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Assessing and Improving the Cognitive and Visual Driving Fitness of Older Long-Haul Truck Drivers - Phase I

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16. Abstract

Driving is a highly dynamic task that requires intact cognitive and visual skills to perform safely. Driving trucks loaded with hazardous materials requires even more careful planning and consideration to avoid unanticipated shifts in the center of gravity associated with sharp turns while speeding (slushing) or liquid surge associated with sharp braking. Such planning and consideration are highly dependent on cognitive and visual skills for accuracy. In the first year of this proposal, we developed a driving fitness assessment battery that consisted of tests that have been shown in the geriatric literature to be reliable and valid measures of driving-related cognitive and visual skills in older adults. These tests consist of the Snellen Maze Test, Trails A and B, Range of Motion and Gait Speed. Cognitively, the Mini Mental Status Examination (MMSE) has had significant limitations in driving fitness; therefore, alternative cognitive tools such as theSaint Louis University Mental Status (SLUMS) and Montreal Cognitive Assessment (MoCA) exam were included, if appropriate.. Drivers with a Commercial Driver's License (CDL) will be recruited and given this battery of tests to: 1) Assess their cognitive and visual fitness, 2) establish the usefulness and effectiveness of these tests to drivers before embarking on the journey, and 3) identify potential risk factors that contribute to unsafe driving. This is Year 1 of a five-year grant. Over the course of the grant, we anticipate the study will be helpful in identifying drivers who have cognitive and/or visual impairments that may make driving a truck, especially one carrying hazardous materials, unsafe. A unique aspect of this part of the study is the possibility of improving driving fitness by offering drivers with demonstrated cognitive and visual deficits the opportunity to retrain and improve such skills in a technologically advanced high-fidelity simulator.

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List of Abbreviations

Commercial Driver's License (CDL)
Commercial Motor Vehicle (CMV)
Federal Motor Carrier Safety Administration (FMCSA)
Iowa Department of Transportation (IaDOT)
Kansas Department of Transportation (KDOT)
Mid-America Transportation Center (MATC)
Missouri Department of Transportation (MoDOT)
National Institute for Occupational Safety and Health (NIOSH)
Nebraska Department of Roads (NDOR)
Nebraska Transportation Center (NTC)
Transportation Research Board of the National Academies (TRB)
University Transportation Center (UTC)
United States Department of Transportation (USDOT)
Useful Field of View (UFOV)

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Abstract

Driving is a highly dynamic task that requires intact cognitive and visual skills to perform safely. Driving trucks loaded with hazardous materials requires even more careful planning and consideration to avoid unanticipated shifts in the center of gravity associated with sharp turns while speeding (slushing) or liquid surge associated with sharp braking. Such planning and consideration are highly dependent on cognitive and visual skills for accuracy. In the first year of this proposal, we developed a driving fitness assessment battery that consisted of tests that have been shown in the geriatric literature to be reliable and valid measures of driving-related cognitive and visual skills in older adults. These tests consist of the Snellen Maze Test, Trails A and B, Range of Motion and Gait Speed. Cognitively, the Mini Mental Status Examination (MMSE) has had significant limitations in driving fitness; therefore, alternative cognitive tools such as the Useful Field of View (UFOV) exam were included.

Drivers with a Commercial Driver's License (CDL) will be recruited and given this battery of tests to: 1) Assess their cognitive and visual fitness, 2) establish the usefulness and effectiveness of these tests to drivers before embarking on the journey, and 3) identify potential risk factors that contribute to unsafe driving. This is Year 1 of a five-year grant. Over the course of the grant, we anticipate the study will be helpful in identifying drivers who have cognitive and/or visual impairments that may make driving a truck, especially one carrying hazardous materials, unsafe. A unique aspect of this part of the study is the possibility of improving driving fitness by offering drivers with demonstrated cognitive and visual deficits the opportunity to retrain and improve such skills in a technologically advanced high-fidelity simulator.

Chapter 1 Purpose, Background, and Rationale

One of the cardinal missions of the Federal Motor Carrier Safety Administration (FMCSA) of the United States Department of Transportation is to improve safety on our nation's highways. That includes reducing the number of accidents that involve commercial truck drivers, including hazardous and non-hazardous material transportation. Such accidents have a high potential to cause serious harm to the public and the environment. In addition to the several initiatives that have been put in place by the FMCSA to reduce accidents involving trucks hauling hazardous materials, there is a need to (i) improve driving fitness by determining the cognitive and visual fitness, and rehabilitating pertinent components of drivers who drive commercial vehicles; (ii) develop a sensitive measure of cognitive and visual alertness that can indicate cognitive overload capable of resulting in an accident; (iii) using a simulator, begin design of an alert system that will notify all emergency medical services within a specific radius of an accident of the nature of the hazardous materials being hauled by the commercial vehicle and the extent of damage.

