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Vehicle ownership and other predictors of teenagers risky driving behavior: Evidence from a naturalistic driving study

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ABSTRACT

Objective: Risky driving behavior may contribute to the high crash risk among teenage drivers. The current naturalistic driving study assessed predictors for teenagers' kinematic risky driving (KRD) behavior and the interdependencies between them.

Method: The private vehicles of 81 novice teenage drivers were equipped with data acquisition system that recorded driving kinematics, miles driven, and video recordings of the driver, passengers and the driving environment. Psychosocial measures were collected using questionnaires administered at licensure. Poisson regression analyses and model selection were used to assess factors associated with teens' risky driving behavior and the interactions between them.

Results: Driving own vs shared vehicle, driving during the day vs at night, and driving alone vs with passengers were significantly associated with higher KRD rates (Incidence rate ratios (IRRs) of 1.60, 1.41, and 1.28, respectively). Teenagers reporting higher vs lower levels of parental trust had significantly lower KRD rates (IRR = 0.58). KRD rates were 88% higher among teenagers driving with a passenger in their own vehicle compared to teenagers driving with a passenger in a shared vehicle. Similarly, KRD rates during the day were 74% higher among teenagers driving their own vehicle compared to those driving a shared vehicle.

Conclusions: Novice teenagers' risky driving behavior varied according to driver attributes and contextual aspects of the driving environment. As such, examining teenagers' risky driving behavior should take into account multiple contributing factors and their interactions. The variability in risky driving according to the driving context can inform the development of targeted interventions to reduce the crash risk of novice teenage drivers.

1. Introduction

Teenage drivers are one of the most vulnerable groups of road users and are overrepresented in crash statistics (National Highway Traffic Safety Administration (NHTSA, 2016). In 2014, teenage drivers at the age of 15–20 years old, represented 6% of U.S. licensed drivers, yet accounted for 9% of total fatal crashes. Motor vehicle crashes are the leading cause of injury and death for teenagers in the U.S., with 170,000 injuries and 1717 deaths in 2014 (National Highway Traffic Safety Administration (NHTSA, 2016). Teenagers over-involvement in crashes has been attributed to an array of interconnected factors, including young licensure age, lack of driving experience, and high risk-taking propensity, among others (Mirman et al., 2012; Shope, 2006; Shope and Bingham, 2008; Simons-Morton et al., 2011a; Williams, 2003).

Elevated g-force events provide an objective measure of Kinematic Risky Driving (KRD) and serve as a common focus for interventions (Carney et al., 2010; Prato et al., 2010; Simons-Morton et al., 2012a, 2013). Previous research indicated that KRD rates are substantially higher among young drivers than older, experienced drivers, and that engaging in KRD is prospectively associated with increased crash risk among teen drivers (Simons-Morton et al., 2012b, 2015). Klauer et al. (2009) showed that high KRD rates were strongly correlated with high crash and near-crash (CNC) rates among high mileage drivers. Similar findings were obtained in an instrumented vehicle study conducted with teenage drivers, showing significant positive association between monthly KRD and the CNC rates of the following month (Simons-Morton et al., 2013). The association between KRD and CNC rates make the former an important measure of driving behavior and represent an intervention target to reduce teen crash events (Carney et al., 2010).

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Teenagers' kinematic risky driving behavior has been linked to multiple factors relating to either the driver or the driving environment (Simons-Morton et al., 2005; Falk et al., 2014), but research has identified only few consistent predictors. Although sensation-seeking temperament, risk-taking propensity, susceptibility to peer influence, and perception of risky driving (Prato et al., 2010; Simons-Morton et al., 2011a; Taubman-Ben-Ati et al., 2015; Mirman et al., 2012) have been theoretically linked to risky driving, prior studies have reported inconsistent associations. Parenting behaviors, such as monitoring and involvement in teenagers' pre- and post-licensure, have also been inconsistently associated with safer driving behavior (Mirman et al., 2012; Prato et al., 2010; Simons-Morton and Ouimet, 2006). Taubman-Ben-Ari et al. (2015) reported a positive association between higher risky driving reported by parents and their male teenage drivers. Similarly, perceived social norms favoring risky driving have been associated with teenagers' own risky driving (Simons-Morton et al., 2011a; Taubman-Ben-Ati et al., 2015; Shope, 2006). Simons-Morton et al. (2011a) reported that the perceived risky behavior of a teenage driver's closest friends was also s significant predictor of the teenage driver's own KRD rate. In a driving simulator study that assessed the effect of social norms on teenage driving, Simons-Morton and colleagues found greater risky driving among male teenagers driving with a risk-accepting peer versus teenagers driving with a risk-adverse peer (Simons-Morton et al., 2014).

