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SPECIAL ISSUE ARTICLES ON NATURALISTIC DRIVING RESEARCH

Jonathana F. Antin, Feng Guo, Youjia Fang, Thomas A. Dingus, Miguel A. Perez, Jonathan M. Hankey. *A validation of the low mileage bias using naturalistic driving study data*. Pages 115-120.

This paper evaluated the low mileage bias (LMB) phenomenon for senior drivers using data mined from the Second Strategic Highway Research Program (SHRP 2) Naturalistic Driving Study. Supporters of the LMB construct postulate that it is only those seniors who drive the lowest annual mileage who are primarily responsible for the increased crash rates traditionally attributed to this population in general. The current analysis included 802 participants, all aged 65 or older who were involved in 163 property damage and injury crashes, and deemed to be at-fault in 123 (75%) of those instances. Poisson regression models were used to evaluate the association between annualized mileage driven and crash risk. Results show that the crash rate for drivers with lower annualized mileage (i.e., especially for those driving fewer than approximately 3000miles per year) was significantly higher than that of drivers with higher annualized mileage, and that 25% of the overall sample were low- mileage drivers according to this criterion. Data were also evaluated by gender and meta-age group (i.e., younger-old: 65–74 and older-old: 75–99), and the results were consistent across these sub-groups. This study provides strong support for the existence of the LMB. These results can help to reshape how transportation safety stakeholders view senior drivers in general and help them to focus their efforts on those seniors most in need of either risk-reducing countermeasures or alternative means of transportation.

Vicki Williams, Shane McLaughlin, Robert McCall, Tim Buche. *Motorcyclists' self-reported riding mileage versus actual riding mileage in the following year*. Pages 121-126.

Accurate motorcyclist mileage estimates are important because self-evaluation of riding experience is related to riding behavior, the relationship of self-reported to actual or future mileage is necessary in targeting training and considering survey responses, and motorcycle crash statistics require accurate travel data. This study collected real-world data from motorcyclists over the course of two months to two years per rider. This paper explores motorcyclists' self-reported annual riding mileage (obtained via pre-study surveys) and the actual amount of riding during the study (based upon odometer readings and GPS data). Of the 91 riders who had been riding for at least a year before the study, significantly more (73%) rode less the following year than reported for the previous year. The recorded annualized mileage averaged 89% of the reported mileage

from the previous year. Analyses based on estimated average annual mileage were similar to those using the previous year estimation, and the pattern held regardless of age group, motorcycle type, or gender. The exception was novice or returning riders, who tended to either significantly underestimate or increase actual mileage as they began (or continued) to ride. Motorcyclists' estimation of riding experience expressed as mileage may not be indicative of current or future mileage. Reliance on self-reported mileage during training to categorize groups, for interpretation of studies, or to develop motorcycle travel data and safety statistics may be unrealistic. Certainly any use of self-reported mileage should incorporate the concept that mileage overestimation seems likely. Because questions about previous year and average annual mileage may elicit similar responses, motorcyclist surveys should be constructed to prompt the most thoughtful responses in terms of mileage estimations. In general, reported mileage should not be relied upon as an accurate predictor of future actual mileage.

- **Keywords:** Motorcycle; Mileage estimation; Self-reported mileage; Naturalistic study; Motorcyclist survey

J.P. Ehsani, D. Haynie, M.C. Ouimet, C. Zhu, C. Guillaume, S.G. Klauer, T. Dingus, B.G. Simons-Morton. *Teen drivers' awareness of vehicle instrumentation in naturalistic research*. Pages 127-134.

Naturalistic driving methods require the installation of instruments and cameras in vehicles to record driving behavior. A critical, yet unexamined issue in naturalistic driving research is the extent to which the vehicle instruments and cameras used for naturalistic methods change human behavior. We sought to describe the degree to which teenage participants' self-reported awareness of vehicle instrumentation changes over time, and whether that awareness was associated with driving behaviors. Forty-two newly-licensed teenage drivers participated in an 18-month naturalistic driving study. Data on driving behaviors including crash/near-crashes and elevated gravitational force (g-force) events rates were collected over the study period. At the end of the study, participants were asked to rate the extent to which they were aware of instruments in the vehicle at four time points. They were also asked to describe their own and their passengers' perceptions of the instrumentation in the vehicle during an in-depth interview. The number of critical event button presses was used as a secondary measure of camera awareness. The association between self-reported awareness of the instrumentation and objectively measured driving behaviors was tested using correlations and linear mixed models. Most participants' reported that their awareness of vehicle instrumentation declined across the duration of the 18-month study. Their awareness increased in response to their passengers' concerns about the cameras or if they were involved in a crash. The number of the critical event button presses was initially high and declined rapidly. There was no correlation between driver's awareness of instrumentation and their crash and near-crash rate or elevated g-force events rate. Awareness was not associated with crash and near-crash rates or elevated g-force event rates, consistent with having no effect on this measure of driving performance. Naturalistic driving studies are likely to yield valid measurements of driving behavior.

