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The Effect of Passengers and Risk-Taking Friends on Risky Driving and Crashes/Near Crashes Among Novice Teenagers

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Abstract

Purpose—The high crash rates of novice teenage drivers are thought to be due to inexperience and risky driving behavior, exacerbated by passengers, night, and other complex driving conditions. This research examined factors associated with crash/near crash and risky driving rates among novice teenagers, including night vs day, passenger presence and characteristics, and driver psychosocial factors.

Method—The vehicles of 42 newly-licensed teenage drivers were equipped with recording systems that collected data on driving performance and occupant characteristics during their first 18 months of licensure. Survey data were collected at four measurement times. Poisson regression with random effects was used to analyze crash/near crash and elevated g-force event rates (i.e., risky driving); incident rate ratios (IRRs) measured associations with covariates.

Results—Crash/near crash rates among novice teenagers were 75% lower in the presence of adult passengers and 96% higher among those with risky friends. Teenage risky driving was 67% lower with adult passengers, 18% lower with teenage passengers; 20% lower during early night than day; and 109% higher among teens with relatively more risky friends.

Conclusions—The low rate of risky driving in the presence of adult passengers suggests that teens can drive in less risky fashion. The higher rate of risky driving among those with risky friends suggests that risky driving may be socially influenced.

Introduction

The high crash rates of novice teenage drivers are thought to be due to early age at licensing, inexperience, and youthful risk taking, exacerbated by complex driving conditions.^{1–2} Both age at licensure inexperience appear to make independent contributions to the high rate of crashes among novice drivers.³ Newly licensed drivers of any age experience high rates of crashes that decline rapidly for a period of months and then more slowly for a period of

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years. However, the older the age at licensure the lower the initial crash rate and the faster the decline. Despite a decline over time among novices, crash rates remain elevated relative to experienced adults throughout the early years of driving, particularly among teenagers. 4

In addition to young age and inexperience, crash rates are also higher under certain driving conditions, such as passengers and driving at night.⁴ Speeding and other risky driving behavior are commonly associated with crashes among young drivers.⁴ Similarly, crash risk is higher in the presence of teenage passengers, particularly teenage male passengers, and lower in the presence of adult passengers.⁵ Through their actions or manner passengers can increase or decrease attention to the driving task and exert direct pressure to drive in a more or less risky or safe way.

Risky Driving and Associated Factors

Not all crashes are due to risky driving, but research suggests that risky driving increases crash risk, particularly speeding.¹⁻⁴ Notably, driving too fast for conditions is a common factor in crashes because, among other reasons, speed reduces the amount of time available to react to events and increases stopping distances. Therefore, elevated gravitational force (*g*-force) events caused by sudden acceleration or deceleration and hard turns are another important measure of risky driving.

The relationship of elevated *g*-force events to crash risk has been of particular interest since the advent of in-vehicle monitoring devices equipped with accelerometers. Elevated *g*-force events due to rapid acceleration and deceleration can reduce the amount of time available to respond to hazards and increase the potential for loss of vehicle control.⁶⁻⁸ Elevated *g*-force events are associated with crash risk⁸⁻¹⁰ and on average younger drivers have higher rates of elevated *g*-force events.⁸⁻⁹ Not surprisingly, fleet operators commonly install in-vehicle monitoring devices in trucks and record elevated *g*-force events in an effort to reduce this form of “risky driving” among truck drivers.¹¹ These monitoring devices are now marketed to the families of young drivers and several studies have reported declines in risky driving among young drivers after the installation of these devices with immediate feedback to the driver and stored feedback to the parents.¹²⁻¹⁴

Despite the growing interest in the prevention of risky driving among novice teenage drivers, there is limited information about the factors associated with teenage risky driving. Adolescents are thought to take more risks than adults in general and with respect to driving.¹⁵⁻¹⁶ As noted, risky driving is greater among teenagers in the presence of teenage passengers, particularly teenage male passengers.¹⁷ Other factors that have been associated with risky driving among teenagers include sensation seeking temperament,¹⁸ risk taking propensity,¹⁹⁻²¹ actual risk taking behavior,¹⁸⁻²²⁻²³ lax parental management,¹⁹⁻²⁴ and affiliation with risk-taking peers.²⁵ Adolescents may be particularly susceptible to peer influence, which can include overt pressure and subtle influence on social norms that encourage or discourage risk behavior where adolescents behave in ways they perceive to be acceptable and expected by their close friends and peer group.²⁴⁻²⁸