The Mid-America Transportation Center (MATC) was designated by the United States Department of Transportation as the Region VII University Transportation Center (UTC) in 2017. MATC is a consortium comprised of the University of Nebraska Lincoln, University of Nebraska-Omaha, University of Nebraska-Medical Center, University of Kansas, University of Kansas-Medical Center, Missouri University of Science and Technology, University of Iowa, Nebraska Indian Community College, and Lincoln University. MATC's partners include the Iowa Department of Transportation (IaDOT), the Kansas Department of Transportation (KDOT), Missouri Department of Transportation (MoDOT), the Nebraska Department of Roads (NDOR),

the United States Department of Transportation (USDOT), and various private and public sector transportation organizations.

This project is needed to meet MATC's vision to become a nationally recognized center of transportation excellence focused on developing new knowledge, innovative solutions, and the next generation of transportation professionals necessary to sustain the U.S. transportation system in a manner that is safer, more effective, more efficient, environmentally friendly, and sustainable. Older drivers are becoming increasingly prominent, maintaining their cognitive and visual fitness is essential for their safety and the safety of others sharing the road.

1.1 Aim and Hypotheses

Driving is a highly dynamic task that requires intact cognitive and visual skills to perform safely. Driving commercial vehicles that are loaded with hazardous materials requires even more careful planning and consideration to avoid unanticipated shifts in the center of gravity associated with sharp turns while speeding (slushing) or liquid surge associated with sharp braking. Such planning and consideration are highly dependent on cognitive and visual skills for accuracy.

By doing this study we hope to: A. Assess CDL drivers' cognitive and visual fitness, B. Establish the usefulness and effectiveness of these tests to drivers before embarking on the journey, C. identify potential risk factors that contribute to unsafe driving, and D. Evaluate the effect of an intervention program to improve reduced visual, cognitive, and driving skills

1.2 Study Significance

We anticipate that this study will be helpful in identifying CDL drivers who have cognitive and/or visual impairments that may make driving a commercial vehicle, including those carrying hazardous materials, unsafe. A unique aspect of this part of the study is the

possibility of improving driving fitness by offering drivers with demonstrated cognitive and visual deficits the opportunity to retrain and improve such skills in a technologically advanced high-fidelity simulator.

Moreover, this project will also meet Mid-America Transportation Center (MATC)'s research goal to make fundamental advancements in basic and theoretical research related to improving the safety of the US and Region VII transportation systems. A key focus is to ensure that this research product will be implemented by regional and national transportation agencies.

1.3 Literature Review

There are approximately 1.7 million long-haul truck drivers in the USA, either for hire or in private fleets (Hege et al., 2015). Truck driving is the second most common occupation in the USA (following retail sales), employing 1 in 35 adult men. Commercial motor vehicle (CMV) drivers make up a substantial proportion of the workforce, however, it is anticipated there will be shortage of drivers in the coming years in the USA. Many studies in the US have examined crash risk in CMV (Chen & Xie, 2014). Data from the US show that truck drivers account for 16–20% of all crashes, costing billions of dollars annually (Mayhew et al., 2011). While reducing the number of injurious and fatal accidents is paramount to public safety, determining causative factors are equally important in reducing crash risk.

One review found associations between fatigue and crash risk as well as other factors related to truck design and maintenance, such as unsecure cargo and weather conditions (Robb, Sultana, Ameratunga, & Jackson, 2008). Yet, this review was not inclusive of long-haul truck drivers; it included taxi drivers, professional drivers, company car drivers, as well as studies related to medical personnel and nurses. The review also included studies from countries that are not similar to the North American context (Robb et al., 2008).

Recent US studies show that factors related to demographics as well as health and wellness are associated with crash risk including age, gender (men), low back pain, cardiovascular disease, stress, untreated sleep apnea and diabetes, as well as obesity (Apostolopoulos et al., 2012; Apostolopoulos, Sonmez, Shattell, & Belzer, 2010; Apostolopoulos et al., 2011). Thus, CMV drivers are considered a vulnerable or high-risk segment of the population by the US Federal Motor Carrier Safety Administration (FMCSA), the Transportation Research Board of the National Academies (TRB), and the National Institute for Occupational Safety and Health (NIOSH). CMV drivers are plagued with high rates of disease often attributed directly to the nature of the job (Lemke, Apostolopoulos, Hege, Sönmez, & Wideman, 2016).

The work environment exposes both truck and bus drivers to long work hours (up to 14 h/day), prolonged sitting, excessive noise and vibration and generally unhealthy lifestyles (Lemke et al., 2016). Truck drivers are more likely to use tobacco, to be physically inactive, to have poor diets, and to have disrupted sleep cycles and higher levels of stress), leading to an increased risk of cardiovascular disease, psychological and musculoskeletal disorders (MSDs) compared to the general population (Apostolopoulos et al., 2012). These risk factors and conditions, particularly among long-haul drivers, can produce work-place injuries and impact work productivity and driving performance.