Factors associated with the driving environment, such as weather conditions, passenger presence, and time-of-day may also contribute to teenagers' risky driving behavior. Driving with a teenage passenger is considered to be a factor uniquely associated with teen crash risk (Williams et al., 2007; Ouimet, et al., 2015; Tefft et al., 2012). Presumably, teenage passengers increase crash risk through social influence, either pressure to increase risk or social norms that favor more risky driving (Ouimet et al., 2015). In their review of driving restrictions at the provisional license stage, Lin and Fearn (2003) suggested that driving with a teen passenger significantly increased the likelihood of involvement in fatal crashes, and that the risk increased with the number of teenage passengers. In a recent systematic review, Ouimet et al. (2015) concluded that passenger presence increased the overall fatal crash risk of teenagers compared to driving alone. However, the relationship between teenage passenger presence and non-fatal crash outcomes could not be confirmed. Hence, the complex influence of teenage passenger presence on teenage driving behavior is still not fully understood. Finally, driving at night has also been found to be associated with significantly higher fatal crash risk compared to driving during the day among young drivers (Rajaratnam et al., 2015; Shope and Bingham, 2008; Williams, 2003). However, Simons-Morton et al. (2011a) found that KRD behavior among novice drivers was significantly lower at night than during the day.

Vehicle ownership may be a particularly important factor contributing to teenagers risky driving behavior and elevated crash risk. There is a growing body of research indicating that vehicle ownership is associated with teen driving exposure, risky driving behavior, and crash risk (Scott-Parker et al., 2015; Williams et al., 2006). Gershon et al. (2017) showed that teens with primary vehicle access had both higher miles driven, and greater number of trips compare to teens with shared vehicle access. García-España et al. (2009) reported that crash risk of teenagers driving their own vehicle was more than double than the crash risk of teenagers who had shared vehicle access. Gershon at al. (2017) found that teenagers with primary vehicle access were more likely to drive with teenage passengers, while teenagers with a shared access were more likely to drive with an adult in the vehicle. The combination of driving their own vehicle with teenage passenger may place teenage drivers at highly elevated crash risk.

The current study assesses naturalistic driving data to identify predictors for KRD and evaluate the variability in their associations according to the driving contexts. We focused on the interactions between vehicle ownership, passenger presence, day/night driving, and wet/dry road conditions and their associations with KRD rates.

2. Method

2.1. Participants

A total of 81 newly licensed teenaged drivers (53% females) participated in the study, average age 16.48 years old (SD = 0.33). Participants were recruited from a region of southwest Virginia, USA soon after obtaining a learner's permit and were followed for up to 12 months after earning a provisional driver's license. All participants had normal or corrected-to-normal vision, access to a reliable vehicle with a liability insurance, and had to be residing within a one-hour drive of the research center. Identical twins and teens diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) were excluded from the study. No other selection criteria were applied. All procedures followed an approved institutional protocol. Parental consent and teen assent were obtained.

2.2. Vehicle instrumentation

Participants' private vehicles were equipped with Data Acquisition System (DAS), which was developed at the Virginia Tech Transportation Institute (Dingus et al., 2006). The DAS included: (i) a computer to record vehicle kinematic data such as vehicle speed, and three-dimensional acceleration, (ii) Global Positioning System (GPS) to assess location and distance driven and (iii) video cameras to monitor the driver's face, hands, body positioning, and the dashboard. An additional camera was used to capture a snapshot of the vehicle interior once every 10 min. The images were used to assess vehicle occupancy. Data collection and coding were conducted on the trip level and followed a rigid, systematic protocol. Data were collected from 2011 to 2014.

2.3. Measures

2.3.1. Kinematic risky driving (KRD) measure

G-force events were classified as KRD based on the following thresholds: (i) longitudinal acceleration ($\geq$0.30 g), (ii) longitudinal deceleration ($\leq$-0.45 g), (iii) lateral negative (left) turn ($\leq$-0.50 g), (iv) lateral positive (right) turn ($\geq$0.50 g), and (v) yaw ($\pm$ 6° per second). The thresholds used to determine the events were based on previous studies (Simons-Morton et al., 2011b, 2012a). Rates were calculated as events per one thousand miles.

2.3.2. Demographic and environmental measures

In addition to gender and vehicle ownership, the following factors were documented for each driver in each trip: wet/dry road conditions, day/night driving, and passenger presence. The coding process of these factors was done by experienced coders who reviewed every video clip of each recorded trip. Coders identified the driver, passenger presence, number of passengers, and passenger attributes, such as gender and age. Day/night was determined by the recorded times of sunrise and sunset of the day the trip occurred.

2.3.3. Self-reported measures

A battery of questionnaires was administered at licensure, 6- and 12-months after licensure. This study considered only data collected at licensure, focusing on the following variables: driver's risk perception (e.g., "How much risk for crash or injury do you think newly licensed teens have if they drive late at night on the weekend?", scale ranging from 1-lowest risk to 5-highest risk); sensation-seeking behavior (e.g., "I like to do frightening things," scale ranging from 1-strongly disagree to 5-strongly agree); friends' risky driving, a sub-scale of Akers measure (e.g., "My friends think it is cool for us to drive all over the place at night on the weekend looking for parties?", scale ranging from 1-