No single theory adequately explains the high crash rates among teenage drivers, but risk taking is an attractive hypothesis. The well-documented tendency of youth to engage in risk taking behavior can be attributed to inexperience, immaturity, poor judgment, and susceptibility to social influence.²⁶⁻²⁹ Like substance use and some forms of delinquent behavior, driving provides immediate thrills and uncertain consequences that may be particularly attractive to some adolescents. Indeed, like substance use it may be socially mediated to some extent.²⁷ If risky driving is due to social influence, it would be expected to be lower in the presence of adult passengers and higher in the presence of teenage passengers and among those with risky friends. If risky driving is due to perceptions that

risky driving is normative, they would be expected to be higher among those with risk taking friends. If risky driving is due to risk taking propensity, it would be expected to be higher among those who engage in other risky behavior, such as substance use, and those who score relatively higher on measures of sensation seeking.

Current Study

Most previous assessments of risky driving have been based on self reports^{20-24,25} and police reports.³⁰ In-vehicle monitoring methods are an advance in that they provide objective assessment of both miles driven and the *g* forces exerted by the vehicle as it maneuvers, allowing accurate calculation of rates.³¹ A recent instrumented vehicle study found that elevated *g*-force event rates were greatest among the youngest drivers studied, 18–20 year olds.⁹ Employing similar methodology, the Naturalistic Teenage Driving Study assessed driving performance during the first 18 months of licensure of 42 newly-licensed drivers and at least one of their parents.³² In previous analyses of these data it was reported that rates of crashes and near crashes (CNC) and elevated *g*-force events were 3–4 times higher for teenagers than parents (Simons- Morton et al., under review).³² Crash rates among teenage drivers declined over time, while elevated *g*-force rates did not.

The purpose of this analysis of data from the Naturalistic Teenage Driving Study is to examine factors associated with crashes and near crashes (CNC) and elevated *g*-force event rates among novice teenage drivers. The factors of interest are time of day, passenger presence and characteristics, and psychosocial characteristics of the driver. We hypothesize that CNC and risky driving rates will be lower with adult passengers and higher with teenage passengers and at night; and higher among sensation seekers, substance users, and those with risk-taking friends.

Method

Participants

Newly-licensed teenagers and their parents were recruited in Blacksburg and Roanoke, Virginia, where teenagers can obtain a provisional driver's license at the age of 16 years and three months that allows them to drive without supervision but with no more than 1 passenger for 6 months and not between midnight to 4 am. Identical twins and teenagers with Attention Deficit Disorder or Attention Deficit Hyperactivity Disorder were excluded from the study. In the teenage sample, there were 22 females and 20 males with a mean age of 16.4 years (*SD*=0.3). At least one parent of each participating teenager was also recruited and in some cases two parents participated, resulting in 21 male and 34 female parents whose driving in the instrumented vehicle was recorded and analyzed. The Virginia Tech University Human Subjects Review Board reviewed and approved the protocol. Parental consent and teenage assent were obtained.

Vehicle Instrumentation

Instrumentation was installed in the participants' vehicles within 3 weeks of provisional licensing and maintained for 18 months. The data acquisition system includes a computer storing kinematic (*g*-force) data collected by accelerometers, video recorders, and a GPS.⁹ To assess passenger presence, sex, and age group, two cameras took periodic blurred still shots (to protect passengers' anonymity) of the interior of the vehicle, including the lap area of the rear passenger seat. Other cameras continuously monitored the driver's face and torso, areas reachable by the driver's hands including the dashboard, and the forward and rearward roadway. Audio was not recorded. Research assistants physically swapped hard drives from computers installed in the trunk of participants' vehicles. The data collection lasted from June 2006 to September 2008.