Taking the above factors into consideration, the average life expectancy of truck drivers in the US is 12–20 years lower than the general population (Crizzle et al., 2017). The first International Conference on Commercial Driver Health and Wellness was sponsored by the FMCSA, The US Department of Transportation and NIOSH in 2010. Several priority areas emerged from this conference, particularly the need for a better understanding of the combined

impact of multiple risk factors (i.e., irregular schedules, long hours of work, poor diet and nutrition, stress) on driver health and wellness, as well as productivity and safety.

While there is consensus that CMV drivers are an at-risk population for poorer health, there has been no critical appraisal of the motor, cognitive, and visual determinants of driving safety. This study will delve into this arena. Second, rehabilitation strategies to improve these driving-related impairments will be explored.

Chapter 2 Methodology and Findings

Drivers over age 18 licensed to drive commercial vehicles (i.e: possessing CDL licenses) will be recruited and given a series of tests to: 1) Assess their cognitive and visual fitness, 2) Establish the usefulness and effectiveness of these tests to drivers before embarking on the journey, and 3) Identify potential risk factors that contribute to unsafe driving. Consequently, a prospective case series will be the study design. The sample size over the course of the 5 year project will be 250 (approximately 85 annually), with each participant being given the same tests but in randomized order to prevent bias and to limit confounding factors. Participants who are unable to provide written informed consent or attend all testing sessions when scheduled will be excluded from the study results. Additionally, there will not be any laboratory testing involved in this study.

2.1 Methodology and Study Procedure

Each study participant will undergo all procedures and tests on the same day. The estimated time for testing evaluation, excluding informed consent overview, will be no more than two hours. Informed consent will be obtained prior to participants' participation in the study, at the scheduled time of their testing session. The informed consent document will detail the procedures and right of the individual partaking in the study. Any subject who finds the procedures objectionable for any reason will be given the opportunity to terminate participation as described above. In addition, subjects will be informed that they can discuss any questions they have about the research procedures or their performance with the experimenter. In addition, prior to beginning each testing session, demographic and clinical information including age, sex, BMI, blood pressure, level of education, and driving history will be collected for each participant.

As a part of each participant's scheduled testing session, they will undergo a series of cognitive, visual and physical assessments. These assessments include the following:

2.1.1 Cognitive assessment (20 minutes)

The cognitive assessment will include the Stroke Drivers Screening Assessment (Abiodun Emmanuel Akinwuntan et al., 2013), the Useful Field of View (Edwards et al., 2006), and the Montreal Cognitive Assessment (Nasreddine et al., 2005), and Trail Making Tests A and B.

2.1.2 Visual assessment (5 minutes)

The Keystone vision screener will be used to assess visual acuity, depth perception, visual field, glare recovery, color perception, depth perception, and eye coordination (stereopsis).

2.1.3 Range of motion and gait speed (5 minutes)

A standard physical exam including range of motion testing and gait speed will be performed.

2.1.4 Simulator assessment (20 minutes)

Subjects will complete an evaluation in a driving simulator. This evaluation will comprise a drive in daily-life traffic while obeying the rules of the road. We will assess driving abilities under low and high cognitive demand.

2.1.5 Pupil recording

No extra time. During the simulator tests, an eye tracker will monitor their pupils. The pupil size will give an estimate of their alertness.

2.2 Findings and Revisions

Legal clearance to conduct this study took six months. The University of Kansas legal team deemed that we were not obligated to report a driver who did not pass our research tests, to the DOT, DMV, or the employer. Clearance was given in April 2018. Since then, we have had

our marketing tools revised three times and IRB has issued clearance. During the end of year one, our team has worked diligently to contact local and national vendors and corporations that employ the majority of the long-haul truck drivers in the Kansas City area. We anticipate active testing shortly. Based on feedback from partner institutions and prospective participants, and to maximize enrollment, we have expanded the inclusion criteria to include drivers over the age of 18 who possess a commercial driver's license (CDL); this will expand our participant pool to include drivers who are bus drivers, coach drivers, and short-haul and long-haul truck drivers. We will take the results gathered from these drivers and make comparative analyses of their performances based on the industry of their employer.

Chapter 3 Conclusions and Recommendations

Year one of this study was utilized to gain IRB approval while solidifying legal clearance and training our research team. Recruitment efforts to promote our study have led to the revision of our inclusion criteria to include all participants over 18 years of age who possess a current CDL. These changes in addition to inroads made with local employers of drivers that fit our inclusion criteria bode well for the success of the study in years two through five.

Prospective participants and their employers shared an incentive to compensate them for the time and travel was required to participate in the study. Consequently, at this time, a $25 gift card will be given to each eligible driver that participates in the study. With our year two funding, we hope to raise that to $50 per participant. Additionally, assessment of participants will be expanded to include aggregate findings of each participant based on the industry in which they are employed. The information gathered from this type of categorical analysis will allow us to make possible evaluations regarding the impact these industries have on the health and fitness of their employees' ability to drive. Also, this information can be utilized to make future recommendations to improve working conditions such that employees' fitness and performance as drivers can be improved and/or sustained successfully.

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