition and/ or vision status test is recommended for a pilot study. These represent a significant improvement over the current system, especially for screening the vision of all driver's license applicants and renewals. However, the ESRA DVAT ™, in entirety, and the ESRA VAPT™ are needed to address the issue of driver safety, as it relates to at-risk, novice, older, and dementia drivers. The incidence of dementia is expected to jump 400% over the next twenty years (Whitmer, et al., 2005). Therefore, this system and procedure have tremendous potential

to reduce collision, injury, and fatality risks and the staggering costs associated with these events as they affect drivers of all ages.

We also call for new and uniform federal visual standards and vision tests in all US states. This way, a completely automated, computerized, and linked system can provide driver identification and licensure process simplification. It can also eliminate the number of drivers who may not visually qualify for a driver's license in one state from obtaining a license in another state. Federal visual standards and tests support similar recommendations as these relate to driver's licenses and other documents introduced through both The 9/11 Commission Report (2004) and by The 9/11 Commission Report Implementation Act of 2004, S.2774.

Additionally, it is necessary to accelerate the periods between driver's license issuance and renewal for vision testing, in particular for: Drivers age 15-19 years (every two years), Drivers age 50-70 years (every two years), Drivers age 70 years and over (every one year), and all other drivers (every four years). It is the actual driver's license testing methodology, *in conjunction with* the frequency of driver's license renewal and testing periods that requires improvements. Once these testing enhancements are in place, then the accelerated driver's license renewal periods and any short-term driving skill assessment courses serve as supplementary and precautionary safety measures.

Furthermore, as gas prices soar and driver's license bureaus are burdened with staffing matters, motor vehicle maintenance costs, and long queues, the ESRA DAT ™, Dynamic Assessment for Transportation, may provide cost-effective, quick, and "environmentally friendly" methods of conducting and/ or supplementing traditional on-road driver's license tests, with little or no staff intervention, once all important safety concerns are adequately researched and addressed. Fully automated vision attention/ cognition tests (such as the UFOV®) and knowledge tests may also provide a more thorough assessment of licensees than what is now available. These ESRA systems and procedures may also reduce the incidence of fraudulent schemes and issuances of driver's licenses, commercial driver's licenses, and hazardous materials transportation licenses.

Therefore, the Arizona Department of Transportation may provide a model for automated testing improvements for all other states, countries, and agencies to follow if a pilot vision test and, ultimately, a statewide system, are implemented as prescribed.

The full report *New, Improved, Comprehensive, and Automated Driver's License Test and Vision Screening System,* Final Report 559(1) by Sandy H. Straus, ESRA Consulting Corporation, 1650 South Dixie Highway, Third Floor, Boca Raton, Florida 33432 , Telephone: 561-361-0004, e-mail: shs@esracorp.com (Arizona Department of Transportation, report number FHWA-AZ-04-559(1), published March 2005) is available from the Arizona Transportation Research Center, 206 S. 17 Ave., Mail Drop 075R, Phoenix, AZ 85007; phone 602-712-3138, and on the web: http://www.azdot.gov, http://www.esracorp.com Notice is hereby provided that a patent application has been filed on one or more of the systems and methods described herein.