Measures

Crashes and Near Crashes—Codiers reviewed each video footage of highly elevated g-force events (e.g., $\leq -0.65g$ longitudinal deceleration) to identify crashes and near crashes (for more details, see Lee et al., under revision). Crashes involved contact with an object, irrespective of the vehicle speed, and near crashes were events similar to a crash but without actual contact with an object.⁹ Given the rarity of crashes and the high costs of naturalistic studies limiting sample size, combining crashes and near crashes for analysis purposes were examined and evaluated as a valid option that increase possible analytic strategies.³¹

Risky Driving—The following elevated g-force events were assessed: longitudinal deceleration/hard braking ($\leq -0.45 g$); longitudinal acceleration/rapid starts ($\geq 0.35 g$), hard left ($\leq -0.50 g$) and hard right turns ($\geq 0.50 g$), and yaw (± 6 degrees within 3 seconds). Yaw is a measure of correction after a change in heading and is calculated as the difference in degree and velocity of an initial turn and the correction. For each measure the specific g force at which an event was counted was of sufficient force to make passengers uncomfortable, modest enough to be sensitive to skill improvements, and common enough to provide stable rates when aggregated over 3-month periods. The Cronbach's alpha for the five individual measures was 0.78 for teenage drivers and 0.65 for parent drivers. A composite variable combined all events above (or below) the five g-force event thresholds using Wahlberg's method.⁸

Vehicle Occupants and Night Driving—Codiers reviewed video data for each vehicle trip (defined as ignition on to ignition off) to identify the driver. Inter-observer reliability was greater than 0.80 (Fleiss Kappa) for passenger sex and relative age. Ambient natural lighting at the start of the trip was used to code day or night driving; late night runs from 10 pm to 6 am.

Sensation Seeking—The 40-item Sensation Seeking Scale Form V33 was administered at baseline. The questionnaire contains a total score and the following subscales: boredom susceptibility, thrill and adventure seeking, disinhibition, and experience seeking. For each item, participants have to choose between a lower and a higher sensation seeking statement (e.g., I am not interested in experience for its own sake vs. I like to have new and exciting experiences and sensations even if they are a little frightening, unconventional, or illegal). Each of the five scores were dichotomized according to the median split among all subjects.

Risk Behavior—A measure of self-reported risk behavior included four items adapted from previous studies of adolescent substance use.³⁴ The scale was composed of the following items: On how many occasions have you done the following things in the last 30 days: drank alcohol, been drunk, had five or more drinks/occasion, used marijuana? Responses were on a 7-point scale ranging from “never” to “40+ times”. The average of the four assessments was dichotomized according to the median split.

Risk-Taking Friends—Participants were asked seven questions about their friends' risky behavior: “How many of your friends would you estimate ... smoke cigarettes, drink alcohol, get drunk at least once a week, use marijuana, drive after having two or more drinks in the previous hour, exceed speed limits, and do not use safety belts (none, a few, some, most, all)”. The first three questions were adapted from a previous study.²⁴ The average of the four assessments was dichotomized according to the median split.

Statistical Analyses

Poisson regression models were used to analyze counts of CNC and elevated g-force events with the logarithm of the mileage driven as an offset (equivalent to adjusting for mileage as

exposure) and with a subject-specific random effect to account for over-dispersion and correlation. Poisson regression with random effects provided estimates of median incidence rates (IRs) of CNC (per 10,000 miles) and elevated g-force events (per 100 miles) for teenage drivers under specific passenger conditions. Incident rate ratios (IRRs) were used to measure the association of risky driving with covariates, including time of day (day, early night, or late night), passengers (none, adults, or teenagers without adults), and driver characteristics (sex and psychosocial variables). An IRR of 1.0 would indicate no difference, 0.5 would indicate 50% lower risk and 1.5 would indicate 50% greater risk for teenage drivers relative to their parents. In univariate analyses each covariate was examined separately in a model adjusted for time since licensure (measured in quarters) and significant covariates were then evaluated in a multivariate model that again adjusted for time since licensure.

Results

Miles Driven

Average mileage per month for teenage drivers was 366 miles, an average of over 6000 miles for the 18 month study period. Parents drove a mean of 3000 miles with a median of 1058 miles during the study period.