- **Keywords:** Naturalistic driving; Instrumentation; Awareness; Teenage drivers; Passengers

Helen Loeb, Jinyong Kim, Kristy Arbogast, Jonny Kuo, Sjaan Koppel, Suzanne Cross, Judith Charlton. *Automated recognition of rear seat occupants' head position using Kinect™ 3D point cloud*. Pages 135-143.

Child occupant safety in motor-vehicle crashes is evaluated using Anthropomorphic Test Devices (ATD) seated in optimal positions. However, child occupants often assume suboptimal positions during real-world driving trips. Head impact to the seat back has been identified as one important injury causation scenario for seat belt restrained, head-

injured children (Bohman et al., 2011). There is therefore a need to understand the interaction of children with the Child Restraint System to optimize protection. Naturalistic driving studies (NDS) will improve understanding of out-of-position (OOP) trends. To quantify OOP positions, an NDS was conducted. Families used a study vehicle for two weeks during their everyday driving trips. The positions of rear-seated child occupants, representing 22 families, were evaluated. The study vehicle – instrumented with data acquisition systems, including Microsoft Kinect™ V1 – recorded rear seat occupants in 1120 driving 26 trips. Three novel analytical methods were used to analyze data. To assess skeletal tracking accuracy, analysts recorded occurrences where Kinect™ exhibited invalid head recognition among a randomly-selected subset (81 trips). Errors included incorrect target detection (e.g., vehicle headrest) or environmental interference (e.g., sunlight). When head data was present, Kinect™ was correct 41% of the time; two other algorithms – filtering for extreme motion, and background subtraction/head-based depth detection are described in this paper and preliminary results are presented. Accuracy estimates were not possible because of their experimental nature and the difficulty to use a ground truth for this large database. This NDS tested methods to quantify the frequency and magnitude of head positions for rear-seated child occupants utilizing Kinect™ motion-tracking. This study's results informed recent ATD sled tests that replicated observed positions (most common and most extreme), and assessed the validity of child occupant protection on these typical CRS uses. Optimal protection in vehicles requires an understanding of how child occupants use the rear seat space. This study explored the feasibility of using Kinect™ to log positions of rear seated child occupants. Initial analysis used the Kinect™ system's skeleton recognition and two novel analytical algorithms to log head location. This research will lead to further analysis leveraging Kinect™ raw data – and other NDS data – to quantify the frequency/magnitude of OOP situations, ATD sled tests that replicate observed positions, and advances in the design and testing of child occupant protection technology.

- **Keywords:** Child occupant protection; Naturalistic driving study; 3D mapping; Microsoft Kinect; Point cloud

Andrej Ivanco. *Fleet analysis of headway distance for autonomous driving*. Pages 145-148.

Modern automobiles are going through a paradigm shift, where the driver may no longer be needed to drive the vehicle. As the self-driving vehicles are making their way to public roads the automakers have to ensure the naturalistic driving feel to gain drivers' confidence and accelerate adoption rates. This paper filters and analyzes a subset of radar data collected from SHRP2 with focus on characterizing the naturalistic headway distance with respect to the vehicle speed. The paper identifies naturalistic headway distance and compares it with the previous findings from the literature. A clear relation between time headway and speed was confirmed and quantified. A significant difference exists among individual drivers which supports a need to further refine the analysis. By understanding the relationship between human driving and their surroundings, the naturalistic driving behavior can be quantified and used to increase the adoption rates of autonomous driving. Dangerous and safety-compromising driving can be identified as well in order to avoid its replication in the control algorithms.

- **Keywords:** Naturalistic driving; Autonomous; Radar data; SHRP2; Headway distance

Yuan Wang, Shan Bao, Wenjun Du, Zhirui Ye, James R. Sayer. *Examining drivers' eye glance patterns during distracted driving: Insights from scanning randomness and glance transition matrix*. Pages 149-155.

Visual attention to the driving environment is of great importance for road safety. Eye glance behavior has been used as an indicator of distracted driving. This study examined

and quantified drivers' glance patterns and features during distracted driving. Data from an existing naturalistic driving study were used. Entropy rate was calculated and used to assess the randomness associated with drivers' scanning patterns. A glance-transition proportion matrix was defined to quantity visual search patterns transitioning among four main eye glance locations while driving (i.e., forward on-road, phone, mirrors and others). All measurements were calculated within a 5s time window under both cell phone and non-cell phone use conditions. Results of the glance data analyses showed different patterns between distracted and non-distracted driving, featured by a higher entropy rate value and highly biased attention transferring between forward and phone locations during distracted driving. Drivers in general had higher number of glance transitions, and their on-road glance duration was significantly shorter during distracted driving when compared to non-distracted driving. Results suggest that drivers have a higher scanning randomness/disorder level and shift their main attention from surrounding areas towards phone area when engaging in visual-manual tasks. Drivers' visual search patterns during visual-manual distraction with a high scanning randomness and a high proportion of eye glance transitions towards the location of the phone provide insight into driver distraction detection. This will help to inform the design of in-vehicle human-machine interface/systems.

- **Keywords:** Driver distraction; Naturalistic driving; Eye glance behavior; Visual search patterns; Glance transition matrix

Pnina Gershon, Chunming Zhu, Sheila G. Klauer, Tom Dingus, Bruce Simons-Morton. *Teens' distracted driving behavior: Prevalence and predictors*. Pages 157-161.