Teen-Parent Comparison of Crashes and Near Crashes

There were 37 crashes and 242 near crashes among teenage participants for the entire 18-month study period; parents were involved in 2 crashes and 32 near crashes. 32 Crashes among teenagers included four that resulted in police reports and one that resulted in injury for which hospitalization was not required.

Risky Driving

Video footages of a sample of elevated g-force events were reviewed to assess the percentages of valid events vs. those that can be attributed to potholes or other road conditions. Accordingly, 788 of the 816 (96.6%) hard stops, 1,012 of the 1,065 (95.0%) rapid starts, 576 of 576 (100.0%) hard left turns, and 704 of 709 (99.3%) hard right turns were determined to be valid. Of the valid events, 79.1% of hard stops, 95.8% of hard starts, 91.0% of hard left turn, and 79.1% of hard right turns were attributed to misjudgment. Based on these findings, all events were included in analyses.

Spearman rank order correlations between individual rates of risky driving and CNC rates for teenage participants were 0.75 for rapid starts, 0.76 for hard stops, 0.53 for hard left turns, 0.62 for hard right turns, 0.46 for yaw, resulting in a correlation between CNC and the composite measure of risky driving of 0.60.

CNC and Risky Driving Rates by Passengers, Night, Driver Sex and Psychosocial Factors

Shown in Table 1 are the properties of the psychosocial variables. With the exception of two sensation seeking subscales, all alpha values were ≥ 0.80 .

Separately for CNC and the composite measure of risky driving, univariate models were fit to assess the relationships with passenger presence, night driving, driver sex, sensation seeking, substance use, and risk-taking friends. For each dependent variable, each covariate was examined separately in a random effect Poisson regression model adjusted for time since licensure (in quarters). Further, the interaction between each covariate and time since licensure was also examined. The univariate findings are shown in Table 2. P values based on likelihood ratio tests indicate the significance of the IRR's for the overall study period (p1) and whether the quarterly IRR's are identical (p2).

The CNC rate among teenage drivers was lower in the presence of adult passenger (IRR=0.25) and higher among teenage drivers with more risk-taking friends (IRR=1.96), as shown in Table 2 and Figure 1a. CNC rates did not vary significantly by night, driver sex, or driver substance use.

For risky driving, the presence of adult and teenage passengers (IRR = 0.33 and 0.82, respectively) and driving at night and late at night (IRR = 0.80 and 0.94, respectively) were negatively associated with risky driving. Risky driving was significantly lower among both male and female teenage drivers in the presence of both male and female teenage passengers (data not shown). In contrast, having more risk-taking friends (IRR = 2.09) was associated with higher rates of risky driving, while driver substance use was not. The IRRs varied over time for all measures except adult passengers. Risky driving by passenger condition is illustrated in Figure 1b.

In multivariate analyses, shown in Table 3, CNC was significantly associated with adult passengers (IRR=0.26) and risk-taking friends (IRR=1.87), while risky driving was negatively associated with adult (IRR= 0.32) and teen (IRR= 0.81) passengers and early night (IRR=0.81) and positively associated with risk-taking friends (IRR=1.97). Under the assumption that passenger effects would be greater among teenage drivers with risky friends, we examined the interaction of risky friends on the relationships between teenage passengers and risky driving, but the interaction was not significant (data not shown).

Discussion

In previous analysis of data from the Naturalistic Teenage Driving Study we reported that CNC among novice teenage drivers declined over the first 18 months of licensure, but remained more than 3 times higher than parent rates.³² Elevated g-force event rates among teenage drivers did not decline over time and were more than 4 times higher than adult rates over the course of the study. ³² In the current paper we report that CNC and elevated g-force event rates among teenage drivers varied by passenger presence and driver psychosocial variables. Specifically, compared to the no passenger condition, CNC and risky driving rates were lower in the presence of adult passengers and risky driving rates were lower in the presence of teenage passengers and higher among teenagers with risky friends.