Teen drivers' over-involvement in crashes has been attributed to a variety of factors, including distracted driving. With the rapid development of in-vehicle systems and portable electronic devices, the burden associated with distracted driving is expected to increase. The current study identifies predictors of secondary task engagement among teenage drivers and provides basis for interventions to reduce distracted driving behavior. We described the prevalence of secondary tasks by type and driving conditions and evaluated the associations between the prevalence of secondary task engagement, driving conditions, and selected psychosocial factors. The private vehicles of 83 newly-licensed teenage drivers were equipped with Data Acquisition Systems (DAS), which documented driving performance measures, including secondary task engagement and driving environment characteristics. Surveys administered at licensure provided psychosocial measures. Overall, teens engaged in a potentially distracting secondary task in 58% of sampled road clips. The most prevalent types of secondary tasks were interaction with a passenger, talking/singing (no passenger), external distraction, and texting/dialing the cell phone. Secondary task engagement was more prevalent among those with primary vehicle access and when driving alone. Social norms, friends' risky driving behaviors, and parental limitations were significantly associated with secondary task prevalence. In contrast, environmental attributes, including lighting and road surface conditions, were not associated with teens' engagement in secondary tasks. Our findings indicated that teens engaged in secondary tasks frequently and poorly regulate their driving behavior relative to environmental conditions. Practical applications: Peer and parent influences on secondary task engagement provide valuable objectives for countermeasures to reduce distracted driving among teenage drivers.

- **Keywords:** Distracted driving; Naturalistic study; Teen drivers; Secondary task engagement; Risk

Bo Wang, Shauna Hallmark, Peter Savolainen, Jing Dong. *Crashes and near-crashes on horizontal curves along rural two-lane highways: Analysis of naturalistic driving data*. Pages 163-169.

Prior research has shown the probability of a crash occurring on horizontal curves to be significantly higher than on similar tangent segments, and a disproportionally higher number of curve-related crashes occurred in rural areas. Challenges arise when analyzing the safety of horizontal curves due to imprecision in integrating information as to the temporal and spatial characteristics of each crash with specific curves. The second Strategic Highway Research Program(SHRP 2) conducted a large-scale naturalistic driving study (NDS),which provides a unique opportunity to better understand the contributing factors leading to crash or near-crash events. This study utilizes high-resolution behavioral data from the NDS to identify factors associated with 108 safety critical events (i.e., crashes or near-crashes) on rural two-lane curves. A case-control approach is utilized wherein these events are compared to 216 normal, baseline-driving events. The variables examined in this study include driver demographic characteristics, details of the traffic environment and roadway geometry, as well as driver behaviors such as in-vehicle distractions. Logistic regression models are estimated to discern those factors affecting the likelihood of a driver being crash-involved. These factors include high-risk behaviors, such as speeding and visual distractions, as well as curve design elements and other roadway characteristics such as pavement surface conditions. This paper successfully integrated driver behavior, vehicle characteristics, and roadway environments into the same model. Logistic regression model was found to be an effective way to investigate crash risks using naturalistic driving data. This paper revealed a number of contributing factors to crashes on rural two-lane curves, which has important implications in traffic safety policy and curve geometry design. This paper also discussed limitations and lessons learned from working with the SHRP 2 NDS data. It will benefit future researchers who work with similar type of data.

- **Keywords:** Traffic safety; SHRP 2; Naturalistic driving study; Rural two-lane highway; Horizontal curve

Yi G. Glaser, Feng Guo, Youjia Fang, Bing Deng, Jonathan Hankey. *Investigate moped-car conflicts in China using a naturalistic driving study approach*. Pages 171-175.

Mopeds are a popular transportation mode in Europe and Asia. Moped-related traffic accidents account for a large proportion of crash fatalities. To develop moped-related crash countermeasures, it is important to understand the characteristics of moped-related conflicts. Naturalistic driving study data were collected in Shanghai, China from 36 car drivers. The data included 2,878h and 78,296km driven from 13,149 trips. Moped-car conflicts were identified and examined from the passenger car driver's perspective using kinematic trigger algorithms and manual video reduction. A total of 119 moped-car conflicts were identified, including 74 high g-force conflicts and 45 low g-force events. These conflicts were classified into 22 on-road configurations where both similarities and differences were found as compared to Western Countries. The majority of the conflicts occurred on secondary main roads and branch roads. Hard braking was the primary response that the car drivers made to these conflicts rather than hard steering. The identified on-road vehicle-moped conflict configurations in Shanghai, China may be attributed to the complicated traffic environment and risky behavior of moped riders. The lower prevalence of hard steering in Shanghai as compared to the United States may be due to the lower speeds at event onsets or less available steering space, e.g., less available shoulder area on Chinese urban roads. The characteristics of moped-car conflicts may impact the design of active safety countermeasures on passenger cars. The pilot data from Shanghai urban areas suggest that countermeasures developed for China may require some modifications to those developed for the United States and European countries, although this recommendation may not be conclusive given the small sample

size of the study. Future studies with large samples may help better understand the characteristics of moped-car conflicts.

- **Keywords:** Moped; Driver response; Naturalistic driving study; Moped-car conflict; Conflict configuration

Jianqing Wu, Hao Xu. *Driver behavior analysis for right-turn drivers at signalized intersections using SHRP 2 naturalistic driving study data*. Pages 177-185.

Understanding driver behavior is important for traffic safety and operation, especially at intersections where different traffic movements conflict. While most driver-behavior studies are based on simulation, this paper documents the analysis of driver-behavior at signalized intersections with the SHRP 2 Naturalistic Driving Study (NDS) data. This study analyzes the different influencing factors on the operation (speed control) and observation of right-turn drivers. A total of 300 NDS trips at six signalized intersections were used, including the NDS time-series sensor data, the forward videos and driver face videos. Different factors of drivers, vehicles, roads and environments were studied for their influence on driver behavior. An influencing index function was developed and the index was calculated for each influencing factor to quantitatively describe its influencing level. The influencing index was applied to prioritize the factors, which facilitates development and selection of safety countermeasures to improve intersection safety. Drivers' speed control was analyzed under different conditions with consideration of the prioritized influencing factors. Vehicle type, traffic signal status, conflicting traffic, conflicting pedestrian and driver age group were identified as the five major influencing factors on driver observation. This research revealed that drivers have high acceleration and low observation frequency under Right-Turn-On-Red (RTOR), which constituted potential danger for other roadway users, especially for pedestrians. As speed has a direct influence on crash rates and severities, the revealed speed patterns of the different situations also benefit selection of safety countermeasures at signalized intersections.

- **Keywords:** Driver behavior; Naturalistic driving study; Signalized intersection

Raha Hamzeie, Peter T. Savolainen, Timothy J. Gates. *Driver speed selection and crash risk: Insights from the naturalistic driving study*. Pages 187-194.

This study investigates how speed limits affect driver speed selection, as well as the related crash risk, while controlling for various confounding factors such as traffic volumes and roadway geometry. Data from a naturalistic driving study are used to examine how driver speed selection varies among freeways with different posted speed limits, as well as how the likelihood of crash/near-crash events change with respect to mean speed and standard deviation. Regression models are estimated to assess three measures of interest: the average speed of vehicles during the time preceding crash/near-crash and baseline (i.e., normal) driving events; the variation in travel speeds leading up to each event as quantified by the standard deviation in speeds over this period; and the probability of a specific event resulting in a crash/near-crash based on speed selection and other factors. Speeds were relatively stable across levels-of-service A and B, within a range of 1.5mph on average. Speeds were marginally lower (3.3mph) on freeways posted at 65mph versus 70mph. In comparison, speeds were approximately 10.2 to 13.4mph lower on facilities posted at 55mph or 60mph. Speeds were shown to be 2.5mph lower in rainy weather and 11mph lower under snow or sleet. Significant correlation was observed with respect to speed selection behavior among the same individuals. Mean speeds are shown to increase with speed limits. However, these increases are less pronounced at higher speed limits. Drivers tend to reduce their travel speeds in presence of junctions and work zones, under adverse weather conditions, and particularly under heavy congestion. Crash risk increased with the standard deviation in

speed, as well as on vertical curves and ramp junctions, and among the youngest and oldest age groups of drivers.

Jingru Gao, Gary A. Davis. *Using naturalistic driving study data to investigate the impact of driver distraction on driver's brake reaction time in freeway rear-end events in car-following situation*. Pages 195-204.

The rear-end crash is one of the most common freeway crash types, and driver distraction is often cited as a leading cause of rear-end crashes. Previous research indicates that driver distraction could have negative effects on driving performance, but the specific association between driver distraction and crash risk is still not fully revealed. This study sought to understand the mechanism by which driver distraction, defined as secondary task distraction, could influence crash risk, as indicated by a driver's reaction time, in freeway car-following situations. A statistical analysis, exploring the causal model structure regarding drivers' distraction impacts on reaction times, was conducted. Distraction duration, distraction scenario, and secondary task type were chosen as distraction-related factors. Besides, exogenous factors including weather, visual obstruction, lighting condition, traffic density, and intersection presence and endogenous factors including driver age and gender were considered. There was an association between driver distraction and reaction time in the sample freeway rear-end events from SHRP 2 NDS database. Distraction duration, the distracted status when a leader braked, and secondary task type were related to reaction time, while all other factors showed no significant effect on reaction time. The analysis showed that driver distraction duration is the primary direct cause of the increase in reaction time, with other factors having indirect effects mediated by distraction duration. Longer distraction duration, the distracted status when a leader braked, and engaging in auditory-visual-manual secondary task tended to result in longer reaction times. Given drivers will be distracted occasionally, countermeasures which shorten distraction duration or avoid distraction presence while a leader vehicle brakes are worth considering. This study helps better understand the mechanism of freeway rear-end events in car-following situations, and provides a methodology that can be adopted to study the association between driver behavior and driving features.

- **Keywords:** Naturalistic Driving Study; Rear-end event; Driver distraction; Reaction time; Car-following

REGULAR ARTICLES

Ying Wang, Liming Liang, Leonard Evans. *Fatal crashes involving large numbers of vehicles and weather*. Pages 1-7.