The lower rates of CNC (−79%) and risky driving (−68%) in the presence of adult passengers are consistent with other research⁵ and with the contention that teenage driving performance is due to attention and preferred style and not simply a matter of vehicle management skill. Adult passengers would be expected to co-drive and encourage teenage drivers to attend carefully to the driving task. Presumably, adult passengers would also influence the in-vehicle environment, reducing distraction and maintaining a relatively serious mood.

Surprisingly, CNC rates did not vary by teenage passenger presence and risky driving rates were lower (19%) in the presence of teenage passengers than with no passengers, contrary to data on fatal and observational data on risky driving behavior. ^{5,17} Apparently, the primary effect of teenage passengers was to discourage risky driving, consistent with the finding by Fleiter, Lennon, and Watson.³⁵ Teenage passengers might exert direct peer influence against risky driving (“Don’t take corners so fast!”), or indirect, possibly unintended, influence on driver perceptions that passengers or other peers do not favor risky driving.

We did not find the expected variability in CNC and risky driving according to self-report measures of substance use¹⁹ and risk propensity.^{18,21} Therefore, our data do not support the hypothesis that risky driving and CNC were due to teenage propensity for risk taking.

However, we expected and found risk-taking friends to be positively associated with risky driving, consistent with an effect of risky-accepting social norms on risk behavior. Both the perception and the actuality of having risk-taking friends would be expected to influence the drivers' perceptions about the acceptability of and social expectations with regard to risky driving behavior.^{25,36} It may be that most passengers reduce risk driving, but that some increase risky driving. However, we did not find that the relationship between teenage passenger presence and risky driving varied by the number of risky friends. Therefore, our data are most consistent with the contention that the primary effect of teenage friends on risky driving is on injunctive norms and not on direct pressure. Injunctive norms are formed by the perceived attitudes and expectations of teenagers' family and friends and have been shown to be associated with adolescent risk behavior.³⁶

Study Strengths and Limitations

The objective measurement of teenager and parent driving outcomes and an 18-month period of assessment are among the primary strengths of the study. The small size, however, prevented analysis of the risk of multiple passengers and combinations of risk factors and limits generalization of the findings. In general the crashes were minor, none resulting in serious injury, and the driving conditions may have been different in nature from those associated with fatal crashes.

Conclusion

Novices demonstrated their ability to drive in a less risky fashion at night and in the presence of passengers, particularly adult passengers. Therefore, risky driving and CNC rates in this sample do not appear to be due to passenger presence. However, the finding that those with risky friends were more likely to engage in risky driving and experience crashes and near crashes suggests that injunctive norms due to peer group affiliation may be important in teenage driving risk.

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Figure 1. Quarterly median incidence rates (IR) for crashes and near crashes (CNC) (a) and the composite risky driving measure (b) among teenage drivers with no passengers (solid line), teenage passengers (dashed line), and adult passengers (dotted line).

Table 1

Psychosocial measures: number of items, range, means, standard deviations, and scale alpha coefficients for teenage participants.

Psychosocial Measures	# of Items	Range	Mean (SD)	Cronbach's Alpha
Sensation Seeking Scale (Form V)				
Baseline				
Total	40	1–2 ^a	1.38 (0.17)	0.87
Boredom susceptibility	10	1–2	1.26 (0.20)	0.62
Disinhibition	10	1–2	1.25 (0.26)	0.84
Experience seeking	10	1–2	1.37 (0.22)	0.65
Thrill and adventure seeking	10	1–2	1.64 (0.29)	0.81
Teen substance Use Behavior				
Baseline	4	0–7 ^b	0.28 (0.61)	0.83
6 Month	4	0–7	0.47 (1.26)	0.93
12 Month	4	0–7	0.49 (1.00)	0.88
18 Month	4	0–7	0.60 (1.12)	0.92
Risky Friends				
Baseline	7	0–4 ^c	0.81 (0.54)	0.80
6 Month	7	0–4	1.10 (0.77)	0.90
12 Month	7	0–4	1.14 (0.75)	0.89
18 Month	7	0–4	1.29 (0.69)	0.86

Note.