Adverse weather has been recognized as a significant threat to traffic safety. However, relationships between fatal crashes involving large numbers of vehicles and weather are rarely studied according to the low occurrence of crashes involving large numbers of vehicles. By using all 1,513,792 fatal crashes in the Fatality Analysis Reporting System (FARS) data, 1975–2014, we successfully described these relationships. We found: (a) fatal crashes involving more than 35 vehicles are most likely to occur in snow or fog; (b) fatal crashes in rain are three times as likely to involve 10 or more vehicles as fatal crashes in good weather; (c) fatal crashes in snow [or fog] are 24 times [35 times] as likely to involve 10 or more vehicles as fatal crashes in good weather. If the example had used 20 vehicles, the risk ratios would be 6 for rain, 158 for snow, and 171 for fog. To reduce the risk of involvement in fatal crashes with large numbers of vehicles, drivers should slow down more than they currently do under adverse weather conditions. Driver deaths per fatal crash increase slowly with increasing numbers of involved vehicles when it is snowing or raining, but more steeply when clear or foggy. We conclude that in order

to reduce risk of involvement in crashes involving large numbers of vehicles, drivers must reduce speed in fog, and in snow or rain, reduce speed by even more than they already do.

- **Keywords:** Traffic crashes; Traffic fatalities; Traffic safety; Adverse weather; Data analysis

Albert P.C. Chan, Francis K.W. Wong, Carol K.H. Hon, Sainan Lyu, Arshad Ali Javed. *Investigating ethnic minorities' perceptions of safety climate in the construction industry*. Pages 9-19.

An increasing number of ethnic minorities (EMs) have been employed in the construction industry to alleviate severe labor shortages in many countries. Unfortunately, statistics show that EMs have higher fatal and non-fatal occupational injury rates than their local counterparts. However, EMs are often underrepresented in safety climate (SC) research as they are difficult to reach and gauge their perception. A positive relationship has been widely found between SC and safety performance. Understanding the safety perceptions of EMs helps to reduce injuries and improve their safety performance. Based on a sample of 320 EMs from 20 companies in the construction industry, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used to identify the SC factors of EMs, and validate the extracted factors, respectively. Multivariate analysis of variance was undertaken to examine mean differences in perceptions of SC by personal characteristics. Three SC factors for EMs encapsulating 16 variables were identified through EFA. The hypothesized CFA model for a three-factor structure derived from EFA showed a satisfactory goodness-of-fit, composite reliability, and construct validity. Three SC factors were identified, namely: (a) safety management commitment, safety resources, and safety communication; (b) employee's involvement and workmate's influence; and (c) perception of safety rules, procedures and risks. The perceptions of SC differed significantly by nationality, marital status, the number of family members supported, and drinking habit. This study reveals the perception of EMs toward SC. The findings highlight the areas for safety improvement and provide leading indicators for safety performance of EMs. The findings are also enlightening for countries with a number of EMs, such as the United Sates, the United Kingdom, Australia, Singapore, and the Middle East.

- **Keywords:** Safety climate; Ethnic minority; Exploratory factor analysis (EFA); Construction management; Confirmatory factor analysis (CFA)

Bing Wang, Chao Wu, Bo Shi, Lang Huang. *Evidence-based safety (EBS) management: A new approach to teaching the practice of safety management (SM)*. Pages 21-28.

Introduction: In safety management (SM), it is important to make an effective safety decision based on the reliable and sufficient safety-related information. However, many SM failures in organizations occur for a lack of the necessary safety-related information for safety decision-making. Since facts are the important basis and foundation for decision-making, more efforts to seek the best evidence relevant to a particular SM problem would lead to a more effective SM solution. Therefore, the new paradigm for decision-making named "evidence-based practice (EBP)" can hold important implications for SM, because it uses the current best evidence for effective decision-making. Methods: Based on a systematic review of existing SM approaches and an analysis of reasons why we need new SM approaches, we created a new SM approach called evidence-based safety (EBS) management by introducing evidence-based practice into SM. Results: It was necessary to create new SM approaches. A new SM approach called EBS was put forward, and the basic questions of EBS such as its definition and core were analyzed in detail. Moreover, the determinants of EBS included manager's attitudes towards EBS; evidence-based consciousness in SM; evidence sources; technical support; EBS human resources; organizational culture; and individual attributes. Conclusions: EBS is a new

and effective approach to teaching the practice of SM. Of course, further research on EBS should be carried out to make EBS a reality. Practical applications: Our work can provide a new and effective idea and method to teach the practice of SM. Specifically, EBS proposed in our study can help safety professionals make an effective safety decision based on a firm foundation of high-grade evidence.

- **Keywords:** Safety management (SM); Approach; Evidence; Evidence-based practice (EBP); Evidence-based safety (EBS) management

Allan F. Williams. *Graduated driver licensing (GDL) in the United States in 2016: A literature review and commentary*. Pages 29-41.

This is the sixth in a series of reviews of research on graduated driver licensing (GDL) published in the Journal of Safety Research, the present review covering the period mid-2012 through 2016. In the two decades since GDL programs began to be introduced on a widespread basis in the United States, a vast amount of research has been published. The current review discusses recent research and the present state of knowledge on the following topics: characteristics of the novice driver population; effects of GDL on crashes for ages 16–19; the learner and intermediate periods; night and passenger restrictions; cellphone laws; GDL for older novices; enforcement of GDL rules; and programs attempting to influence GDL compliance and safe driving practices in general. GDL stands out as a successful policy for reducing teen driver crashes and is worth building on to extend its benefits. Strengthening existing GDL programs has the most potential for producing further crash reductions.

- **Keywords**: Driver licensing; Novice drivers; Young drivers; Motor vehicle crashes; Graduated driver licensing

Michael A. Flynn, Brenna Keller, Sheli C. DeLaney. *Promotion of alternative-sized personal protective equipment*. Pages 43-46.

With more diversity in the workforce, companies are producing PPE such as hard hats, safety glasses, coveralls, foot protection, and safety harnesses for a larger range of body shapes and sizes. However, gray literature reports suggest that barriers exist to getting alternate sized PPE from the manufacturer to the workers who need it. The purpose of this study is to determine the extent to which alternative-sized PPE is marketed. A web-based review of seven major manufacturers of PPE was conducted to determine: (a) whether or not they offer alternative-sized products, (b) if these products are clearly labeled, and (c) if images used to display PPE are representative of a diverse workforce. Of the seven PPE manufacturers investigated, six had at least one product that was marketed as gender and/or size alternatives however, alternative sizes were more common for larger body types. Alternative-sized products rarely included size charts, and the models used to display PPE were overwhelmingly white males of average size. Despite the growing availability of alternative-sized PPE, it can be difficult to find these products, which suggests that they are rarely promoted or labeled as alternative-sized. Our study indicates that companies should expand their product lines and more aggressively market and promote these items. Guidance on how to properly fit their products would also be extremely helpful to the end-user. Manufacturers could improve the availability of alternative-sized PPE and increase their promotion of these products on their websites and in their catalogs. Individual companies and safety professionals may assist in this process by demonstrating demand for alternative-sized PPE.

- **Keywords:** Translation research; Workforce diversity; PPE; Occupational safety and health; Marketing

Jessica J. Davis, Elizabeth G. Conlon. *Identifying compensatory driving behavior among older adults using the situational avoidance questionnaire*. Pages 47-55.

Driving self-regulation is considered a means through which older drivers can compensate for perceived declines in driving skill or more general feelings of discomfort on the road. One form of driving self-regulation is situational avoidance, the purposeful avoidance of situations perceived as challenging or potentially hazardous. This study aimed to validate the Situational Avoidance Questionnaire (SAQ, Davis, Conlon, Ownsworth, & Morrissey, 2016) and identify the point on the scale at which drivers practicing compensatory avoidance behavior could be distinguished from those whose driving is unrestricted, or who are avoiding situations for other, non-compensatory reasons (e.g., time or convenience). Seventy-nine Australian drivers (Mage=71.48, SD=7.16, range: 55 to 86years) completed the SAQ and were classified as a compensatory-restricted or a non-restricted driver based on a semi-structured interview designed to assess the motivations underlying avoidance behavior reported on the SAQ. Using receiver-operator characteristic (ROC) analysis, the SAQ was found to have high diagnostic accuracy (sensitivity: 85%, specificity: 82%) in correctly classifying the driver groups. Group comparisons confirmed that compensatory-restricted drivers were self-regulating their driving behavior to reduce the perceived demands of the driving task. This group had, on average, slower hazard perception reaction times, and reported greater difficulty with driving, more discomfort when driving due to difficulty with hazard perception skills, and greater changes in cognition over the past five years. The SAQ is a psychometrically sound measure of situational avoidance for drivers in baby boomer and older adult generations. Use of validated measures of driving self-regulation that distinguish between compensatory and non-compensatory behavior, such as the SAQ, will advance our understanding of the driving self-regulation construct and its potential safety benefits for older road users.

- **Keywords:** Driving self-regulation; Older drivers; Situational avoidance; Hazard perception; ROC analysis

Eric R. Teoh, David G. Kidd. *Rage against the machine? Google's self-driving cars versus human drivers*. Pages 57-60.

Automated driving represents both challenges and opportunities in highway safety. Google has been developing self-driving cars and testing them under employee supervision on public roads since 2009. These vehicles have been involved in several crashes, and it is of interest how this testing program compares to human drivers in terms of safety. Google car crashes were coded by type and severity based on narratives released by Google. Crash rates per million vehicle miles traveled (VMT) were computed for crashes deemed severe enough to be reportable to police. These were compared with police-reported crash rates for human drivers. Crash types also were compared. Google cars had a much lower rate of police-reportable crashes per million VMT than human drivers in Mountain View, Calif., during 2009–2015 (2.19 vs 6.06), but the difference was not statistically significant. The most common type of collision involving Google cars was when they got rear-ended by another (human-driven) vehicle. Google cars shared responsibility for only one crash. These results suggest Google self-driving cars, while a test program, are safer than conventional human-driven passenger vehicles; however, currently there is insufficient information to fully examine the extent to which disengagements affected these results. Results suggest that highly-automated vehicles can perform more safely than human drivers in certain conditions, but will continue to be involved in crashes with conventionally-driven vehicles.