^aThe Sensation Seeking Scale Form-V is a forced choice scale: the lower sensation seeking statement = 1, the higher = 2;

^bResponse options ranged from “Never” (0) to “40+ times” (7) in the last 30 days;

^cResponse options ranged from “None” (0) to “All” (4).

Table 2

Univariate analyses of covariate associations with CNC and the composite measure for teenage risky driving with estimates and tests of IRRs overall and quarterly.

Covariate	Overall	p1	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 5	Quarter 6	p2
<u>Crash/Near Crash</u>									
<u>Passengers</u>									
Adult vs. None	0.25	0.001	0.41	0.26	0.00	0.00	0.00	0.56	0.612
Teen vs. None	1.06	0.696	1.35	0.72	1.40	0.89	0.77	1.04	1.630
<u>Time of day</u>									
Early night vs. Day	0.92	0.597	1.08	1.22	0.90	1.08	0.79	0.42	0.473
Late night vs. Day	1.00	0.988	1.50	0.75	1.03	1.16	0.00	1.16	0.531
<u>Driver Sex</u>									
Male vs. Female	1.02	0.948	1.05	1.50	1.47	0.66	0.66	0.93	0.251
<u>Sensation seeking</u>									
High vs. Low	1.39	0.246	2.33	0.83	1.07	2.06	1.09	1.38	0.106
<u>Substance use</u>									
High vs. Low	0.76	0.337	0.96	0.40	0.58	1.50	0.70	0.85	0.038
<u>Risky friends</u>									
More vs. Fewer	1.96	0.013	2.18	1.26	1.74	3.61	1.56	2.21	0.284
<u>Risky Driving</u>									
<u>Passengers</u>									
Adult vs. None	0.33	0.000	0.36	0.41	0.28	0.29	0.26	0.37	0.134
Teen vs. None	0.82	0.000	1.06	0.76	0.67	0.89	0.74	0.83	0.000
<u>Time of day</u>									
Early night vs. Day	0.80	0.000	0.80	0.84	0.86	0.81	0.81	0.70	0.034
Late night vs. Day	0.94	0.045	0.74	0.77	1.03	1.03	1.09	1.01	0.000
<u>Driver Sex</u>									
Male vs. Female	1.20	0.550	0.94	1.45	1.48	1.20	1.12	1.10	0.000
<u>Sensation seeking</u>									
High vs. Low	1.02	0.962	1.22	0.80	0.91	1.03	1.17	1.05	0.000
<u>Substance use</u>									
High vs. Low	1.03	0.921	0.97	0.75	0.95	1.01	1.30	1.29	0.000

Covariate	Overall	p1	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 5	Quarter 6	p2
Risky friends									
More vs. Fewer	2.09	0.013	1.92	1.90	2.14	1.96	2.47	2.19	0.000

Note. Each covariate is examined separately in a random effect Poisson regression model that also adjusts for quarter. P1 is a p value based on a likelihood ratio test for whether the overall IRR equals 1. P2 is a p value based on a likelihood ratio test for whether the quarterly IRRs are identical.

Table 3

Multivariate analyses of covariate associations with CNC and the composite measure for teenage risky driving for the overall study period, with simultaneous adjustment for quarter, time of day, passengers, and risky friends.

Covariate	IRR [95% CI]	p
<u>Crash/Near Crash</u>		
Passengers		
Adult vs. None	0.26 [0.10–0.73]	0.010
Teen vs. None	1.01 [0.77–1.32]	0.944
Time of day		
Early night vs. Day	0.93 [0.69–1.26]	0.626
Late night vs. Day	0.98 [0.56–1.70]	0.946
Risky friends		
More vs. Fewer	1.87 [1.12–3.84]	0.017
<u>Risky Driving</u>		
Passengers		
Adult vs. None	0.32 [0.29–0.36]	0.000
Teen vs. None	0.81 [0.78–0.83]	0.000
Time of day		
Early night vs. Day	0.81 [0.78–0.84]	0.000
Late night vs. Day	0.95 [0.89–1.01]	0.075
Risky friends		
More vs. Fewer	1.97 [1.15–3.40]	0.014

Note: The p value is based on a Wald test for whether the corresponding IRR equals 1.