- **Keywords:** Autonomous vehicle; Self-driving; Driving automation; Motor vehicle crashes; Highway safety

Farzana Sathar, Mohamed Aqiel Dalvie, Hanna-Andrea Rother, Leslie London. *Demographic determinants of chemical safety information recall in workers and consumers in South Africa: A cross sectional study*. Pages 61-71.

Chemical hazard communication is intended to alert users of the potential hazards of chemicals. Hazard information needs to be understood and recalled. Recall of hazard communication is critical when the written form of the information is not available at the time it is required. A cross-sectional study investigating associations between recall of chemical safety information on labels amongst 402 participants including 315 workers and 87 consumers in two provinces of South Africa. Respondents were predominantly male (67.7%), the median age was 37 years (IQR: 30-46years) and less than half of the participants completed high school (47.5%). Multivariate analysis identified the following positive associations with the recall of all the label elements listing the strongest association: call appropriate services and industrial vs consumer sector (OR=2.4; 95% CI: 1.2; 4.6); call appropriate services and transport vs consumer sector (OR=4.4; 95% CI: 1.2; 16.0); flammable symbol and male vs female gender (OR=2.3; 95% CI: 1.0; 5.3); flammable symbol and home language English vs African languages (OR=6.6; 95% CI: 2.1; 21.2); any hazard statement and home language Afrikaans vs African languages (OR=14.0; 95% CI: 3.6; 54.2), any first aid statement and further education vs none (OR=3.3; 95% CI: 1.3; 8.0), correct chemical name and industry blue collar workers vs non-industry blue collar workers (OR=2.6; 95% CI: 1.1; 6.1), correct chemical name and non-industry white collar occupations vs non-industry blue collar workers (OR=2.7; 95% CI: 1.0; 7.1). The study found a number of potential positive associations which influence recall of label elements of which some (e.g., sector, gender, occupation) suggest further research. Relevant policies in South Africa should ensure that the safety information on chemical labels is clearly visible to read and understandable which aids recall and the reduction in harmful chemical exposures.

- **Keywords:** Comprehension; Recall; Hazard information; Demographics; GHS

David W. Eby, Lisa J. Molnar, Lidia P. Kostyniuk, Renée M. St. Louis, Nicole Zanier, James M. Lepkowski, Gwen Bergen. *Perceptions of alcohol-impaired driving and the blood alcohol concentration standard in the United States*. Pages 73-81.

Although the number of alcohol-impaired driving (AID) fatalities has declined over the past several years, AID continues to be a serious public health problem. The purpose of this effort was to gain a better understanding of the U.S. driving population's perceptions and thoughts about the impacts of lowering the blood alcohol concentration (BAC) driving standard below.08% on AID, health, and other outcomes. A questionnaire was administered to a nationally representative sample of licensed drivers in the U.S. (n=1011) who were of age 21 or older on driving habits, alcohol consumption habits, drinking and driving habits, attitudes about drinking and driving, experiences with and opinions of drinking and driving laws, opinions about strategies to reduce drinking and driving, general concerns about traffic safety issues, and demographics. One-third of participants supported lowering the legal BAC standard, and participants rated a BAC standard of .05% to be moderately acceptable on average. 63.9% indicated that lowering 30 the BAC to .05% would have no effect on their decisions to drink and drive. Nearly 60% of respondents lacked accurate knowledge of their state's BAC standard. Public support for lowering the BAC standard was moderate and was partially tied to beliefs about the impacts of a change in the BAC standard. The results suggest that an opportunity for better educating the driving population about existing AID policy and the implications for lowering the BAC level on traffic injury prevention. The study results are useful for state traffic safety professionals and policy makers to have a better understanding of the public's perceptions of and thoughts about BAC standards. There is

a clear need for more research into the effects of lowering the BAC standard on crashes, arrests, AID behavior, and alcohol-related behaviors.

- **Keywords:** Traffic safety; Public health; Drink driving

Darren Wishart, Klaire Somoray, Amanda Evenhuis. *Thrill and adventure seeking in risky driving at work: The moderating role of safety climate*. Pages 83-89.

Introduction Within many industrialized countries, the leading cause of worker fatalities and serious injuries can be attributed to road trauma. In non-occupational research, high levels of sensation seeking personality, and specifically thrill and adventure seeking, have been associated with risky driving behaviors. In work driving literature, high organizational safety climate has been associated with reduced risky driving in work drivers. However, the extent that factors such as safety climate and thrill seeking interact in regard to work driving safety remains unclear, and the current research examined this interaction. Methods A total of 1,011 work drivers from four organizations participated in the research. Surveys were distributed online and hardcopies were sent via mail. The survey included measures of thrill and adventure seeking, safety climate and work-related driving behaviors, as well as questions relating to participant demographics and information about their work driving. Results The results demonstrated that safety climate significantly moderated the effect of thrill and adventure seeking trait on driving errors, driving violations, and driving while fatigued. Conclusion These results suggest that the development of a strong safety climate has the potential to improve work driving safety outcomes by reducing the impact of particular personality traits such as thrill seeking within an organizational context. Practical application To improve work driving safety, organizations and management need to develop strategies to encourage and foster positive work driving safety climate, particularly within work settings that may attract thrill and adventure seeking employees.

- **Keywords:** Risky driving behaviors; Road safety; Occupational safety; Traffic psychology; Organizational behavior

Mohamed M. Naser, Adnan Zulkiple, Walid A. Al bargi, Nasradeen A. Khalifa, Basil David Daniel. *Modeling pedestrian gap crossing index under mixed traffic condition*. Pages 91-98.

There are a variety of challenges faced by pedestrians when they walk along and attempt to cross a road, as the most recorded accidents occur during this time. Pedestrians of all types, including both sexes with numerous aging groups, are always subjected to risk and are characterized as the most exposed road users. The increased demand for better traffic management strategies to reduce the risks at intersections, improve quality traffic management, traffic volume, and longer cycle time has further increased concerns over the past decade. This paper aims to develop a sustainable pedestrian gap crossing index model based on traffic flow density. It focusses on the gaps accepted by pedestrians and their decision for street crossing, where (Log-Gap) logarithm of accepted gaps was used to optimize the result of a model for gap crossing behavior. Through a review of extant literature, 15 influential variables were extracted for further empirical analysis. Subsequently, data from the observation at an uncontrolled mid-block in Jalan Ampang in Kuala Lumpur, Malaysia was gathered and Multiple Linear Regression (MLR) and Binary Logit Model (BLM) techniques were employed to analyze the results. From the results, different pedestrian behavioral characteristics were considered for a minimum gap size model, out of which only a few (four) variables could explain the pedestrian road crossing behavior while the remaining variables have an insignificant effect. Among the different variables, age, rolling gap, vehicle type, and crossing were the most influential variables. The study concludes that pedestrians' decision to cross the street depends on the pedestrian age, rolling gap, vehicle type, and size of traffic gap before crossing. The

inferences from these models will be useful to increase pedestrian safety and performance evaluation of uncontrolled midblock road crossings in developing countries.

- **Keywords:** Pedestrian; Road crossing; Acceptable gap; Mid-block; Modeling

Jonathan Downs, Ruth Shults, Bethany West. *Attitudes toward mandatory ignition interlocks for all offenders convicted of driving while intoxicated*. Pages 99-103.

Introduction: Ignition interlocks are effective in reducing alcohol-impaired driving recidivism for all offenders, including first-time offenders. Despite their effectiveness, interlock use among persons convicted of driving while intoxicated from alcohol (DWI) remains low. This cross-sectional survey of U.S. adults assessed public support for requiring ignition interlocks for all convicted DWI offenders including first-time offenders. The goal was to update results from a similar 2010 survey in light of new state requirements and increased interlock installations. Methods: Questions were included in the Porter Novelli FallStyles survey, which was fielded from September 28 to October 16, 2015. Participants were the 3,536 individuals who provided an opinion toward requiring ignition interlocks for all offenders. For analyses, opinion toward requiring interlocks for all offenders was dichotomized into 'agree' and 'neutral/disagree.' To handle missing data, 10 imputed datasets were created and pooled using fully conditional specification (FCS). Results: Fifty-nine percent of adults supported requiring interlocks for all DWI offenders. Multivariate analysis revealed that persons who did not report alcohol-impaired driving (AID) were 60% more likely to support requiring interlocks than those who reported AID. Having heard of interlocks also increased support. Support was generally consistent across demographic subgroups. Conclusions: Interlocks for all offenders have majority support nationwide in the current survey, consistent with previous reports. Support is lowest among those who have reported alcohol-impaired driving in the past 30days. These results suggest that communities with higher levels of alcohol-impaired driving may be more resistant to requiring ignition interlocks for all convicted DWI offenders. Future studies should examine this association further. Practical applications: These results indicate that the majority of adults recognize DWI as a problem and support requiring interlocks for all offenders.

Kelly Sarmiento, Robin Lee. *STEADI: CDC's approach to make older adult fall prevention part of every primary care practice*. Pages 105-109.

Primary care providers play a critical role in protecting older adult patients from one of the biggest threats to their health and independence—falls. A fall among an older adult patient cannot only be fatal or cause a devastating injury, but can also lead to problems that can effect a patient's overall quality of life. In response, the Centers for Disease Control and Prevention (CDC) developed the STEADI initiative to give health care providers the tools they need to help reduce their older adult patient's risk of a fall. CDC's STEADI resources have been distributed widely and include practical materials and tools for health care providers and their patients that are designed to be integrated into every primary care practice. As the population ages, the need for fall prevention efforts, such as CDC's STEADI, will become increasingly critical to safeguard the health of Americans. STEADI's electronic health records (EHRs), online trainings, assessment tools, and patient education materials are available at no-cost and can be downloaded online at www.cdc.gov/STEADI. Health care providers should look for opportunities to integrate STEADI materials into their practice, using a team-based approach, to help protect their older patients.

- **Keywords:** Aging; Fall; Injury; Prevention; Senior